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In Cooperation with the University of Wisconsin



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**U. S. FOREST SERVICE
RESEARCH NOTE
FPL-0186
FEBRUARY 1968**

**SURFACE FLAMMABILITY OF
VARIOUS WOOD-BASE BUILDING
MATERIALS**

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Summary

Surface flammability of 29 species of wood in lumber form and 50 commercially produced plywoods, hardboards, fiberboards, and particleboards was measured at the Forest Products Laboratory in the 8-foot tunnel furnace. Results indicate the range in surface flammability that can be expected from the types of lumber and fabricated boards tested.

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Surface Flammability of Various
Wood-Base Building Materials¹

By

Forest Products Laboratory², Forest Service
U. S. Department of Agriculture

Introduction

Building codes and fire protection engineers frequently limit the use of building materials based on the potential surface flammability, or ease with which flames may spread over their surfaces. There have been numerous laboratory test methods developed for measuring this characteristic, with the greatest recognition being given by the code authorities to the 25-foot tunnel furnace method (ASTM Standard E84) developed by the Underwriters' Laboratories, Inc. This large tunnel method requires the use of test specimens 20 inches by 25 feet; this limits the tunnel's use for research and development purposes when a large number of test variables are to be evaluated.

Therefore, the Forest Products Laboratory has developed a smaller scale 8-foot tunnel furnace method for research and development purposes, particularly in the wood product field. This report presents test data obtained by this method on the surface flammability of 29 species of wood in lumber form and 50 commercially produced plywoods, hardboards, fiberboards, and particleboards.

¹This research note is a revision of Forest Products Laboratory Report No. 2140, under the same title, originally written in 1959 by H. D. Bruce and L. E. Downs.

²Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

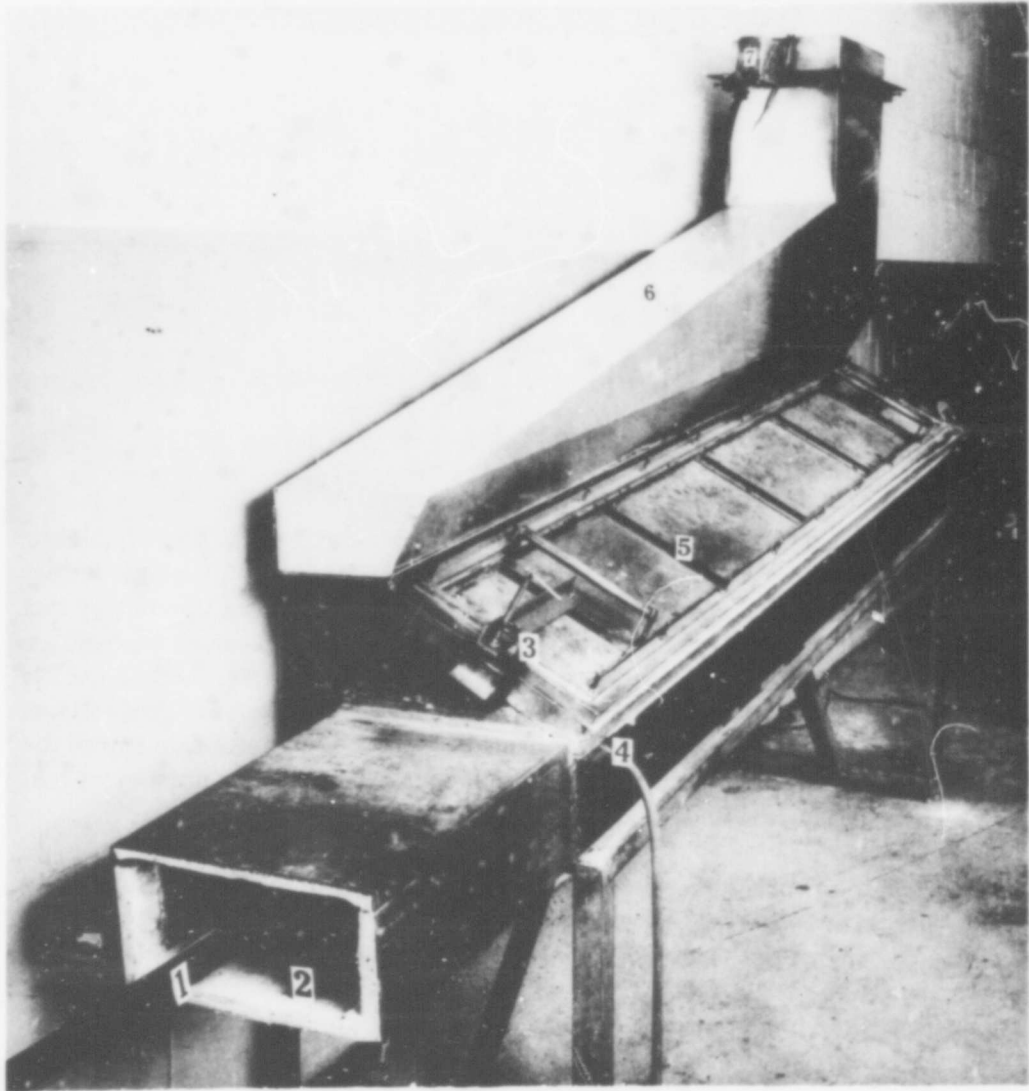


Figure 1. --Specimen side of FPL 8-foot tunnel furnace. 1, Gas supply to main burner; 2, firebox; 3, clamp to hold down cover over test specimen; 4, gas supply to igniting burner; 5, cover over test specimen; 6, hood to collect combustion gases for temperature and smoke measurement; and 7, photoelectric cell for smoke-density measurement.

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Test Method

The 8-foot tunnel-furnace method was described by Bruce and Miniutti in 1958,³ and the current version is listed as ASTM Method E286-65T.⁴

In this test a specimen 14 inches wide by 8 feet long, conditioned to moisture equilibrium in an atmosphere at 30 percent relative humidity and 80° F., is laid in the furnace (fig. 1). The specimen is weighted down by a heavy cover, with asbestos millboard directly against its back. Ignition is provided by a small pilot burner near the lower end of the specimen (specimen slopes slightly lengthwise upward at an angle of 6° from the horizontal). A graduated source of radiant heat is applied to the face of the test specimen from a stainless steel partitioning plate heated by a large T-head gas-burner flame. As the ignition flame moves along the underside of the specimen, this progression is measured and expressed as an index number. Basis for this index is a rating of 100 for flame movement on red oak flooring, (39 pounds per cubic foot in density) and a rating of 0 for progression on asbestos millboard.

Along with flame-spread rates, smoke density and heat contributed by the test specimen were also measured and expressed as index numbers relative to red oak and asbestos, as explained in the reports describing the test method.

Test Materials

The fiberboards, hardboards, particleboards, and plywoods were obtained largely through the courtesy of the respective manufacturers' associations.⁵ All sheets were specimens of commercial mill-run production, and usually 4 by 8 feet in size. From each 4-by-8-foot sheet, three test specimens 14 inches wide by 8 feet long were cut.

The lumber, nominally 1 inch thick, was obtained from sawmills or retail dealers. When conditioned to moisture equilibrium at 30 percent relative

³Bruce, H. D. and Miniutti, V. P. Small Tunnel-Furnace Test for Measuring Surface Flammability. American Society for Testing and Materials Bulletin 230, May 1958.

⁴Other reports on the 8-foot tunnel-furnace method, as well as its use, are given at the end of this report.

⁵The Insulation Board Institute, the Hardboard Association, the Particleboard Association, the Hardwood Plywood Institute, and the Douglas Fir Plywood Association (now American Plywood Association).

humidity and 80° F., the boards were surfaced to a thickness of about 3/4 inch, tongued and grooved,⁶ and assembled into panels held together by three nailed cleats on the back. Pieces shorter than 8 feet were end-squared and butt-joined. Two tests were made on each material, with a third test when the results of the first two were not in adequate agreement.

