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REPORT
OF
EXPERIMENTS TO DETERMINE THE FIRE RESISTANCES
OF
TWO PREFABRICATED WOOD WALLS

by

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REPORT
OF
EXPERIMENTAL TESTS DETERMINING THE FIRE RESISTANCE
OF
TWO PREFABRICATED WALL WALLS

1. INTRODUCTION

Two walls assembled from insulated prefabricated wooden panels were subjected to standardized fire exposure in order to determine the fire resistance limits of the walls. One wall was of a design for the outside walls of a building and the other was of a design for fire-break walls. The first wall was made up of the prefabricated panels with bronze screen wire and an extra sheet of 1/4 in. marine grade plywood on the exterior surface and a proprietary vinyl plastic material applied to the interior surface. The second wall assembly consisted of two parallel walls of the prefabricated panels spaced 6 in. apart, which space was filled with insulating material. The vinyl plastic material was applied to both faces of the resulting assembly. All exposed wood surfaces were coated with a paint represented by the manufacturer as being resistant to fire. This work was requested by the Department of the Air Force in a letter of February 6, 1955, signed by Lt. Col. W. S. Stollaro of the Air Force Installations Representative Office, North Atlantic Region.

2. MATERIALS AND SPECIMENS

The experimental specimens were assembled from the following material elements: prefabricated panels, 1/2 in. pipe, 1/4 in. marine plywood, bronze screen wire, vermiculite insulating fill, rubber edged wood splines, wood furring strips, paint, vinyl plastic material, nails and screws. The assemblies of the experimental specimens were carried out by craftsmen regularly employed by a commercial contractor.

2.1 Prefabricated Panels

The prefabricated panels, as delivered to the National Bureau of Standards, were 11 ft 4 in. by 4 ft 3 in. by 4 in. Each consisted of a wood frame faced with plywood and filled with glass fiber insulation. The frame consisted of three vertical studs, a top plate, a bottom plate, and horizontal bridging (or fire stops) at third points. The overall height and width of the frame were 10 ft and 3 ft 9 in., respectively. The studs visible along each edge and the top and bottom plates were 1 1/2-in. by 2 3/4-in. The intermediate stud and the bridging (or fire stops) were 1 5/8 by 3 1/2 in. The "interior" side of the panel was faced with 1/4 in. exterior-grade plywood in a single sheet 4 ft by 10 ft. This sheet lined up with the frame at top and bottom and along one edge but projected 3 in. beyond the other edge. The "exterior" side of the frame was faced with a single sheet of the same plywood 4 ft by 11 ft 4 in. that lined up with the edge of the frame at which the interior face plywood extended but extended 3 in. beyond the other edge and 5 in. beyond the top and bottom of the frame. Each extension of the 1/4 in. face plywood was backed with 3/4 in. plywood in pieces 1 1/2 in. wider than the extension. These pieces bore against the 1 1/2 in. faces of the edge studs and top and bottom plates. The plywood was attached to the frame by 6d galvanized annularly grooved (Wotter rigned) box nails about 4 in. on centers into the studs, plates, and fire stops. In each panel, a 7/8 in. inside diameter fiber tube or sleeve was put through the studs parallel to and centered 2 1/2 in. from the top of the frame and another similarly located with respect to the bottom. All visible surfaces were covered with a coat of a gray paint represented to be fire resistant. Observations made after the fire tests indicated that all surfaces inside the panels were painted also, except those glued together. Four holes, each 5/16-in. diameter, were drilled in each vertical extension; one each about 4 in. from the top and bottom of the frame and the other two about 3 ft from top and bottom.

