NATIONAL BUREAU OF STANDARDS REPORT

8131

EXPERIMENTAL FIRES IN ENCLOSURES
C.I.B. TEST RESULTS

by

D. Gross



U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS

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U. S. DEPARTMENT OF COMMERCE NATIONAL BUREAU OF STANDARDS



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Abstract

The results of a series of model fire experiments performed under an international cooperative program are reported.

1. Introduction

Following the original suggestion by the British Joint Fire Research Organization (J.F.R.O.) in 1959, for a systematic investigation of the growth of fires in rooms using small-scale models [1], a preliminary series of tests under the sponsorship of the Working Party on Fire Research of the Conseil International du Batiment (C.I.B.) was undertaken by eight laboratories in six countries including the U.S. National Bureau of Standards [2]. The results from that series of eight tests were analyzed by J.F.R.O., who concluded that too great a variation existed between laboratories to permit the start of a larger program without more detailed specification of experimental techniques. More specific test procedures were subsequently suggested in both report form [3] and through a series of letters.

Ten laboratories in eight countries are participating in the current program and this report is the summary record of tests performed at N.B.S.

2. Experimental Procedures

2.1 Test Schedule

The testing scheme outlined in reference [3] provides for examining the effect of six parameters on the rate of burning, temperature and radiation in a compartment containing a wooden crib and a single window opening. The parameters, with the number of combinations in parentheses, were: Shape (5), Scale Size (3), Window Opening (3), Fire Load, or Quantity of Fuel (3), Fuel Dispersion (3) and Fuel Dimension (4). In addition, one laboratory was to examine the effect of wind speed in three directions.

The tests assigned to each laboratory were divided into two series. Series I comprised eight tests each repeated so as to provide an estimate of experimental variation and to establish a common base between laboratories. The Series 2 program assigned to NBS was considerably larger than could reasonably be handled and was deferred.

2.2 Test Compartment

The compartment was constructed according to detailed drawings provided by a cooperating laboratory, Brandveiligheidsinstituut T.N.O., Holland. It consisted of an angle steel framework and asbestos-cement sheets held together with screws (see Figure 1). An asbestos-cement board partition was used for those tests requiring a compartment only one-half the overall length of 2 meters. The width and height were 2 meters and 1 meter, respectively. A removable window assembly was constructed as a single member rather than in two halves.

The prescribed properties of the asbestos sheets were as follows:

Thickness: 0.95 cm (3/8 in.)

Density:

1.5 g/cc

Thermal

Conductivity: 0.00085 cal/sec cm °C

Although an asbestos-cement board of these properties was obtained and used in the initial program in 1959, it was found to be no longer available on this continent. Therefore, and because of the severe fire exposure to which the compartment walls were to be subjected, it was considered necessary to purchase and use the currently available "Superbestos," rated by its manufacturer, Atlas Asbestos Co., Ltd., Montreal, to possess a higher degree of thermal stability during fire exposure. It had the following properties:

Thickness: 0.95 cm

Density: 0.67 g/cc

Thermal

Conductivity: 0.00029 cal/sec cm °C

Severe cracking was experienced nonetheless during the first preliminary test, so that a means of patching was required. The method which proved most satisfactory and was used several times during the program, involved a light spray application of a fire-resistant gypsum plaster with perlite aggregate (avg. applied density 0.43 g/cc, thermal conductivity .00028 cal/sec cm °C.) The same plaster was also applied by trowel to fill in large cracks.

Tests were conducted only after preheating and drying of the compartment to remove moisture absorbed by the asbestos-cement sheets and the plaster. This was done by burning a minimum of 40 kg of scrap wood at the start of each day's testing and, where possible, by consecutive testing. All tests were conducted in the prescribed sequence during the period October 18 to November 4, 1963.

After the first few tests, a noticeable distortion of the window opening was observed and which remained fairly constant throughout the series. Whereas the original design opening was 48 cm, the opening became barrel-shaped and varied from approximately 48.0 cm at the top and bottom to approximately 49.5 cm near the center.

2.3 Wood Cribs

The fuel consisted of wood sticks of nominally square section arranged in cribs with a lattice-type construction. The type of wood prescribed was spruce with a density of 0.39 g/ce ± 10 percent when oven dry. wood used was select grade Engelmann spruce (Picea engelmannii) which was smooth-sawed to size and preassembled into cribs using a thermosetting urea resin adhesive and a small quantity of nails. Details of the construction, composition and average density of each crib are given in Table 1. Cribs were conditioned to constant weight in an atmosphere controlled at 73 ± 2 F and 50 ± 5 percent rh. Prior to test, each crib was adjusted to its prescribed weight by the addition or removal of wood. The average moisture content of each crib at the time of test is also listed in Table 1. In each case, the crib weight comprised the spruce crib, the glue and the fiberboard wicks, but excluded the weight of nails and kerosene.

2.4 Weight Measurements

The tests were performed with one side of the compartment approximately 1.5 meters from the wall of a very large and essentially draft-free room. The compartment was suspended in a steel cradle so that its floor was approximately 1 meter above the building floor. The entire cradle and compartment was suspended and weighed by means of a commercial load cell of the strain gage type. In order to prevent load cell erros due to thermal effects, a cooling water jacket was placed around it. The temperature of the load cell case was monitored in all tests and never exceeded 46°C, the permissible temperature limit for complete conformance to specifications. The load cell output was adjusted to 0.0662 mv/kg (0.0300 mv/lb) and checked out perfectly before and after the test program using known weights. The millivolt output signal was digitally recorded at one minute intervals.

The compartment was levelled prior to each test and required slight relevelling (by means of sliding weights) during a few tests. No account was taken of the buoyancy effect, the magnitude of which might possibly be 4 kg for the scale 1, shape 221 compartment with 160 kg lead.

It was found in a typical test that the weight of the compartment and crib would decrease to a minimum value, corresponding to approximately 1 to 10 kg negative, and regain approximately 5 kg upon cooling to room temperature. The weight of ashes was usually between 0.2 and 0.7 kg.

2.5 Temperature Measurements

Thermocouples for indicating "ceiling" and "floor" temperatures were of 0.0508 cm (0.020 in.) diameter (B & S 24 gauge) chromel and alumel wires with asbestos and glass, silicone impregnated insulation. The beads were bare and unshielded. The thermocouples were inserted through a small hole in the top of the compartment and new thermocouples were used for each test. Temperatures were recorded directly and automatically in digital form at one minute intervals.

2.6 Radiation Measurements

Window (opening) radiation was monitored by Radiometer "H/14" for all tests and the calibration provided by J.F.R.O. (and checked at NBS) was used for conversion of millivolt output readings to intensity values in cal/sec cm². This radiometer was mounted on an outrigger frame attached to the compartment and at a distance of 2 meters from the compartment face for all tests. Except for the first test (NBS No.1, C.I.B. No. 1), all succeeding tests were conducted using a sheet metal screen immediately in front of the radiometer so as to minimize the contribution of radiation from flames above the window opening [4].

Flame radiation was monitored by a similar radiometer placed centrally 10 cm above the top of the compartment and in the plane of the opening. It was fabricated at NBS according to the published description [5], and its cone was blackened to reduce reflections [4]. Radiometer "R 1" was used for all tests with the exception of Test Nos. 7, 15 and 16 (NBS chronological designation), where Radiometer "R 2" was used.

Calibration curves for the three radiometers used are shown in Figure 2.

2.7 Data Recording

Data were automatically recorded in digital form by means of a scanning and recording system [6] programmed to provide a complete set of readings at one minute intervals. Since the measuring potentiometer contained two balancing slidewires, it was possible to obtain both direct temperature readings (with the use of chromel-alumel thermocouples) in the range 0 to 1400°C (±4°C accuracy) and millivolt readings in the range 0 to 14.00 mv (±0.04 mv accuracy). For those cases in which the output from the flame radiometer exceeded 14 mv, a 10 mv bucking signal was used to extend the range of the potentiometer to 24 mv.