Results

The results of all tests are given in tables 1 through 5. No attempt was made to analyze the results to explain the differences in the index values; to do so would require an intimate knowledge of the composition of the commercial materials and research on the effects of various ingredients. The tests, however, indicate the range in surface flammability that can be expected from the types of lumber and fabricated boards tested, and now available for construction purposes.

In earlier tests, close correlation was found between results of the 8-foot tunnel tests and wall-corner tests, which simulate room fires, on 11 different materials. It is believed, therefore, that the results given in this report provide a realistic relative measure of the surface flammability of the various materials tested.

⁶An exception to this method of assembly was made for the redcedar, which could not be tongued and grooved. The redcedar boards were nailed to a backing of 1/4-inch Douglas-fir plywood to form the test panel.

Table 1.--Results of tunnel-furnace tests on 1-inch lumber

Species	Weight	Moisture content	Index numbers ¹		
			Flame-spread	Smoke-density	Heat-contributed
	Lb. per cu. ft.	Percent			
1. Alder (<u>Alnus rubra</u>)	29.6	6.4	118	108	122
.....do.....	29.9	6.5	124	116	119
2. Aspen (<u>Populus tremuloides</u>)	26.5	6.1	128	63	130
.....do.....	28.4	5.9	110	36	108
.....do.....	27.0	6.4	125	118	134
3. Basswood (<u>Tilia americana</u>)	28.6	5.4	123	78	131
.....do.....	27.4	5.4	134	80	124
4. Beech (<u>Fagus grandifolia</u>)	46.5	6.1	99	112	136
.....do.....	47.0	5.4	102	152	144
5. Baldcypress (<u>Taxodium distichum</u>)	29.2	6.6	103	420	109
.....do.....	27.2	7.2	122	359	105
.....do.....	32.4	6.8	107	388	112
6. Birch (<u>Betula alleghaniensis</u>)	39.6	5.4	91	93	92
.....do.....	39.2	5.8	106	84	101
.....do..(grain perpendicular):	39.4	6.0	100	83	95
.....do..(.....do.....):	39.4	5.9	86	143	99
7. Chestnut (<u>Castanea dentata</u>)	28.5	6.1	114	16	89
.....do.....	29.5	6.2	127	17	95
8. Cottonwood (<u>Populus trichocarpa</u>)	27.6	4.9	136	134	135
.....do.....	27.0	5.0	132	115	135
9. Douglas-fir (<u>Pseudotsuga menziesii</u>):	27.7	5.9	117	93	79
.....do.....	26.5	5.9	115	69	72
.....do.(grain perpendicular):	27.1	6.3	108	46	89
.....do.(.....do.....):	27.1	6.3	102	54	88
10. Elm, slippery (<u>Ulmus rubra</u>)	37.4	6.3	79	130	111
.....do.....	38.8	6.2	93	169	102
.....do.....	39.4	5.9	96	155	110
.....do.(grain perpendicular)	38.5	5.6	76	179	98
.....do.(.....do.....)	38.5	5.8	98	177	102
.....do.(.....do.....)	40.1	5.8	84	171	116
11. Fir, white (<u>Abies concolor</u>)	30.0	6.5	112	112	93
.....do.....	29.7	6.9	118	106	93

Table 1.--Results of tunnel-furnace tests on 1-inch lumber (Continued)