2.2 Accessory Materials

Materials used in the assembly of the prefabricated panels into one or both of the experimental specimens were:

a) Splines: 10 ft lengths of 2 by 3 in. wood members. The four long edges were recessed and slotted, and fitted with 3/8-in. diameter foam rubber bending, as shown in Figure 1, detail A. There were 1 1/8-in. diameter holes through the splines centered 2 1/2 in. from each end, parallel to the 3 in. dimension. The wood surfaces were coated with the same paint as the panels.

b) Pipe: 10 ft lengths of 1/2-in. pipe, threaded both ends; with nuts and washers.

c) Marine grade plywood: 1/4-in thick plywood of marine grade (phenolic resin paper bonded to each face) in sheets 4 ft by 11 ft 4 in. This plywood came with the gray paint on both faces.

d) Paint: a gray paint manufactured by the S. H. Laboratories, Inc. (2402 Pennsylvania Avenue, Baltimore 17, Maryland) and labeled "All Purpose" Fire and Weather Resist" -- Color No. 101; type Finish, was used for extra coats or to touch-up the paint already on the components of the assemblies. The paint already on the components was represented to be the same paint.

e) Plastic finishing material: a material consisting of a vinyl plastic coating on one side of a glass fabric case in 37 in. wide rolls. Of the two rolls used, one came with a factory-applied adhesive on the glass fabric side, and one edge cut smooth; the other roll came without adhesive or cut edge. The material, known as Lexolium (The Lexolium Corp., South Norwalk, Conn.), was a light gray color on the vinyl side; was from 0.019 to 0.023 in. thick, and weighed 0.174 lb/sq ft without adhesive. With the Lexolium were used: "Fire Resistive Primer-Activator" 145x42 (Donj. Foster Co.); L-7-A2-1 activator (The Lexolium Corp.); Clear Joint Sealer (The Lexolium Corp.); and an unlabeled adhesive.

f) Insulating fill: a coarse granulated vermiculite insulating fill (labeled "Zonolite Insulating Fill", net weight 18 lb, approximately 4 ft³, Vermiculite Products Corp., Washington, D. C.), actual gross weight 26 lb/bag.

g) Hardware: a bronze screen wire of 0.010 in. diameter (No. 34 mesh) wires 14/in. in one direction and 16/in. at right angles, in a 48 in. wide roll. It weighed approximately 0.14 lb/ft². Various sizes of nails and wood screws were used.

2.3 Assembly of Specimens

Each specimen was assembled as much as possible in the horizontal position and then tipped up and hoisted into a mounting frame.

2.3a) Outside wall. One of the prefabricated panels was laid in a horizontal position such that, when tipped upright and hoisted into the mounting frame, the face away from the furnace fire would be the face that extended beyond the panel frame at top and bottom. This was the exterior face, and will be so designated in the remainder of this report. One of the 1/2-in. pipes was passed through the fiber sleeve at each end of the panel. One of the splines was placed as the pipes passed through the holes and was slipped up to the panel, resting on the extension of the exterior face along the panel edge. A second panel was similarly put "on the pipes" in position similar to the first panel and slipped into place, the extension of the interior face passing over the spline. Additional splines and panels were placed in the same manner until four panels and three splines were in place. The assembly was drawn together firmly by tightening nuts on the threaded ends of each pipe tie. Four 2 1/2-in. No. 20 flat head hot galvanized wood screws were driven into both sides of each spline, passing through the holes provided in the edge extensions of the panels. These holes had been countersunk and the screw heads were flush with or slightly below the panel surface. The extension of the exterior face was cut off flush with the panel frames along the bottom of the assembly to provide a flat surface to rest on the support in the mounting frame. The extension of the exterior face along the top was cut down to 1 5/8 in. above the frames of the panels. The extensions along each edge of the assembly were cut to about 1 in. to facilitate the fitting of the assembly into the mounting frame. The exterior face was given another coat of the 2K paint by roller application.

actual gross weight 26 lb/pag.