For the scanning sequence used, the actual measuring times for each one minute cycle were as follows:

Quantity	Chammel	Time	
		min:sec	
Enclosure Weight, mv	0	0:00(and eand minute	ach succeeding
Window Radiation, mv	31	0:08	TT
Flame Radiation, mv	32	0:09	ĵī
deiling Temperature, °	C 33	0:10	ŤĪ
Floor Temperature, °C	34	0:11	31

In the listing and analysis of data, however, it was assumed that all readings were made at the time corresponding to the weight reading.

3. Results

The results of the sixteen tests performed in the prescribed sequence are listed in the standard form at the end of this report. Statistical averages were computed as requested for the time periods corresponding to 80 and 55 percent of the initial weight (80/55) and to 55 and 30 percent of the initial weight (55/30). The radiation and temperature averages were based upon the appropriate measured values at one-minute intervals, with no attempt at curve-fitting or interpolation. However, the rate of weight loss averages were based upon the interpolated 30, 55 and 80 percent times from a smooth curve drawn through the one-minute readings. Table 2 presents a summary list of all average values for the test series.

4. Observations

The following additional observations were visually noted during the test series:

The entire crib was not involved in flaming simultaneously, but rather burning proceeded from the front third, where the kerosene-soaked wicks were ignited, toward the rear. After burning had involved the front face of the crib, the increasingly taller flames were bent backwards by the inrush of air.

The normal pattern of air inflow at and near the floor level, then up and around at the rear of the compartment, and the exhaust of hot gases and flames at the ceiling level was then always obvious. However, for those tests with only 1/4 window opening, strong fire whirls were observed in the front corners of the compartment near the start of the test. These flaming vortices, which rose directly toward the ceiling and were drawn out of the window opening, lasted only until the burning had increased sufficiently to establish the normal pattern.

It was observed that with the 1/4 window opening the exiting flames and gases filled a larger portion (up to two-thirds) of the window opening than with the full open window (up to one-third). In addition, the flames extended to a greater height outside the compartment (up to 3 meters) in those tests with the 1/4 window opening.

During the major portion of those tests with the full window opening, a definite pattern of flame pulsations with accompanying "swoosh" sounds was noticed. These pulsations occurred with a frequency of approximately one per second. In both instances of a test with a 1/4 window opening (C.I.B. 3), a single rapid burst or mild explosion followed by momentarily increased flaming was observed.

The crib retained its lattice structure until almost the entire weight loss had occurred and then gradually crumbled, this again proceeding from front to rear as the charcoal glowing took place. The weight of the remaining ashes never amounted to more than one percent of the initial crib weight.

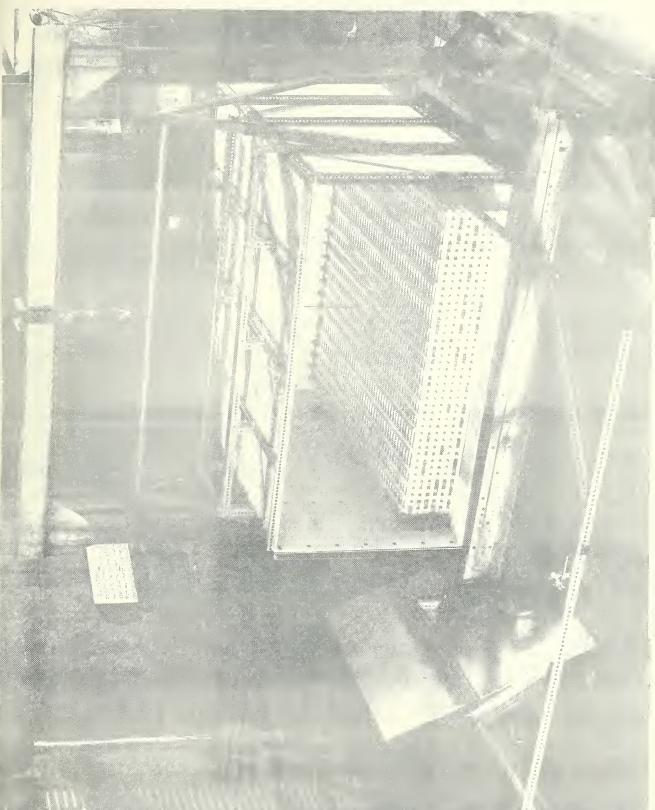
Dark, dense smoke was common to all tests, and for those tests with 80 and 160 kg cribs, the entire building of over 3000 m³ became completely smoke-logged with visibility at eye level reduced to as little as 25 cm.

5. Acknowledgments

I am pleased to acknowledge the aid of John Klein and James Turner in the assembly of the cribs and of David Newman in the efficient performance of the tests and in the summary of the data. Edward Bender, Garnett Robinson and Melvin Womble assembled the compartment and attended to its repair and maintenance throughout.

6. References

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- [2] Gross, D., Ward, D. and Shoub, H. "Fires in Model Rooms, Results of Preliminary Experiments Under an International Cooperative Program," NBS Technical Report No. 6888, July 1960.
- [3] Thomas, P. H., and Mather, J. "Proposals for Next Stage of C.I.B. Programme on Fires in Compartments," C.I.B./C.T.F. No. 61/49 (U.K.), September 1961.
- [4] Letter from P. H. Thomas, dated April 2, 1962.
- [5] McGuire, J. H. and Wraight, H. "A Radiometer for Field Use," J. Sci. Inst. 37, p. 128, April 1960.
- [6] Gross, D., Bailey, W. H., Bender, E. W. and Robertson, A. F. "Central Furnace Control and Recording Facility," NBS Technical Report No. 7015, November 1960.



ig. 1 U.I.D. Test Compartment

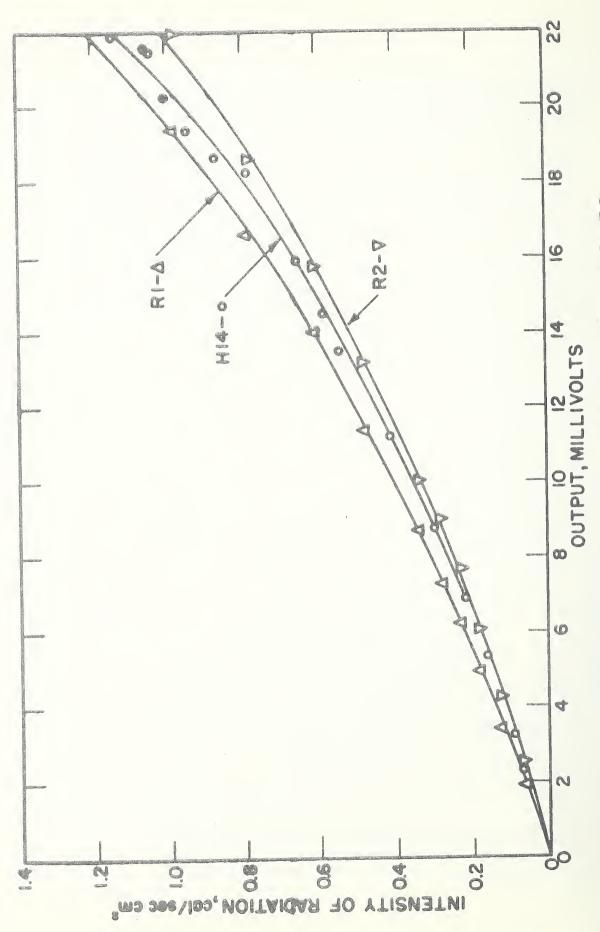


FIG.2-RADIOMETER CALIBRATION CURVES

Table 1. Properties of Test Cribs

	NBS CIB No. No. Designati	IB o. Designat	Designat	signat	ion	Crib No.	Stick Height	Size Width	Packing Density	Weight	Weight Glue	Test Weight	Mean D As Condi	ensity Dry Basis	Moisture Content Dry Basis
.09 0.91 0.73 0.58 79.3 .416 - .95 1.05 0.22 0.83 79.8 .421 .391 7.8 .09 0.91 0.53 1.64 160.0 .395 .366 7.3 .00 1.00 0.38 1.67 160.0 .409 .377 8.1 .09 0.91 0.18 1.16 80.0 .402 .369 8.1 .09 0.91 0.12 0.36 40.0 .408 .385 6.0 .13 0.88 0.11 40.0 .407 .367 8.3 .13 0.88 0.14 40.0 .408 .374 8.3 .13 0.88 0.14 160.0 .408 .374 8.3 .10 0.00 0.87 1.44 160.0 .436 .422 10. .10 0.00 0.03 40.0 .437 .378 9. .10			$_{\mathbb{C}\mathbb{M}}$	$\mathbb{G}\mathbb{H}$	CM	CM	()	CM		Кg			g/cm3		9/
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glue, but excludes nails Uniformity within a single crib varied from ±2% to ±10%. Length = 83 cm or 167 cm nominal. Total weight after conditioning includes fiberboard wicks and dry or kerosene. . ਹ