Species	Weight	Moisture content	Index numbers ¹		
			Flame-spread	Smoke-density	Heat-contributed
	Lb. per cu. ft.	Percent			
12.Hemlock (<u>Tsuga heterophylla</u>)	: 29.9	: 7.3	: 113	: 87	: 95
.....do.....	: 28.2	: 7.5	: 102	: 69	: 95
13.Lauan, Philippine mahogany	: 31.7	: 5.2	: 109	: 38	: 86
.....do.....	: 37.6	: 5.5	: 103	: 72	: 76
.....do.(grain perpendicular):	34.6	: 5.2	: 98	: 59	: 74
.....do.(.....do.....):	34.6	: 5.0	: 99	: 68	: 70
14.Larch (<u>Larix occidentalis</u>)	: 34.4	: 6.8	: 107	: 72	: 98
.....do.....	: 35.4	: 6.8	: 105	: 41	: 98
15.Mahogany (<u>Swietenia macrophylla</u>)	: 30.7	: 6.5	: 100	: 52	: 69
.....do.....	: 28.6	: 6.6	: 107	: 15	: 70
16.Maple, sugar (<u>Acer saccharum</u>)	: 43.4	: 6.2	: 93	: 79	: 79
.....do.....	: 40.0	: 6.2	: 97	: 73	: 86
17.Oak, red (<u>Quercus rubra</u>)	: 39.0	: 5.2	: 100	: 100	: 100
....do..(grain perpendicular)	: 39.0	: 4.5	: 99	: 59	: 102
....do..(.....do.....)	: 39.0	: 5.2	: 99	: 69	: 105
18.Oak, white (<u>Quercus alba</u>)	: 40.8	: 6.3	: 99	: 32	: 90
.....do.....	: 40.7	: 6.5	: 91	: 49	: 92
19.Pine, northern white (<u>Pinus strobus</u>)	: 23.7	: 5.7	: 130	: 149	: 100
.....do.....	: 24.0	: 5.7	: 134	: 237	: 108
20.Pine, ponderosa (<u>Pinus ponderosa</u>)	: 26.6	: 6.5	: 110	: 182	: 100
.....do.....	: 27.0	: 6.6	: 124	: 183	: 102
.....do.....	: 29.6	: 6.3	: 109	: 325	: 103
21.Pine, southern yellow ²	: 28.4	: 6.8	: 102	: 153	: 111
.....do.....	: 30.0	: 6.7	: 102	: 157	: 120
22.Pine, sugar (<u>Pinus lambertiana</u>)	: 24.7	: 6.3	: 118	: 282	: 88
.....do.....	: 22.7	: 5.9	: 130	: 255	: 104
.....do.....	: 24.7	: 6.4	: 128	: 248	: 101
23.Pine, western white (<u>Pinus monticola</u>)	: 26.4	: 6.1	: 128	: 282	: 123
.....do.....	: 27.0	: 6.1	: 113	: 362	: 112
.....do.....	: 24.2	: 5.8	: 129	: 177	: 104

Table 1.--Results of tunnel-furnace tests on 1-inch lumber (Continued)

Species	Weight	Moisture:	Index numbers ¹		
			content:	Flame-:	Smoke- :
			spread:	density:	contributed
	<u>Lb. per</u>	<u>Percent</u>			
	<u>cu. ft.</u>				
24.Redcedar (<u>Juniperus virginiana</u>)	: 33.5	: 9.0	: 105	: 212	: 94
.....do.....	: 34.2	: 8.8	: 114	: 236	: 94
25.Redwood (<u>Sequoia sempervirens</u>)	: 25.9	: 6.4	: 120	: 170	: 64
.....do.....	: 25.2	: 6.4	: 122	: 207	: 72
26.Spruce, Sitka (<u>Picea sitchensis</u>)	: 27.0	: 7.0	: 116	: 72	: 77
.....do.....	: 26.6	: 6.5	: 108	: 42	: 82
27.Sweetgum (<u>Liquidambar styraciflua</u>)	: 31.2	: 6.4	: 94	: 66	: 82
.....do.....	: 32.4	: 6.2	: 107	: 86	: 114
.....do.....	: 33.2	: 7.2	: 113	: 50	: 119
28.Walnut, black (<u>Juglans nigra</u>)	: 35.6	: 5.0	: 105	: 80	: 111
.....do.....	: 39.3	: 5.2	: 108	: 90	: 118
29.Yellow-poplar (<u>Liriodendron tulipifera</u>)	: 30.9	: 5.7	: 121	: 123	: 120
	: 31.2	: 5.7	: 128	: 188	: 130

¹Relative to 100 for red oak lumber and 0 for asbestos board.