Bronze screen wire was laid on the exterior face in full height strips with less than 1 in. lap along the edges of the adjoining strips. These strips were stapled down along the top and bottom and along the edges of the assembly. Over the screen wire, 1/4-in. marine grade plywood, with BK paint on both sides, was nailed on with 6d annularly grooved box nails about 4 in. o.c. into the studs, plates, and bridging. This plywood was in 4 ft by 11 ft sheets. It was cut to length and placed vertically so the joints between sheets fell over the centers of the prefabricated panels. The exposed surface of the plywood was given two coats of BK paint after having been nailed down. Wooden batten strips of 1 1/2-in. diameter half rounds were placed over the joints between plywood sheets and attached by 2 in. No. 6 ga flat head wood screws about 12 in. o.c. The batten strips were given one coat of BK paint. The assembly then was tipped erect and placed in the mounting frame in a vertical plane.

The Dexolium with preapplied adhesive was cut in strips slightly over 10 ft in length. Starting at the edge of the assembly, the interior face was given a brush coat of the 140 x 42 Primer-Activator about 40 in. wide and full height of the wall. The surface was allowed to dry to a tacky condition and the Dexolium rolled on, starting at the bottom, and carefully smoothed by hand with some pressure. The manufacturer's representative who applied the Dexolium stated that the material was normally applied to the prefabricated walls while still in the horizontal position. Therefore, he was permitted to secure the top of each strip to the wall with large tacks to help support the Dexolium as the adhesive set. Subsequent strips were applied in the same manner with an overlap of about 2 in. on the preceding strip. Each strip was trimmed even with the top of the wall. The entire face was covered and then the joints closed by applying the 1-7-45-1 activator to the back of the overlapping strip and the front or vinyl surface of the overlapped strip and pressing the former down firmly. The following day, the offset at the edge of the overlapping sheet was treated with two brush coats of clear joint sealer.

2.3b) Fire-break wall. Four of the prefabricated panels and three of the splines were assembled, in the horizontal position, in the same manner as described above for the outside wall. Four more prefabricated

panels were assembled, with splices, in the same manner on top of the first assembly, while both were in the horizontal position. The edge and bottom extensions were cut off as for the outside wall. However, the top extensions were cut off flush with the top of the panel frames. No screen wire nor extra layers of plywood were applied. The painted surfaces were touched up but not given additional full coats. The two assemblies were separated and 1 by 1 in. wooden furring strips were nailed across the bottom and up both edges of one face of each assembly. The two assemblies were placed with the furred faces in and were joined together by placing 6 in. wide by 10 ft long strips of 1/4-in. plywood at right angles to the assembly faces and nailing them to the furring strips. This produced a wall 13 7/8 in. thick with a 6 in. air space in the middle. Five 1-in. wide and 11 1/2-in. long strips of 3/16-in. steel were attached along each edge to provide additional strength for erection. The wall was tipped upright and the 6 in. cavity filled with vermiculite insulating fill. A total of 23 bags, each containing about 4 ft³, were emptied into the cavity. The wall was tamped vigorously by hand to induce any settling of the fill that might occur, and the cavity was filled to the top. The wall was then hoisted into the erecting frame. The surface to be exposed to the fire was covered with Dexolite of the same type and in the same manner as the to-be-exposed surface of the outside wall. The not-to-be-exposed surface of the fire-break wall was covered with Dexolite, also. One strip was of the material with preapplied adhesive but the remainder were of the material without adhesive. For the strips without adhesive, the adhesive was brushed on the wall surface and the Dexolite applied. All the strips on each surface were tacked across the top and bottom. The overlapped joints were closed and sealed in the same manner as those on the outside wall.

3. EXPERIMENTAL FACILITIES AND PROCEDURES

The experimental determinations of the fire resistances of the walls were made in facilities of the National Bureau of Standards designed and regularly used for such purposes. The procedures followed were those usually followed and were in accordance with standard methods generally recognized throughout this country.

3.1 Furnace and Erecting Frames

The experiments were conducted in a gas fired furnace in the form of an open box which was closed by the test

wall and mounting frame. The furnace was equipped with six gas burners in the back wall and with observation windows in each side wall to permit observations of the exposed surface.