Based on drying at 105°C of a portion of a stick removed from individual crib just prior to test. ċ

Table 2. Summary Sleet

Floor	55/30	104.8	1009	1031	1023	985	952	974	958	980	866	54.2	402	984	366	646	066
Mean F Tempera	80/55	906	895	1016	1055	872	857	64.7	927	959	646	639	737	980	94.3	981	1006
D T	55/30	1090	1028	1078	1093	966	952	1056	1027	1002	1028	500	556	$10^{4.9}$	1027	934	196
Ceiling Temperatu	80/55	919	902	1027	1074	570	857	·496	936	226	959	598	099	982	946	696	166
Flame tion sec cm ²	55/30	Sign of the sign o	.216	.482	·417	,624.	.438	.672	.684	.291	.370	, 04·1	.05h	.405	.359	.225	,318
G - E	80/55	CER	,250	.694	.628	.729	. 562	. 808	. 805	.554	.618	.080	.102	.778	.738	407	. 534.
Window ation ec cm ²	55/30	.161	.156	, 169	.176	. 14.3	. 14.1	.164	.163	.317	.378	.146	.181	.291	.359	.308	.312
an Wadia 1/se	80/55	, 181	, 164.	.140	, 173	, 14.8	9.17.0	.154	.151	904,	0.474.	. 174	.194	,396	.421	.360	,374
Los Los	55/30	2.87	2.93	2.22	2.22	2.44	2,44	2,56	2.50	00 ہے۔	y. 00	1,47	96° T	3,20	4,12	2.53	2.67
Rate Kg/	80/55	3,54	3,56	3.45	3.45	3.31	3.31	3.23	3,28	90.9	5.26	2,33	2,56	4.88	5.88	3.64	3.70
Time	t80	6.1	0.0	5.4	5.0	14.5	13.7	8.4	°,	6.2	10 10	7.1	<i>√</i> ∞	8,9	00.	8.7	8.1
Designation		221-20-1/4	221-20-1/4	211-20-1/4	211-20-1/4	221-40-1/4	221 - 40 - 1/4	$211^{-h}0^{-1/h}$	211-40-1/4	221-20-1	221-20-1	211-20-1	211-20-1	221-40-1	221-40-1	211-40-1	211-4.0-1
CIB No.		-1	\vdash	\approx	\sim	7	7	9	9	2	7	0	0	0	0	\times	\bowtie
NBS No.		\vdash	10	9	14.	\sim	16	70	13	N	12	∞	12	ή.		7	0.
Date 1763		10-18	10-21	10-31	11-1	10-24	10-25	10-29	10-30	10-22	10-23	11 - 1	11-4	10-28	10-29	11-1	

D. C.		20 kg/m ²	l spacing 2 cm. side
U. S. National Bureau of Standards, Washington, D. G.	1 (NBS 1)	Amount of Fuel ::	Dispersion of Fuel: 1 spacing Dimension of Fuel: 2 cm. side
U. S. National Bureau o	C.I.B. Test Designation 1 (NBS 1)	Shape: 221	Scale: I meter Window Opening: 1/4

				Z X	William Opening: 1/4	Chemin	18:5	t -		UID	Dimension of Fuel : 2 cm. Side	IO II	ruer	7	CE: S	0)					
EXFERIMENTAL RESULTS	E																				
Time, min	0	0 2 4 6	7	9	00	10	12	14	8 10 12 14 16 18 20 22 24 26 28	00	20	22	24	26	28	30	32	34	36	38	4
Weight, kg	79.3	79.3 76.3 71.6 64.5	71.6		57.5	50.7	43.6	37.7	57.5 50.7 43.6 37.7 31.7 26.1 20.6 15:9 11.2 7.3 3.4	26.1	20.6	15:0	11.2	7.3		∞.					
Temp. Ceiling, °C 42 422 733 821	42	422	733		882	976	1036	1097	946 1036 1097 1098 1118 1150 1164 1141 1108 1097 1047	1118	1150	1164	1141	1108	1097	1047					
Temp. Floor, °C	30		292 653	808	875	939	1006	1056	1006 1056 1069 1051 1069 1023 995 1006 1012 1003	1051	1069	1023	966	1006	1012	1003					
Vindow Radiation, cal/sec cm ²	000°	.015	.015 .085155	.155	.185	.190	.185	.175	.185 .190 .185 .175 .160 .135 .150 .125 .145 .115	.135	.150	.125	.145	5	.110	001.					
Flame Radiation, cal/sec cm	• 002	.005 .030 .250 .570 .61 >.61 >.61 >.61 >.61 .550 .440 .330 .205 .155	.250	.570	7 19 %	. 61	. 61	2 61	> 61 >	», 61	.550	. 440	.330	. 205	155	.085					

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9		
74		
72		
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49		
62		
09		
80		
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54		
52		
20		
48		
95		
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4.2		
) ° C
Time, min	Weight, kg	Temp. Ceiling,

Window Rediation, cal/sec cm2
Flame Radiation, cal/sec cm2

Temp. Floor, °C

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ζ.)
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5	4

Rate Wt. Loss kg	Time to 80% orig. wt.min	800	pod O
Loss KB Ceiling Temp.°C Floor Temp.°C Window Rad. Call Flame 855/30 0 ₂ 80/55 0 ₂ 55/30 1.80/55 1.85/30 1.80/55 1.85/30 1.80/55 1.81 .161 -		I _£ 55/30	
Loss Kg Ceiling Temp.°C Floor Temp.°C Window Ra R55/30 0e 80/55 0e,55/30 0e,80/55 0e,55/30 10,80/55 0e		I \$80/55	ş
Loss_kB Ceiling Temp.°C Floor Temp.°C Window R55/30 0e,80/55 0e,55/30 0e,80/55 0e,55/30 1,80/55 2.87 919 1090 906 1048 .181	ad. cal	I.,55/30	.161
Loss kg min Ceiling Temp.°C Floor Temp R55/30 6280/55 625/30 6680/55 665 2.87 919 1090 906 1	Window Ra	I,80/55	.181
Loss kg Ceiling Temp.°C F R55/30 6280/55 6255/30 65 2.87 919 1090 9	Temp.°C	05/55/30	1048
Loss kg R55/30 C	Floor	680/55	906
Loss kg R55/30 C	Temp.°C	0e 55/30	1090
	Ceiling	0g 80/55	616
	Loss kg	R55/30	2.87
	Rate Wt.	R80/55	3.54

INTERNATIONAL EXPERIMENTS ON FIRES IN SIMPLE COMPARTMENTS Report Form U. S. National Bureau of Standards, Washington, D. C.