²Botanical species not determinable from wood alone.

Table 2.--Results of tunnel-furnace tests on plywood

Description of plywood	Thick-	Weight	Moisture	Index numbers ¹		
	ness	:	content	Flame-	Smoke-	Heat-
	:	:	:	spread:	density:	contrib-
	:	:	:	:	:	uted
	<u>Inch</u>	<u>Lb. per</u>	<u>Percent</u>	:	:	:
	:	<u>cu. ft.</u>	:	:	:	:
30. Douglas-fir, 3 ply, Interior, A-D, cold-press, protein glue	: 1/4	: 31.2	: 6.6	: 129	: 152	: 125
	: 1/4	: 31.0	: 6.5	: 117	: 182	: 121
31. Douglas-fir, 3 ply, Interior, A-D, hot-press, protein glue	: 1/4	: 30.0	: 6.2	: 120	: 111	: 111
	: 1/4	: 30.4	: 6.0	: 125	: 99	: 117
32. Douglas-fir, 3 ply, Interior, A-D, hot-press, extended phenolresin glue	: 1/4	: 34.7	: 4.9	: 119	: 95	: 120
	: 1/4	: 34.6	: 5.1	: 123	: 68	: 125
	:	:	:	:	:	:
33. Douglas-fir, 3 ply, Exterior, A-C, resin glue	: 3/8	: 32.0	: 4.8	: 118	: 77	: 116
	: 3/8	: 32.0	: 5.0	: 114	: 41	: 102
34. Douglas-fir, 3 ply, Exterior, A-C, resin glue	: 3/8	: 35.7	: 4.7	: 112	: 57	: 120
	: 3/8	: 36.6	: 4.6	: 115	: 97	: 124
35. Douglas-fir, 3 ply, Exterior, A-C, resin glue	: 3/8	: ² 32.8	: 5.1	: 114	: 140	: 107
	: 3/8	: ² 32.8	: 4.9	: 112	: 166	: 100
36. Douglas-fir, 3 ply, Exterior, A-C, resin glue - 1 coat of fire-retardant paint A.	: 3/8	: 34.8	: 5.0	: 83	: 406	: 56
	: 3/8	: 34.9	: 4.7	: 83	: 548	: 59
	:	:	:	:	:	:
37. Douglas-fir, 3 ply, Exterior, A-C, resin glue - 2 coats of fire-retardant paint A.	: 3/8	: 34.0	: 5.1	: 52	: 1022	: 18
	: 3/8	: 33.7	: 5.1	: 53	: 914	: 21
	:	:	:	:	:	:
38. Douglas-fir, 3 ply, Exterior, A-C, resin glue - 1 coat of fire-retardant paint B.	: 3/8	: ² 34.1	: 5.0	: 59	: 722	: 16
	: 3/8	: ² 34.1	: 5.0	: 70	: 773	: 26
	:	:	:	:	:	:
39. Douglas-fir, 3 ply, Exterior, A-C, resin glue - 2 coats of fire-retardant paint B.	: 3/8	: ² 34.1	: 5.0	: 34	: 1117	: 9
	: 3/8	: ² 34.1	: 5.0	: 34	: 1169	: 11
	:	:	:	:	:	:
40. Douglas-fir, 3 ply, Exterior, A-C, resin glue, 2 coats fire-retardant paint C.	: 3/8	: ² 34.1	: 5.2	: 79	: 1000	: 37
	: 3/8	: ² 34.1	: 4.8	: 84	: 1001	: 39
	:	:	:	:	:	:
41. Douglas-fir, 3 ply, Exterior, medium density paper plastic overlay	: 3/8	: 32.3	: 4.7	: 115	: 135	: 120
	: 3/8	: 32.4	: 4.9	: 118	: 113	: 118
	:	:	:	:	:	:

Table 2.--Results of tunnel-furnace tests on plywood (Continued)