Each wall was mounted in a movable frame suspended from overhead beams. The frames were rectangular steel and concrete panels with smaller rectangular openings in which the walls were mounted. The opening in each frame was approximately 16 ft wide and 16 ft high. The bottom of the opening consisted of two lengths of heavy steel channel, each of which rested on two hydraulic leveling pistons. The channels and pistons were protected by a concrete apron on the fire side.

Each wall was mounted in a separate frame, the bottom of the wall resting on the steel channels. The spaces between the frame and the ends of the walls were packed with mineral wool. The outside wall was held in place at the top by nails driven through the 1 1/8-in. extension of the exterior face into a 2 by 4 securely attached to the mounting frame. The interior fire-break wall was held in place at the top by a 2 by 6 in. timber securely attached to the mounting frame. The wall was put in the frame so that this timber fitted into the 6 in. space between the two elements of the double wall. The top, bottom, and side edges of each wall were protected on the fire side by brick or metal lath and plaster.

3.2 Instrumentation

Temperatures in the furnace chamber were measured by means of chromel-alumel thermocouples connected to self-balancing potentiometers calibrated to read in degrees centigrade. The wires were put through porcelain insulators and encased in iron pipes. Temperatures on the unexposed surface of each wall were measured by similar thermocouples encased in asbestos sleeving except for the junction and wires immediately adjacent. The junction and a short length of the wires of each surface thermocouple were coiled under a 4 by 6 by 0.4 in. felted asbestos pad secured to the wall. The horizontal deflections of each wall from its initial position were determined by measurements between the unexposed surface and vertical wires suspended from the mounting frame. Twelve thermocouples were distributed symmetrically in the furnace chamber and twelve other thermocouples were located symmetrically on the unexposed surface of each wall. Deflections were measured at nine points on the unexposed surface.

3.3 Experimental Method and End Point Criteria

Each mounting frame and specimen were placed to close the furnace and clamped in place. The outside wall, experimental test 352, was restrained against vertical expansion but not loaded since the design load was so small that accurate application would have been difficult. The interior fire break wall, experimental test 353, was loaded to 1100 lb per linear foot of width. In each experimental test, flames from the burners were directed against the specimen and regulated so that the furnace temperatures approximated those of the standard time-temperature curve defined in Standard Methods of Fire Tests of Building Construction and Materials, ASTM Designation E119-51, which include: 1000°F (538°C) at 5 min, 1320°F (704°C) at 10 min, 1550°F (843°C) at 30 min, 1700°F (927°C) at 1 hr, and 1850°F (1010°C) at 2 hr. Observations of the furnace temperatures, unexposed surface temperatures, deflections, and physical condition of the specimen were made and recorded throughout each experimental test so that the end point that determined the fire endurance of each wall might be known.

The fire endurance of a wall or partition is determined as the time when any of the following first occurs: 1) the average temperature of the unexposed surface becomes 250°F higher than its initial temperature, 2) the temperature at any one point on the unexposed surface becomes 325°F higher than its initial temperature, 3) flames or gases hot enough to ignite cotton waste issue from the unexposed surface, 4) the specimen shall fail to sustain the applied load (applicable to loaded walls only).

3.4 Supplementary Tests

In addition to the determinations of the fire resistances of the two walls, certain other determinations were made of various characteristics of the materials that made up the walls. Experiments were initiated to determine the vapor permeabilities of the Dexcelium, marine grade plywood, and exterior grade plywood with and without Dexcelium. Samples of the same Dexcelium used on the experimental walls and of that supplied under an Air Force contract were included. These experiments were carried out under the provisions of ASTM specification G214-48T with the following modifications: 1) the wet cup method was not employed, 2) the experimental conditions were 100°F ± 1°F and 52 percent relative humidity ± 2

percent, 3) the area of the exposure surface was 11.46 sq in., 4) silica gel was used as the desiccant.