C.I.B. Test Designation 7 (NBS 2)

					policy policy program	Window.	Shape: Scale: Opening:	e: 221 e: 1 ng: 1	neter		Amount Disper	Amount of Fuel Dispersion of Dimension of B	Amount of Fuel Dispersion of Fuel Dimension of Fuel	ruel	20 kg/m l spacin 2 cm. si	0 kg/m ² spacing cm. side					n gan to an armind religionism	
EXPERIMENTAL RESULTS	L RESUL1	TS I					4															
Time, min		0	8	4	9	00	10	2	14	9	00 =1	20	22 2	24 2	26 28	30	32	34	36	38	70	
Weight, kg		79.8	79.8 78.9 74.3 63.8 52.1	74.3	63.8		41.3	32.4	25.3 1	19.8	14.8 10	10.2 6	6.8 3.	3.9 1	1.34							
Temp. Ceiling,	ng, °C	35	170	170 620 903	903	986	1034]	1005 1	1001	668	856 8	820 6	699 651		537 499							
Temp. Floor,	, °C	32		919	88 616 897 957		1014	983	176	878	854 8	829 7	755 697	7 . 631	1 566							
Window Radiation, cal/sec cm ²	ation,	000	.000 .010 .080 .340 .440	080	.340	0440	.395	.330	.270	210	180 .1	155 .1	135 .110	0.100	00 .085						- •	
Flame Radiation, cal/sec cm	tion,	000.	.000 .005 .055 .430 .605	.055	.430	• 605	.625	.250	.180	.100	0.080.	.055	.040 .025	.5 .010	.0 .010						90 mm - 1166m	
on promotive de constitution d																						
Time, min			42	44	959	84	20	52	54	5.6	80 (2)	09	62 6	9 49	66 68	70	72	74	16	78	.08	80%
Weight, kg																					400 t gp	
Temp. Ceiling,	ng, °C										•	. •									P. F. dr. on gree pa	
Temp. Floor,	٥, د											•									supports All	
Window Rediation, cal/sec cm ²	ation,																					
Flame Radiation, cal/sec cm ²	tion,																				eren gang gratig g	
STATISTICS													1				1				n man distrib	
Rate Wt. Loss kg	Loss min		Ceil	ling	Ceiling Temp. C	D O	Floor		Temp. C	Z Z	Window Rad	ြို့ဆို	cal 2	[S4	Flame Rad	-:-	cm ^Z		Time orige.	to 80%		
R80/55	R55/30		988	0/55	0° 80/22 0° 25/30		880/55	55 0 _b	e _b 55/30	Ios	I ₈ 80/55	I°	I.55/30		I _F 80/55		(£55/30		7	t,80		
90.9	4.00		977		1002	epineterin	959		086	904.	90	6.	317		554	.291	1		9	.2	··· ···	
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U. S. National Bureau of Standards, Washington, D. C.

C.I.B. Test Designation 4 (NBS 3)

40 kg/m	1 spacing	2 cm. side
Amount of Fuel :	Dispersion of Fuel:	Dimension of Fuel:
Shape: 221	Scale: 1 meter	ndow Opening: 1/4

EXPERIMENTAL RESULTS

Window Radiation, .005 .005 .010 .020 .065 .095 .120 .130 .135 .140 .150 .155 .155 .155 .155 .155 .150 .140 .140 .130 cal/sec cm² Flame Radiation, .000 .000 .030 .050 .200 .385 .500 .615 .690 .710 .755 .765 .730 .745 .770 .735 .685 .620 .600 .575 .520 cal/sec cm² 25 54 327 511 717 753 773 808 824 854 879 893 891 926 926 944 960 959 978 1032 1059 21 26 59 118 299 600 760 814 829 858 884 892 889 923 922 937 953 952 973 1023 1045 $160.0_{159.1}^{0}_{159.1}^{2}_{156.5}, \frac{4}{154.3}^{1}_{149.7}^{1}_{143.6}^{13}_{136.5}^{136.5}_{130.1}^{123.4}_{116.5}^{169.5}_{116.5}^{109.4}_{103.0}^{20}_{103.0}^{22}_{96.4}^{24}_{90.5}, \frac{28}{84.478.5}^{28}_{73.4}^{33}_{68.3}^{34}_{68.3}^{35}_{58.7}^{38.5}_{58.7}^{48}_{54.5}^{49}$ Temp. Ceiling, °C 25 54 327 511 717 753 773 808 824 854 879 893 891 926 Temp. Floor, °C Weight, kg Time, min

$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2 907	1 827	. 070	0 030
4.	95	87	.08	.04
76	966	902	100	.045
24	1021	922	.105	.080
72	1034	146	.110	.100
70.5	1001	978	.115	.110
68 12.5	1077	1018	,115	.135
66	1082	1033	.115	.150
64	1.084	1015	.110	.175
62 19.4	1076	1.081	.110	.170
60	1068	1046	.105	.135
58 24.1	1079	1067	.110	.180
56 27.1	1076	1019	.115	.190
54	1088	1015	.115	.245
52	1103	1001	.115	.235
50	1106	(007	.115	. 255
48	1087	018	120	.355
46	109	048	120	385
44	.081	.052	125	425
42 49:7	1079 1	1055 1	.125	.480
Time, min Weight, kg	Temp. Ceiling, °C	Temp. Floor, °C	Window Radiation, cal/sec cm ²	Flame Radiation, cal/sec cm ²
Tir	Ter	Ter	Wir	FI

STATISTICS

Time to 80% orlg. wt.min	£80	14.5
les cmZ	f80/55 I _f 55/30	.624
Flame Rad	I _£ 80/55	.729
id. sec cm2	I ₀ 55/30	.143
Window Rad.	I.80/55	.148
Floor Temp.°C	08/55 0p 55/30	985
Floor	980/55	872
Ceiling Temp.°C	05/55 055/30	995
Ceiling	θg 80/55	870
Rate Wt. Loss kg	R55/30	2.44
Rate Wt.	R80/55	3.31

			Repor	rt Form				
ů.	ŝ	National	Bureau of	Standard	S	Washington,	Ö.	ပဲ
C.H	I.B.	Test Desi	ignation	O (NBS	(4)			

Shape: 221 Amount of Fuel : 40 kg/m² Scale: 1 meter Dispersion of Fuel: 1 spacing Window Opening: 1 Dimension of Fuel: 2 cm. side

EXPERIMENTAL RESULTS

29.5		803	938	.140	.035
300	32.4	884	904	0 .210 .190 .160 .140	.045
36.2		937	934	.190	.075
34	39.8	984	964	.210	.105
44.0		1008	976	.230	.770 .865 .745 .610 .515 .480 .405 .355 .375 .205 .125 .105
30	48.9	1054	986	.250	. 205
54.2	! :	1062	963	.255	.375
26	T.09	1057	987	. 285	.355
66,3		1068	966	.295	.405
22	73.4	1052	166	o ic.	087°
20,5		1029	989	.330	.515
00 pod	88.4	1023	1003	.350	.610
0 0 0 0 0		1005	1005	.380	.745
14	105.6	992	993	.405	.865
112	1	941	676	.405	.770
10	126.8	927	928	.390	.560 .910
ω α α		880	882	.330	.560
9	49.1	814	477	.200	.005 .005 .030 .260
η 4 α		351	41	.040	.030
~ ~	.59.1	53	26	.010	000
0 0		22	22	.005 .010 .040 .200 .330 .390 .405 .405 .380 .350 .330 .310 .295 .285 .255 .250 .230	.005
		ပ္		ion,	• HO
pri	හු	Temp. Ceiling, °C	Temp. Floor, °C	Window Radiation, cal/sec cm ²	Flame Radiation, cal/sec cm
Time, min	Weight, kg	Se.	· FI	ow Re	e Rac
Time	Weig	Temp	Temp	Wind cal	Flam.