Description of plywood	Thick-	Weight	Moisture	Index numbers ¹		
	ness		content	Flame-	Smoke-	Heat-
				spread	density	contrib-
						uted
	Inch	Lb. per	Percent			
		cu. ft.				
42. Douglas-fir, 3 ply, Exterior, medium density paper plastic overlay	: 3/8	: 36.7	: 5.0	: 97	: 194	: 115
	: 3/8	: 37.3	: 5.5	: 86	: 163	: 111
43. Douglas-fir, 3 ply, Exterior, medium density paper plastic overlay	: 1/2	: 40.6	: 4.6	: 113	: 232	: 119
	: 1/2	: 40.2	: 4.7	: 113	: 234	: 112
44. Douglas-fir, 3 ply, Exterior, high density paper plastic overlay	: 3/8	: 35.9	: 4.3	: 105	: 166	: 102
	: 3/8	: 36.4	: 4.2	: 105	: 146	: 101
45. Douglas-fir, 3 ply, Exterior, high density paper plastic overlay	: 3/8	: 33.4	: 4.9	: 106	: 116	: 115
	: 3/8	: 33.4	: 5.3	: 108	: 96	: 115
46. Birch face, 40 mils, yellow poplar core, urea glue	: 1/4	: 35.0	: 5.9	: 117	: 78	: 122
	: 1/4	: 39.0	: 5.9	: 116	: 59	: 135
47. Lauan face, 44 mils, lauan core, urea glue, 3 ply	: 1/4	: 29.4	: 6.7	: 111	: 32	: 113
	: 1/4	: 32.3	: 6.8	: 113	: 68	: 99
48. Red oak face, 40 mils, lauan core, urea glue	: 1/4	: 35.2	: 6.3	: 124	: 74	: 139
	: 1/4	: 34.2	: 6.3	: 124	: 85	: 146
49. Water oak, 3 ply, Exterior, phenolic film glue	: 1/4	: 41.4	: 3.7	: 108	: 49	: 127
	: 1/4	: 43.0	: 3.8	: 111	: 65	: 137
50. Pecan, 3 ply, Exterior, phenolic film glue	: 1/4	: 42.9	: 4.2	: 119	: 38	: 134
	: 1/4	: 44.2	: 4.2	: 125	: 40	: 151
51. Tupelo gum face, 50 mils, tupelo core, urea glue	: 1/4	: 40.4	: 5.1	: 107	: 148	: 138
	: 1/4	: 41.7	: 5.6	: 111	: 139	: 145
52. Black walnut face, 30 mils, lauan core	: 1/4	: 28.5	: 7.5	: 117	: 72	: 90
	: 1/4	: 31.2	: 6.4	: 130	: 94	: 140
53. Black walnut face, 30 mils, fuma core	: 1/4	: 25.8	: 6.2	: 122	: 39	: 95
	: 1/4	: 27.6	: 6.6	: 135	: 65	: 72

¹Relative to 100 for red oak lumber and 0 for asbestos board.

²Approximate.