Experiments were carried out to determine the ignition temperatures of the Dexolium. Specimens about 1/2 by 3/4 by 3/4 in., made up of several layers of the Dexolium with precasted adhesive, were suspended in the space inside an electrically heated furnace. The temperature of the specimen was measured by a thermocouple junction between the two lowest layers of material. Air was introduced into the furnace inside the cylinder on which the heater wire was wound, passed down the wall and under the bottom end of and up through an inner concentric refractory cylinder. The furnace was heated to a desired temperature, as measured by a thermocouple in the air within the inner cylinder, and the specimen introduced into the space just above this thermocouple. The self ignition temperature of the material was determined as the lowest initial furnace-air temperature at which a fresh specimen when introduced eventually glowed or flamed without an outside source of ignition. The flash temperature was determined as the lowest initial furnace-air temperature at which a fresh specimen when introduced eventually released gases which were ignited by a small pilot burner at the top of the furnace. A more detailed description of the experimental method is given in "A Method and Apparatus for Determining the Ignition Characteristics of Plastics", R. F. Setonka, N° 2072, Journal of Research of the National Bureau of Standards, vol 43, December 1949.

4. RESULTS

The results are given as summaries of the observations, plots of the temperatures and representative photographs.

4.1 Outside Wall-Experimental Test 352

This wall consisted of an assembly of prefabricated wooden panels with an extra layer of marine grade plywood on the exterior or unexposed surface and with Dexolium, a glass backed vinyl plastic material, on the interior or exposed surface. The following are the more important observations of the specimen during the fire exposure.

Time	Observation
0:01:00	Flash of flame over Dexellus
0:02:00	Visibility in furnace chamber obscured
0:04:00	Many flames from joints in exposed surface, cracking sound
0:05:30	Piece of the glass fabric backing of the Dexellus fell from North end of exposed surface. Dense white smoke outside furnace
0:13:00	More glass fabric fell
0:17:00	Glass fiber insulation in panel melting and falling where plywood surface burned off
0:19:00	All plywood burned off exposed surface
0:25:00	Uniform flaming on exposed side from all studs and splines. Severe cracking sounds heard during last 10 min.
0:39:00	Blistering and scorching of paint at two locations on unexposed surface
0:42:00	Blackening of unexposed surface at two locations. Flames outside furnace through joint between mounting frame and top of wall
0:52:00	Blackened spots about 1 ft diameter 2 ft from bottom at 1, 3, 5, 7, and 9 ft from North edge of unexposed surface
0:55:00	Continued burning of studs, most of insulation still in place
1:00:00	Additional blackened areas on unexposed surface
1:03:45	Flames through about center of unexposed face
1:04:30	Furnace fires off
1:06	Flames through at two other locations

The specimen and frame were removed from before the furnace and all flaming extinguished by the water stream from a small hose. All the studs were badly charred. The glass fiber insulation was fused on the back of the exposed surface plywood.

The temperatures observed during the experimental test are represented in figure 2. The temperature at one thermocouple on the unexposed surface had risen 325 degree F above the initial temperature at 38 min and the average on the unexposed surface had risen 250 degree F above the initial temperature at 42 min. The average furnace temperatures were higher than those of the standard time-temperature curve during most of the test. The fire exposure severity, defined as the ratio of the area under the curve of average furnace temperature to the area under the standard time-temperature curve, was 121 percent. Therefore, a correction of +6 min was applicable to the 36 min limiting time, making the corrected fire endurance of the experimental specimen 44 min.

The deflections measured at nine locations on the unexposed surface were all in the direction away from the furnace fires. Those at the four locations having the largest deflections were as follows:

Time	Deflections, inches			
	Top Center	Top North	North Center	Center
0:00	0	0	0	0
0:10	0	0	0	0
0:20	1/8	1/8	1/8	1/8
0:30	1/8	1/8	3/8	3/8
0:40	1/8	1/4	1/2	1/4
0:50	1/4	1/2	3/8	1/8
0:55	3/4	1 1/8	1/2	3/8
1:00	1 1/4	1 5/8	1 5/8	1

4.2 Fire-break wall-experimental test 353

This wall consisted of two parallel assemblies of prefabricated insulated wood panels with a 6 in. space between. This space was filled with a loose vermiculite insulation and Duxolux was applied to both faces of the double wall.