74 76 78 80		•			
74					
72	0.	315	349	.030	.000
89	1.4	359	406	.040	000°
				.045	
499	2.9	435	474	.050	005
624		437	516	090	. 010 .
09	5.9	486	.695	.070	.010
582	1	539	623	.080	.015 .010
9	0.	99	54	06	020
1542	' '	586	899	.095	.020
52	13.4	959	688	.110	5 .030
1508)))	645	735	.115	.035
48	18.2	699	749	.120	.030
2006		919	797	.140 .130 .120 .120	.050 .030 .030 .030
44	23.6	721	998	.130	.030
42	26.5	844	901 866 797 749 735 688 668 6	.140	.050
Time, min	Weight, kg	Temp. Ceiling, °C	Temp. Floor, °C	Window Radiation, cal/sec cm ²	Flame Radiation, cal/sec cm ²

	Time to 80% orig. wt.min	£80	9.8
1	l. cal	I _E 55/30	405
	Flame Rad	I _£ 80/55	.778
1	d sec cm	I.55/30	.291
	Window Rad	I,80/55	.396
	Temp.°C	980/55 9,55/30	984
	Floor	980/55	980
	Ceiling Temp.°C	0e 80/55 0e 55/30	1049
		0 ⁶ 80/55	982
•	Rate Wt. Loss kg	R80/55 R55/30	3.20
STATISTICS	Rate Wt.	R80/55	4.88

INTERNATIONAL EXPERIMENTS ON FIRES IN SIMPLE COMPARTMENTS Report Form U. S. National Bureau of Standards, Washington, D. G.

C.I.B. Test Designation 6 (NBS 5)

					à	The same of the sa	Chelland and the same				The state of	-									
					Wi	Window	Shape: Scale: Opening:	244	211 1 meter 1/4	\$	Amou Disp Dime	Amount of Fu Dispersion o	Fue	Fuel:	40 kg 1 spa 2 cm.	40 kg/m ² spacing cm. side	o.				
EXPERIMENTAL RESULTS	AL RESUL	S)																			
Time, min		0	8	4	9	∞	10	12	14	16	18	20	22	24 2	26 2	28 3(30 32	34	38	6.3 60	7
Weight, kg		80.0	80.0 78.9 77.0.72.0	77.0		65.2	58.5	51.9	45.9 4	40.03	35.0 2	29.8 2	25.1 20	20.6 16	16.8 12	12.9 9.	9.7 6.	7 3.	9 1.2	6.	
Temp. Ceiling, °C	ing, °C	58	58 169 768	768	826	885	945	985	998 1	1029 1	1065 1(1067 10	1087 10	1097 1103	03 10	1089 1092	92 1068	8 1050	0 1013		
Temp. Floor,	z, °C	2.5	07	225	828	889	951	975	954	955	975	979	988	986 1001		988 1001	01 979	9 971	. 956	936	
Window Radiation, cal/sec cm2			.005 .010 .030 .080	.030		.120	.150	.160	.170	.170	.165	160	.155 .1	.150 .140		.140 .130	30 .115	5 .120	0 .115	.100	
Flame Radiation, cal/sec cm2	ation,	0000	.000 .005 .060 .415	090.		. 685	. 835	.840 .820		. 770	. 069.	. 610	260 .	.560 .490 .430	30 .375	75 -310	10 .245		.230 .185	.150	
Time, min			42	42 44	95	48	50	52	54	56	500	09	62 (9 49	9 99	68 .70	0 72	74	76	73	8
Weight, kg																					
Temp. Ceiling,	ing, °C																				
Temp. Floor,	, e			,																	
Window Rediation, cal/sec cm ²	iation, n2												•								
Flame Radiation, cal/sec cm ²	ation, n2																				
STATISTICS													C ,								
Rate Wt.	Wt. Loss kg	1	Ceil	ing I	Ceiling Temp.°C		Floor		Temp.°C	- F	Window Ra	Rad. sec	cal cal	Acquire Co.	Flame R	Rad	cal sec cm2	4770Ppp	Time	Time to 80%	%:
R80/55	R55/30		0e 80	0e 80/55 0	06/55/30		0880/55	55 0 b	0°/22/30	T°8	°80/55	lee!	I,55/30		I _f 80/55	no target	I_55/30		0.4.4.0	2 000	
3.23	2.56	e-adequae	796	Numerica (negotie	1056		947	0	974	9	154	pm.	.164		808	9	.672			8.4	
Assessment of sufficient and suffici	The second second					3						75		24		24		2			

U. S. National Bureau of Standards, Washington, D. C.

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I_£55/30

I_£80/55

I,55/30

I°80/22

680/55 655/30

0 80/55 0 55/30

R55/30

R80/55

Report Form	U. S. National Bureau of Standards, Washington, D. C.	(NBS 7)	Amount of Fuel : 40 kg/m^2 Dispersion of Fuel: 1 spacing		
Repor	U. S. National Bureau of	C.I.B. Test Designation Y	Shape: 211 Scale: 1 meter	Window Opening: 1	
					EAREKIMEN TAL KESULIS

Time, min	Weight, kg	Temp. Ce	Temp. Floor, °C	Window Radia	Flame Radiation, cal/sec cm	ا ساخسند	Time, min	Weight, kg	Temp. Ce	Temp. Floor, °C	Window Radiation, cal/sec cm ²	Tomo Do
end.	59	Temp. Ceiling, °C	or, °C	Window Radiation, cal/sec cm ²	itation,			80	Temp. Ceiling, °C	or, °C	adiation,	Flame Radiarion
0	80.0	22	20	.03	. 005	,		(
2	7.67	37	25	.010	.005		42	2.9	359	383	.070	010
0 2 4 6	80.0 79.7 77.9 73.8	22 37 191 715	20 25 65	.035.010 .020 .100	.005 .005 .010 .080		42 44 46	2.0	359 322 .325	363	.070 .065 .060	010
9	73.8	715	331	.100	.080		959	2.0 1.0	.325	358	090.	010 010 020
60	9.99	957	696	.315	.470		84	0	273	324	.050	
10	58.4	987	266	.380	.525		20					
12	51.0	950	978	.365	.370		52		•			
12 14 16	8.44	362	978	.345	.285		54					
	38.9	666	981	.345	.280		26					
00	33.4	977	977	.315	.255		20					
20	28.6 24.2	895	931	.290	.170		09					
22		751	863	-230	.085		62					
24	20.7 17.9	724	849	.210	.075		99					
26		625	829	.170	.050 .040		99					
28	15.0 12.4	260	841	.155	040		9					
30	2.4 1	463	827	.130	.030		70			,		
32	11.1	044	827	.115	.020		72					
34	°°	429	682	.105	.020		74					1-) 1
36	7.1	387	299	060°	.015		92					
38	5.3	349	195	.085	010		78				•	
40	9.	356	418	.075	.010		80					

y	Time to 80%	£80	GC)
٠.	sec cm2	I _£ 55/30	.225
	Flame Rad	I_80/55	
	Rad sec cm2	I.55/30	.308
	Window Ra	Ie80/55	.360
	Temp. C	80/55 0 55/30	676
	Floor	880/55	981
	Ceiling Temp. °C	0655/30	934
	Celling	0 80/55 0 55	696
	Rate Wt. Loss min	R55/30	2.53
STATISTICS	Rate Wt.	R80/55	3.64

Report Form

National Bureau of Standards, Washington, D. C.

9 (NBS 8) Test Designation C.I.B.

				1					- Constant		0									
						Shap	Shape: 211	good		Amo	Amount of Fuel	f Fue		••	20 kg/m	~				
				M	7000	Scale:	3 6	Scale: I meter	14	Dis	Dispersion of Fuel:	on of	Fuel		spacing	00 TO 000				
EXPERIMENTAL RESULTS	S)	0			1	1	1	t 3 1	-		, ' 3				
Time, min	0	2	4	9	00	10	12	10 12 14 16 18	16	60	20	22	22 24	26	28	30	32	34	36	හ ග
Weight, kg	40.0	39.2	38.1	34.4	29.9	24.9	20.8	77.00	14.9	40.0 39.2 38.1 34.4 29.9 24.9 20.8 17.8 14.9 12.2 9.9 8.1 6.0 4.6 3.6 2.4 1.6 .7	9.	500.	6.0	9.4	3.6	2.4	9		.1 2	2
Temp. Ceiling, °C	27	16	27 76 259 451	451	169	691 594 519	519	529 491 455	491	455	456	429	400	397	364	346	327	289	273	249
Temp. Floor, °C	26	115	26 115 266	501 719	719	979	555		552 596 482	482	532	398	406 398		328	321	292	262	248	. 237
Window Radiation, cal/sec cm2	000°	.010	.035	.080	.195	.190	.165	:150	.130	.000 .010 .035 .080 .195 .190 .165 .150 .130 .120 .110 .100 .080 .075	110	100	.080	.075	.070 .065	. 065	090.	.050	040	040
Flame Radiation, cal/sec cm	000	000°	000°	.030	-115	.085	.055	040	.030	.000 .000 .005 .030 .115 .085 .055 .040 .030 .030 .030 .025 .020 .015 .010 .010 .010 .010 .005	.030	.025	.020	.015	010	010	010	.010	000	.005