Table 3.--Results of tunnel-furnace tests on fiberboards

Description of fiberboard	Thick-	Weight	Moisture	Index numbers ¹		
	ness		content	Flame-	Smoke-	Heat-
				spread	density	contrib-
						uted
	Inch	Lb. per	Percent			
	:cu. ft.:					
STRUCTURAL INSULATING BOARD						
54. Douglas-fir fiber,	: 1/2	: 18.0	: 4.6	: 124	: 171	: 73
"D" factory	: 1/2	: 18.0	: 4.7	: 72	: 153	: 71
finish	: 1/2	: 18.0	: 4.8	: 76	: 238	: 59
55. Southern yellow pine	: 1/2	: 18.5	: 6.0	: 59	: 168	: 40
fiber, "F" factory	: 1/2	: 18.3	: 5.8	: 46	: 213	: 36
finish	: 1/2	: 18.2	: 5.3	: 47	: 122	: 34
56. Southern yellow pine fiber, "D"	: 1/2	: 19.2	: 5.5	: 127	: 95	: 114
factory finish, acoustical	: 1/2	: 19.2	: 5.5	: 130	: 55	: 109
tile (no perforations)	:	:	:	:	:	:
57. Aspen fiber, "D" factory	: 1/2	: 19.3	: 5.2	: 153	: 41	: 138
finish	: 1/2	: 19.3	: 5.0	: 163	: 47	: 138
58. Aspen fiber, asphalt im-	: 3/4	: 19.8	: 3.6	: 170	: 954	: 173
pregnated	: 3/4	: 20.2	: 3.7	: 169	: 969	: 172
59. Bagasse fiber, "D" factory	: 1/2	: 21.0	: 4.7	: 135	: 52	: 57
finish	: 1/2	: 21.0	: 4.7	: 145	: 94	: 59
60. Southern yellow pine and cotton-	: 1/2	: 24.1	: 3.7	: 145	: 2167	: 148
wood fiber, asphalt impreg-	: 1/2	: 24.0	: 3.6	: 158	: 2323	: 198
nated	:	:	:	:	:	:
MEDIUM DENSITY BUILDING FIBERBOARD						
61. Reclaimed paper, laminated	: 3/16	: 31.8	: 6.0	: 100	: 197	: 81
.....do.....	: 3/16	: 31.7	: 5.8	: 132	: 100	: 96
.....do.....	: 3/16	: 29.8	: 5.6	: 139	: 68	: 204
62. Reclaimed paper, laminated,	: 3/8	: 31.8	: 4.9	: 144	: 156	: 208
weatherproof	: 3/8	: 31.6	: 5.2	: 144	: 128	: 205
63. Aspen fiber, resin impregnated	: 0.43	: 33.6	: 1.8	: 102	: 1201	: 160
factory primed for house paint:	: 0.43	: 33.5	: 1.8	: 97	: 1214	: 174

¹Relative to 100 for red oak lumber and 0 for asbestos board.

Table 4.--Results of tunnel-furnace tests on hardboards

Description of hardboard	Thick-	Weight	Moisture	Index numbers ¹		
	ness		content	Flame- spread	Smoke- density	Heat- contrib- uted
	<u>Inch</u>	<u>Lb. per</u> <u>cu. ft.</u>	<u>Percent</u>			
64. Aspen and yellow pine fiber, phenol resin, wax, wet felted, screen back	: 1/4 : 1/4 :	: 60.6 : 61.7 :	: 3.9 : 3.9 :	: 100 : 99 :	: 330 : 406 :	: 195 : 201 :
65. Douglas-fir fiber plus bark, phenol resin, wet felted, screen back	: 1/4 : 1/4 :	: 58.8 : 61.3 :	: 4.3 : 4.7 :	: 97 : 97 :	: 225 : 272 :	: 150 : 156 :
66. Douglas-fir fiber, wax, phenol resin, air felted, dry pressed:	: 1/4 : 1/4	: 67.5 : 65.6	: 5.0 : 5.0	: 93 : 94	: 576 : 596	: 163 : 170
67. Douglas-fir fiber, wax, phenol resin, wet felted, screen back	: 1/4 : 1/4	: 57.6 : 57.9	: 3.9 : 3.9	: 94 : 93	: 424 : 428	: 162 : 161
68. Willow plus oak fiber, wax, resin, wet felted, dry pressed:	: 0.22 : 0.22	: 50.5 : 52.3	: 3.2 : 3.1	: 119 : 119	: 147 : 116	: 176 : 178
69. Douglas-fir fiber, oil-tempered, wax, phenol resin, wet felted, screen back	: 1/4 : 1/4 :	: 61.3 : 63.6 :	: 4.3 : 4.1 :	: 94 : 94 :	: 227 : 259 :	: 165 : 178 :
70. Douglas-fir and redwood fiber, oil-tempered, wet felted, dry pressed	: 1/4 : 1/4 :	: 72.0 : 69.6 :	: 3.2 : 3.0 :	: 87 : 92 :	: 662 : 652 :	: 164 : 167 :

¹Relative to 100 for red oak lumber and 0 for asbestos board.