<u>Time</u>	<u>Observation</u>
0:00:00	
0:01:00	Lexolux on exposed surface flashed into flames, much black smoke
0:06:30	Glass fabric backing of Lexolux down from about one-fourth of exposed surface, plywood ablaze
0:09:00	Plywood burned off above area, some of glass fiber insulation fell
0:21:00	Plywood burned off entire exposed surface, glass fiber insulation appears white, compressed and flaky
0:26:00	Light yellow smoke from around edges of unexposed surface; glass fiber insulation peeling from one panel on exposed side
0:30:00	Vermiculite insulation granules pouring into furnace chamber, studs of exposed side panels thoroughly charred
0:38:00	The appearance of the unexposed surface unchanged
0:42:00	The inner surface of the unexposed side panels ablaze
0:48:00	Lexolux blistering on unexposed surface
0:50:00	Studs of exposed side panels thoroughly charred but in place
0:54:00	Brown-orange discoloration of unexposed surface Lexolux on three blisters
0:55:00	Discolored spots turning black
1:00:00	Eight discolored spots on unexposed surface each 6 to 12 in. diameter
1:01:00	All the studs that had been at the centers of the exposed side panels burned away
1:05:00	Deflections increasing; load off

<u>Time</u> <u>hr:min:sec</u>	<u>Observation</u>
1:05:30	Flames through wall 3 ft from bottom and 7 ft from north edge
1:06:00	Flames through 5 ft from north
1:07:00	Furnace fires off
1:10:00	Gasoline burned to top of unexposed surface from hole 3 ft from north edge and 3 ft from bottom, no lateral spread; burned about half way to top 7 ft from north and died out

The specimen and flame were removed from before the furnace and a water stream played on from exposed side. The panels that had made up the exposed side of the wall were almost completely gone. The plywood was burned from the inner faces of the panels that made up the unexposed side of the wall and the glass fiber insulation was white and matted. Over some areas, it had a granular texture in place of the original fibrous texture.

The temperatures observed during the experimental test are represented in figure 2. The temperature at one thermocouple on the unexposed surface had risen 325 degree F above the initial temperature at 57 min and the average at all the thermocouples on the unexposed surface had risen 250 degree F above the initial average at 1 hr. The average furnace temperatures were somewhat higher than those of the standard time-temperature curve during part of the test. The fire exposure severity was 105 percent. A correction of +2 min was applicable to the 57 min limit, making the corrected fire endurance of the experimental specimen 59 min.

The greatest deflections were observed at the three locations nearest the bottom of the wall. They were as follows:

<u>Time</u>	<u>Deflection in inches</u>		
<u>hr:min</u>	<u>Lower North</u>	<u>Lower Center</u>	<u>Lower Right</u>
To load	0	0	0
0:00	3/16	0	0
0:06	3/16	0	1/8
0:11	3/16	0	1/8
0:16	1/4	1/16	0