040

Temp. Ceiling,

Temp. Floor, °C

Window Redigtion, cal/sec cm²

Flame Radiation, cal/sec cm2

	Time to 80 orig. wt.ml	£80	7.1	
	sec cm2	f80/55 If55/30	170°	
	Flame Rad	I _f 80/55	080	
	d. sec cm2	I ₅ 55/30	.146	
	Window Rad	I.80/55	.174	
	Floor Temp.°C	980/55 955/30	542	
	Floor	980/55	639	
	Temp.°C	θ _e 55/30	500	
	Ceiling Temp	0e 80/55 0e 5.	598	
	Rate Wt. Loss kg.	R55/30	1.47	
STATISTICS	Rate Wt.	R80/55	2.33	

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				- M	أعطاهم	Shape: Scale:	9 9 6	211 1 meter	Et al.	Am	ount	of Fu	Amount of Fuel Dispersion of Fuel:		40 kg/m ² I spacing	2 8 0					
EXPERIMENTAL RESULTS	TS			Ē	8000	Tip do		-}		1	nens1	o uc	Ulmension of Fuel :		2 cm. side	ide					
Time, min	0	7	4	9	co	8 10 12 14 16	12	77	16	8	20	22	24	26	18 20 22 24 26 28 30	0	32	34	36	00	70
Weight, kg	80.0	80.0 79.6 77.0 72.0 64.0 55.7 48.3 41.9 35.9 30.5 25.4 21.8 18.2 15.2 12.7 10.8	77.0	72.0	0.49	55.7	48.3	41.9	35.9	30.5	25.4	21.8	18.2	15.2	12.7	0.8	5.00	7.0	5.0	4.7	2 5
Temp. Ceiling, °C	26	26 42 447 918 973 1003 1006 1014 1018	447	918	973	1003	1006	1014	1018	931 938	938	727	695	584	558	507	677	410	401	00	335
Temp. Floor, °C	23	23 28 59 895 984 1024 1023 1008 1031	59	895	984	1024	1023	1008	1031	991 946	946	861	818	669	699 630 559				413	380	351
Window Radiation, cal/sec cm ²	000°	.000 .010 .035 .245 .350 .390 .380 .360 .340 .310 .260 .215 .190 .165 .140 .120 .110	.035	.245	.350	.390	.380	.360	.340	.310	.260	.215	.190	.165	140	120	110	. 095			.070
Flame Radiation, cal/sec cm	0000	.000 .000 .050 .490 .585 .570 .495 .475 .465 .270 .145 .090 .090	.050	064.	585	.570	.495	.475	.465	.270	.145	060.	060.	.050	.050 .030 .020 .010 .010 .005	020	010	010	0005		0000
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54		211	211	.030	• 002
52	•5	220	221	.030	-5003-
50	್ಥ	235	242	.040	- 5002-
400	•	255	255	.040	-002-
99	1.7	267	289	.045	- 9002-
45 44	2.8 2.4 1.7	286	301	060 .050 .045	005005005005005005
42	2.8	311	324	090°	000
					*
Time, min	Weight, kg	Temp. Ceiling, °C	Temp. Floor, °C	Window Radiation, cal/sec cm2	Flame Radiation, cal/sec cm2

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Time to 80%	E L	08	00	
	I 55/30	4-4	000	}
Flame Rad	I.80/55	1.9	534	
Cal	1,55/30	Control of the Contro	2 2 2	
Window Rad	I.80/55		374	200
Temp.°C	9,55/30	2	066	
Floor	8,80/55 8,5		1006	
Ceiling Temp. C	80/55 0 55/30		196	
Ceiling	68 80/55		166	Constitution of the control of the c
Loss Kg	R55/30		2.67	And the second name of the secon
31 7 1	R80/55		3.70	Annual Control of the

Weport Form
U. S. National Bureau of Standards, Washington, D. C.

C.I.B. Test Designation 1 (NBS 10)

EXPERIMENTAL RESULTS

Time, min 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 Weight, kg Weight, kg Roll 78.1 75.9 70.2 63.4 56.6 49.3 42.7 36.3 30.6 25.1 20.1 15.7 12.0 8.8 6.1 4.1 2.4 1.1 .23 Temp. Ceilling, °C 42 314 495 764 842 874 921 967 1011 1036 1105 1117 1098 1052 1001 910 817 736 697 Temp. Floor, °C 20 189 396 741 838 873 917 937 994 1024 1077 1088 1082 1094 1021 945 913 833 728 633 551 Window Radiation, 000 010 030 105 140 160 175 175 170 150 130 125 120 110 105 100 005 005 005 005 005 005 00	040	.3	269	551	070	.030
	3	.2	736	633	.045	.030-
	36	1.1	817	728	.055	-020-
	34	2.4	910	833	.075	-000-
	32	4.1	1001	913	.095	.025
	30	6.1	1052	945	.100	.055
	28	∞ ∞	1098	1021	.105	.130
	26	12.0	1117	1094	.110	.230
	24	15.7	1105	1082	.120	.370
	22	20.1	1112	1088	.125	.465
	20	25.1	1106	1077	.130	.135
	100	30.6	1036	1024	.150	.215
	16	36.3	1011	766	.170	.245
	14	42.7	196	937	.175	.275
	12	49.3	921	917	.175	.285
	10	56.6	874	873	.160	.250
	60	63.4	842	838	.140	.145
	9	.70.2	764	741	.105	.385
	4	75.9	495	396	.030	.050
	2	78.1	314	189	.010	.010
	0	80.0	42	20	000.	000

Weight, kg

Time, min

Temp. Ceiling,

Temp. Floor, °C

Window Rediation, cal/sec cm²

Flame Radiation, cal/sec cm²

STATISTICS

Time to 80% orig. wt.min	£80	8.0
les cal	I _f 55/30	.216
Flame Rad	I _f 80/55	.250
sd. cal	I.55/30	.156
Window Rad	I°80/55	.164
Floor Temp.°C	80/55 0 _b 55/30	1009
Floor	980/55	895
Ceiling Temp.°C	0°22/30	1028
Ceiling	980/55 985	905
Rate Wt. Loss kg	R55/30	2.93
Rate Wt.	R80/55	3.56

W. S. National Bureau of Standards, Washington, D.

C.I.B. Test Designation 0 (NBS 11)

EXPERIMENTAL RESULTS	ខ្មា			E B	o wopu	Shape: 221 Scale: 1 meter Window Opening: 1	221	meter		Amou Disp Dime	Amount of Fuel : 40 kg/m ² Dispersion of Fuel: 1 spacing Dimension of Fuel: 2 cm. side	Fuel n of F	Fuel	7 2 2	kg/u	6 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8		•			
Time, min	160°0 2 153°8 6 132°7 1 107°1 14 16 18 20 22 24 26 40°4 30 332 34 36 38 140	2	53.8	6 13	832.7	10 10	12	14 8	16	138	20	22 5	77	7 92	238	30	32	34	36	38	07%
Weight, kg	1	58.2	*-1	44.3	11	8.6	9/	6.5	7	5.1	5	8.6	7	6.5	en .	5.9	2	7.6		6.03	1
Temp. Ceiling, °C 25 135 579 773 851 914 941 969 999	25	135	579	773	851	914	941	696	666		010 1	035 1	065 1	.061 1	045 1	018	995	932	843	793	9IL
Temp. Floor, °C	21	23	54	23 54 684 851	851	911 940 962	940	962	995	1	- 1009 999 991 972 972 952 952 947 935 925 829	666	166	972	972	952	952	. 276	935	925	829
Window Radiation, .000 .010 .090 .240 .340 .405 .425 .435 .425 cal/sec cm ²	0000	010°	.090	.240	.340	. 405	425	435	425	1	360 .340 .325 .285 .280 .245 .235 .225 .200 .170 .160	340	325	285	280	245 .	235 .	225	200	170	160
Flame Radiation, cal/sec cm2	000	•002	.140	.325	. 665	.780	885	. 740	565	1	345	280	220	. 095	. 075	025 .	015	-000	010-	010-	.010
cal/sec cm2	000	5000	•140	325	500	08/	885	740	5 65	1	345	280	220	. 095		075	075 .025 .	075 .025 .015 .	075 .025 .015 .000	015 .025 .015 .000010	ridme nadiation, .000 .005 .140 .325 .665 ./80 .885 ./40 .565345 .280 .220 .095 .075 .025 .015 .000010010 .010010