Table 5.--Results of tunnel-furnace tests on particle boards

Description of particle board	Thick-	Weight	Moisture	Index numbers ¹		
	ness	:	content	Flame-	Smoke-	Heat-
				spread:	density:	contrib-
						uted
	<u>Inch</u>	<u>Lb. per</u>	<u>Percent</u>			
		<u>cu. ft.</u>				
71. Douglas-fir hammer-mill particles, wax, phenol resin	: 3/4	: 36.0	: 5.0	: 98	: 270	: 107
	: 3/4	: 35.8	: 5.1	: 102	: 270	: 107
72. Ponderosa pine sawdust, phenol resin	: 1/4	: 68.4	: 5.4	: 87	: 742	: 149
	: 1/4	: 67.3	: 5.3	: 87	: 654	: 157
73. Southern yellow pine chips, phenol resin, extruded	: 7/8	: 41.4	: 6.0	: 83	: 52	: 75
	:	:	:	:	:	:
74. Southern yellow pine chips, urea resin, extruded	: 7/8	: 36.9	: 5.5	: 90	: 59	: 87
	:	:	:	:	:	:
75. Southern yellow pine flakes and chips, urea resin	: 3/4	: 47.4	: 6.6	: 92	: 71	: 117
	: 3/4	: 46.7	: 6.7	: 97	: 87	: 120
76. Pine, maple, cottonwood chips and fiber, urea resin	: 11/16	: 42.1	: 4.6	: 99	: 64	: 110
	: 11/16	: 42.2	: 5.2	: 97	: 73	: 114
77. Pine, ash, maple, sweetgum chips, urea resin, extruded	: 1.2	: 50.2	: 4.2	: 97	: 182	: 111
	: 1.2	: 48.8	: 3.6	: 95	: 208	: 113
78. Pine, ash, maple, sweetgum chips, phenol resin, extruded	: 1.2	: 50.1	: 3.8	: 91	: 124	: 104
	: 1.2	: 47.5	: 3.8	: 93	: 155	: 109
79. White pine chips, urea resin	: 3/4	: 41.3	: 6.0	: 102	: 144	: 135
	: 3/4	: 38.8	: 6.1	: 106	: 157	: 142

¹Relative to 100 for red oak lumber and 0 for asbestos board.

REPORTS DEALING WITH DEVELOPMENT AND USE

OF FPL 8-FOOT TUNNEL-FURNACE METHOD

- "Small Tunnel-Furnace Test for Measuring Surface Flammability,"** by H.D. Bruce and V. P. Miniutti. U.S. Forest Products Laboratory Report 2097, 1957. (This report was brought up to date in 1967 and published, under the same title, as U.S. Forest Service Research Note FPL-0167, Forest Products Laboratory, Madison, Wis.)
- "Surface Flammability as Determined by the FPL 8-Foot Tunnel Method,"** by C. C. Peters and H. W. Eickner. U. S. Forest Products Laboratory Report 2257, 1962.
- "Surface Flammability of Various Decorative and Fire-Retardant Coatings for Wood as Evaluated in FPL 8-Foot Tunnel Furnace,"** Official Digest of Paint Technology and Engineering 35(463): 800-813, 1963.
- "Correlation Between 8-Foot Tunnel Furnaces,"** by H. W. Eickner. U.S. Forest Service Research Note FPL-058. Forest Products Laboratory, Madison, Wis., 1964.
- "Method of Test for Surface Flammability of Building Materials Using an 8-Foot (2.44 meter) Tunnel Furnace,"** American Society for Testing and Materials Method E286-65T.
- "Fire-Retardant Effects of Individual Chemicals on Douglas-fir Plywood,"** by H. W. Eickner and E. L. Schaffer. Fire Technology, May, pp. 90-104, 1967.