Time, min	42	45 44	95	48	48 50	52 54	54	56 58		60 62	62	49	99 99	70 72 74 76 78	72	74	92	80
Weight, kg	15.5	12.5	15.5 12.5 16.2		5.7	4.3	2.6	7.8 5.7 4.3 2.6 1.1 .0	0.									
Temp. Ceiling, °C	629	679 637	614	568	8 530 4	491	475	470 444	44									
Femp. Floor, °C	818	797	787	77	744	113	705	638 527	27				٠					
Vindow Radiation, cal/sec cm2	.150	150 .140 .135		.120	110	560	. 085	.120 .110 .095 .085 .075.070	020		٠							
lame Radiation, cal/sec cm ²	010.	010-	01001001001001001001001	-010-	.010-	.010-	.010-	.015	015		101			3				

	Time to 80%	80	8
	d. cal	I _f 55/30	.359
	Flame Rad	I _f 80/55	.738
	Rad. cal	I.55/30	.359
	Window R	I.80/55	.421
	Floor Temp.°C	05/55/30	995
	Floor	980/55 955	943
	Ceiling Temp.°C	0e 80/55 0e 55/30	1027
	Ceiling	0e 80/55	946
	- I	R55/30	4.12
TATISTICS	Rate Wt.	R80/55	5.88

INTERNATIONAL EXPERIMENTS ON FIRES IN SIMPLE COMPARTMENTS Report Form U. S. National Bureau of Standards, Washington, D. C.

Test Designation 9 (NBS 12)

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•	ing side		0	9	237	300	.055	.00.	0							0	1.55/3		C.
	20 kg/m spacing cm. sid		00	ń	010	324	.060	-005	00					•		e Rad	80/55	2000	District Control
	p=1 CV		50	♂	00 (%)	32	500	010.	9		-	٠				E alle	CO	ia)	6
	Muel Muel		4	() ()	m m	900	000	010	4				•		c	· (N	2000	20100 12	
	ion of Mel		0	4.3	342	9	.085	0.00	8							0	1 5 5 C		C
3	Amount of Dispersion Dimension		000	5	370	337	060	0.00	9							20	rener	ndian-o	rited
STATE OF THE STATE	AHO		CO post	5	403	613	0	050	17)							Window	1 80/55		100
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- 1	2		M	60	573	60	© &	0.00	50								757	200000	3738
രാ	Shap Scale		0	~ ~	608	707	e. 0	.070	9							00	Q		8
C. F. B.	Window		60	26.1	53	(D) (D) (D)	.200	0.00	4	,						Ç	C		576
	3		Ø	E.	594	700	090 .140	.075	4							Femo.	a d	1000	0
			7	40.0 38.3 36.1 31.5 26.	367	50		.000 .005 .015 .075 .095	44			•				Co.		000000000000000000000000000000000000000	tore
			N	ന ത	364	203	.005 .025	200.	24							ច	0	9	
		(A)	9	0.04	9	28	.005	000								ha	e4 6		
		RESULTS			9	Ç	0	60			e e	0	11 0 0 2 0	1160 E 0 E 0		S.S.C.	nim	2 10 2	1
		EXPERIMENTAL	Time, min	Weight, Ka	Temp. Ceiling,	Temp. Floor,	Window Radiation, cal/sec cm2	Flame Radiagion, cal/sec cm	Time, min	Weight, kg	Temp. Ceiling,	Temp. Floor,	Window Rediation, cal/sec cm2	Flame Radiation, cal/sec cm ²		Rate Wr. 1.088 Kg	44 000	rout 32	

INTERNATIONAL EXPERIMENTS ON FIRES IN SIMPLE COMPARTMENTS Report Form U. S. National Bureau of Standards, Washington, D. C.

C.I.B. Test Designation 6 (NBS 13)

EXPERIMENTAL RESULTS Time, min O 2 4 6 8 10 12 14 16 18 18 18 18 18 18 18 18 18			38 4(939	842	.085	.050
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .			36	5,1	989	846	.100	060.
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .			34	4.3	1016	847	.110	.140
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .			32	6.7	1047	869	.120	.200
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	m/mg lng	מים	30	10.0	1 0.61	952	.130	.275
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	spaci	•	28	13.0	1058	1005	.145	.350
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	, H. c	•	26	17.0	1049	1012	.150	.425
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	Fuel	3	24	21.2	1057	666	.155	.475
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	on of	1	22	25.3	1039	972	.160	.730
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	punt o	1	20	30.3	1048	943	.165	.615
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	Dis	i i	00	35.1	1036	954	.165	.700
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	! -		9 [40.7	1967	946	,165	.810
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	met met		14	46.8	968	959	.165	.840
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	e: 2]	5	12	52.8	935	932	.155	.845
TS 0 2 4 6 80.0 79.2 76.7 72.4 6 47 114 760 845 22 25 76 837 .000 .005 .020 .075 .	Shar Scal	4	10	59.3	913	606	.140	.745
TS 0 2 4 6 80.0 79.2 76.7 72.4 47 114 760 845 22 25 76 837 .000 .005 .020 .075	Mopu		00	0.99	881	879	.110	.575
	13:		9			837		
			4	76.7	160	76	.020	.065
			2	79.2	114	25	- 002	0000
		21	0	80.0	47	22	000.	000
		EXPERIMENTAL RESUL	Time, min	Weight, kg	Temp. Ceiling, °C	Temp. Floor, °C	Window Radiation, cal/sec cm ²	

Weight, kg
Temp. Ceiling, °C
Temp. Floor, °C
Window Rediation,
cal/sec cm²
Flame Radiation,
cal/sec cm²

74 76

9 9

Time, min

STATISTICS

Time to 80%	Orig. Wt.min	T	0	80 . 6	
d. cal		I ₅ 55/30	4	. 684	
Flame Rad		I _f 80/55		.805	
d call		I.55/30		.163	
Window Rad		I.80/55		.151	
Temp.°C		0° 25/30		958	
Floor		980/55 955/		927	
Temp.°C	0 1 2 2 0	Ue >>/30		1027	the state of the s
Ceiling	11/000	9500/22 B655/		936	The state of the s
Loss kg	00/1990	05/50		2.50	
Rate Wt.	DOO/65	CC /004		3.28	

1 spacing 2 cm. side 20 kg/m2 Washington, Dispersion of Fuel: Amount of Fuel National Bureau of Standards, 3 (NBS 14) Report Form Test Designation 1 meter Shape: 211 Scale: .H.

Dimension of Fuel :

Window Opening: 1/4

0 (19 (19 9 30 3 0 60 6 0100 00 N 09 ~1 Q/ .050 3 174 OF .060 .035 .025 000 825 5 .050 080 60 99 90 000 OIT: 00 mi 196 800 0130 1,60 992 1074 1104 1071 1036 5 40.0 38.6 36.7 29.7 24.1 18.1 13.8 10.7 ad ad proof o 315 666 E-4 05 7 .000 .005 .040 .540 .630 .520 986 1068 1021 0 .130 .175 00 6 673 591 .025 010. ∞ ~ ~ 210 0000 5 27 EXPERIMENTAL RESULTS o o Window Radiation, cal/sec cm2 Flame Radiation, Temp. Ceiling, Temp. Floor, cal/sec cm Weight, kg Time, min

2 0/ 9 9 49 6 0 (Q) 5 3 3 <1; 60; 40 44 27 Weight, kg Time, min

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9

9 Temp. Ceiling,

Window Redigtion, Temp. Floor,

cal/sec cm4

Flame Radiation, cal/sec cm2

STATISTICS

Time to 30% orige we min	00	5.6
cal sec cm2	I_£55/30	714.
Flame Rad	I \$80/55	.628
d. sec cm2	I.55/30	.176
Window Rad	I.80/55	.173
Floor Temp. C	0°/22/30	1023
10013	880/55 0.5	1055
Ceiling Temp. C	0680/55 0655/30	1093
Ceiling	0 _e 80/55	1074
Rate Wt. Loss kg	R55/30	2.22
Rate Wt.	R80/55	m J-

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7 (NBS 15)

Test Designation

C.I.B.

Report Form

S. National Bureau of Standards, Washington, D. C.

(NBS 16) Test Designation 4 8

1 spacing 2 cm. side 40 kg/m2 Dispersion of Fuel: Amount of Fuel Scale: 1 meter Window Opening: 1/4 Shape: 221

EXPERIMENTAL RESULTS

Time, min	160.0 155.9 147.3	ev	1, 2, 0,	VQ.	00 (end O	27.	imel off,	90	©) n=1	27.0	6	770	28	60 00 00 00 00 00 00 00	0	132	at m	9	(C)	3
Feetont, X		57.8	157.8 152.8	52.8		40.7	formal	27.4	3)	(C) (C)	100.9			00 00 00		77.0		66.3		200	1
Temp. Ceiling, °C	35	293	35 293 421 693 735	693	735	756	792	0317	836	678	854	00 10	881	80	010	922	945	926	796	975	00
Temp. Floor, °C	25		65 83 186 455	186	455	ped 	789	817	836	849	354	859	© ©	006	5	926	676	426	961	7/6	600
Window Radiation, cal/sec cm ²	0000:	.010	.000 .010 .020 .050 .085	.050	.085	105	- 20	.140	.140	5	.145 .150		.150	, F. J.	 ru	051	000	077.	22	64 67	120
Flame Radiation,	000.	.010	.000 .010 .020 .160 .285	091.		.440	.530	.560	.5555	.620	.570	.540	.560	000	.530	o IZ	.470	0440	. 400	60 60 10	ω ν Θ
															,						2-0 B
Time, min		42	44	400	4° 00	9	25	34	200	90	9	8	\$	(Q) (Q)	60	0	12	1	9/	99 Po	60
Weight, kg		48.6	48.6 44.8 41.2 37.6	41.2		34.2	31.2	28.5	25.4	22.9	20.3	6.	15.6	14.0	, ed	eo	60 00	6	3.	4.6	(n)
Temp. Ceiling, °C		1003	1003 1019 1020 1019	1020		1032	1029	1026	~ F	1014	1004 1	1010	966	992	186	700	116	60	9	60	\$0 \$0 \$0
lemp. Floor, °C	•	1002	1005 1021 1019 1019	1010		1009	1002	966	966	992	166	1007 1019	6101	1009	\$	89	(3) (3)	80	00 10 10	90	60 El
Window Radiation, cal/sec cm2		51	.115 .110 .110 .105	0		-105	001.	.105	105	50	.100 .105		50 = .	S .	001.	8	001	00 1	0.60	.085	0
Flame Radiation, cal/sec cm2		.300	.300 .240 .210 .215	.210		06	.190	.165	091.	140	001.	.115 .090		.070	.070	.055	1	.030	.020	010	6.
STATISTICS																			1	•	1 db is from

Time to 80% orig. wt.min	£80	F- (F)
d sec cal	I 55/30	.438
Flame R	I _E 80/55	.562
d. cal	I,55/30	141.
Window Rad.	I.80/55	-146
Floor Temp. C	6,55/30	952
100E	880/55 8 55	857.
Celling Temp. C	0e55/30	952
Ceiling	0,80/55 0,55/30	857
Rate Wt. Loss kg	R55/30	2.44
Eate Wt.	E80/55	الم الم

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. Resistance and Reactance. Electrochemistry. Electrical Instruments. Magnetic Measurements. Dielectrics. High Voltage. Absolute Electrical Measurements.

Metrology. Photometry and Colorimetry. Refractometry. Photographic Research. Length. Engineering Metrology. Mass and Volume.

Heat. Temperature Physics. Heat Measurements. Cryogenic Physics. Equation of State. Statistical Physics. Radiation Physics. X-ray. Radioactivity. Radiation Theory. High Energy Radiation. Radiological Equipment. Nucleonic Instrumentation. Neutron Physics.

Analytical and Inorganic Chemistry. Pure Substances. Spectrochemistry. Solution Chemistry. Standard Reference Materials. Applied Analytical Research. Crystal Chemistry.

Mechanics. Sound. Pressure and Vacuum. Fluid Mechanics. Engineering Mechanics. Rheology. Combustion Controls.

Polymers. Macromolecules: Synthesis and Structure. Polymer Chemistry. Polymer Physics. Polymer Characterization. Polymer Evaluation and Testing. Applied Polymer Standards and Research. Dental Research.

Metallurgy. Engineering Metallurgy. Metal Reactions. Metal Physics. Electrolysis and Metal Deposition. Inorganic Solids. Engineering Ceramics. Glass. Solid State Chemistry. Crystal Growth. Physical Properties. Crystallography.

Building Research. Structural Engineering. Fire Research. Mechanical Systems. Organic Building Materials. Codes and Safety Standards. Heat Transfer. Inorganic Building Materials. Metallic Building Materials.

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

Data Processing Systems, Components and Techniques, Computer Technology, Measurements Automation, Engineering Applications, Systems Analysis,

Atomic Physics. Spectroscopy. Infrared Spectroscopy. Far Ultraviolet Physics. Solid State Physics. Electron Physics. Atomic Physics. Plasma Spectroscopy.

Instrumentation. Engineering Electronics. Electron Devices. Electronic Instrumentation. Mechanical Instruments. Basic Instrumentation.

Physical Chemistry. Thermochemistry. Surface Chemistry. Organic Chemistry. Molecular Spectroscopy. Elementary Processes. Mass Spectrometry. Photochemistry and Radiation Chemistry.

Office of Weights and Measures.

BOULDER, COLO.

CRYOGENIC ENGINEERING LABORATORY

Cryogenic Processes. Cryogenic Properties of Solids. Cryogenic Technical Services. Properties of Cryogenic Fluids.

CENTRAL RADIO PROPAGATION LABORATORY

Ionosphere Research and Propagation. Low Frequency and Very Low Frequency Research. Ionosphere Research. Prediction Services. Sun-Earth Relationships. Field Engineering. Radio Warning Services. Vertical Soundings Research.

Troposphere and Space Telecommunications. Data Reduction Instrumentation. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Spectrum Utilization Research. Radio-Meteorology. Lower Atmosphere Physics.

Radio Systems. Applied Electromagnetic Theory. High Frequency and Very High Frequency Research. Frequency Utilization. Modulation Research. Antenna Research. Radiodetermination.

Upper Atmosphere and Space Physics, Upper Atmosphere and Plasma Physics. High Latitude lonosphere Physics. Ionosphere and Exosphere Scatter. Airglow and Aurora. lonospheric Radio Astronomy.

RADIO STANDARDS LABORATORY

Radio Standards Physics. Frequency and Time Disseminations. Radio and Microwave Materials. Atomic Frequency and Time-Interval Standards. Radio Plasma. Microwave Physics.

Radio Standards Engineering. High Frequency Electrical Standards. High Frequency Calibration Services. High Frequency Impedance Standards. Microwave Calibration Services. Microwave Circuit Standards. Low Frequency Calibration Services.

Joint Institute for Laboratory Astrophysics-NBS Group (Univ. of Colo.).



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