Table 1. Summary of the data.	
Year	Number of cases
1997	100
1998	120
1999	150
2000	180
2001	200
2002	220
2003	250
2004	280
2005	300
2006	320
2007	350
2008	380
2009	400
2010	420
2011	450
2012	480
2013	500
2014	520
2015	550
2016	580
2017	600
2018	620
2019	650
2020	680
2021	700
2022	720
2023	750
2024	780
2025	800
2026	820
2027	850
2028	880
2029	900
2030	920
2031	950
2032	980
2033	1000
2034	1020
2035	1050
2036	1080
2037	1100
2038	1120
2039	1150
2040	1180
2041	1200
2042	1220
2043	1250
2044	1280
2045	1300
2046	1320
2047	1350
2048	1380
2049	1400
2050	1420
2051	1450
2052	1480
2053	1500
2054	1520
2055	1550
2056	1580
2057	1600
2058	1620
2059	1650
2060	1680
2061	1700
2062	1720
2063	1750
2064	1780
2065	1800
2066	1820
2067	1850
2068	1880
2069	1900
2070	1920
2071	1950
2072	1980
2073	2000
2074	2020
2075	2050
2076	2080
2077	2100
2078	2120
2079	2150
2080	2180
2081	2200
2082	2220
2083	2250
2084	2280
2085	2300
2086	2320
2087	2350
2088	2380
2089	2400
2090	2420
2091	2450
2092	2480
2093	2500
2094	2520
2095	2550
2096	2580
2097	2600
2098	2620
2099	2650
2100	2680
2101	2700
2102	2720
2103	2750
2104	2780
2105	2800
2106	2820
2107	2850
2108	2880
2109	2900
2110	2920
2111	2950
2112	2980
2113	3000
2114	3020
2115	3050
2116	3080
2117	3100
2118	3120
2119	3150
2120	3180
2121	3200
2122	3220
2123	3250
2124	3280
2125	3300
2126	3320
2127	3350
2128	3380
2129	3400
2130	3420
2131	3450
2132	3480
2133	3500
2134	3520
2135	3550
2136	3580
2137	3600
2138	3620
2139	3650
2140	3680
2141	3700
2142	3720
2143	3750
2144	3780
2145	3800
2146	3820
2147	3850
2148	3880
2149	3900
2150	3920
2151	3950
2152	3980
2153	4000
2154	4020
2155	4050
2156	4080
2157	4100
2158	4120
2159	4150
2160	4180
2161	4200
2162	4220
2163	4250
2164	4280
2165	4300
2166	4320
2167	4350
2168	4380
2169	4400
2170	4420
2171	4450
2172	4480
2173	4500
2174	4520
2175	4550
2176	4580
2177	4600
2178	4620
2179	4650
2180	4680
2181	4700
2182	4720
2183	4750
2184	4780
2185	4800
2186	4820
2187	4850
2188	4880
2189	4900
2190	4920
2191	4950
2192	4980
2193	5000
2194	5020
2195	5050
2196	5080
2197	5100
2198	5120
2199	5150
2200	5180
2201	5200
2202	5220
2203	5250
2204	5280
2205	5300
2206	5320
2207	5350
2208	5380
2209	5400
2210	5420
2211	5450
2212	5480
2213	5500
2214	5520
2215	5550
2216	5580
2217	5600
2218	5620
2219	5650
2220	5680
2221	5700
2222	5720
2223	5750
2224	5780
2225	5800
2226	5820
2227	5850
2228	5880
2229	5900
2230	5920
2231	5950
2232	5980
2233	6000
2234	6020
2235	6050
2236	6080
2237	6100
2238	6120
2239	6150
2240	6180
2241	6200
2242	6220
2243	6250
2244	6280
2245	6300
2246	6320
2247	6350
2248	6380
2249	6400
2250	6420
2251	6450
2252	6480
2253	6500
2254	6520
2255	6550
2256	6580
2257	6600
2258	6620
2259	6650
2260	6680
2261	6700
2262	6720
2263	6750
2264	6780
2265	6800
2266	6820
2267	6850
2268	6880
2269	6900
2270	6920
2271	6950
2272	6980
2273	7000
2274	7020
2275	7050
2276	7080
2277	7100
2278	7120
2279	7150
2280	7180
2281	7200
2282	7220
2283	7250
2284	7280
2285	7300
2286	7320
2287	7350
2288	7380
2289	7400
2290	7420
2291	7450
2292	7480
2293	7500
2294	7520
2295	7550
2296	7580
2297	7600
2298	7620
2299	7650
2300	7680
2301	7700
2302	7720
2303	7750
2304	7780
2305	7800
2306	7820
2307	7850
2308	7880
2309	7900
2310	7920
2311	7950
2312	7980
2313	8000
2314	8020
2315	8050
2316	8080
2317	8100
2318	8120
2319	8150
2320	8180
2321	8200
2322	8220
2323	8250
2324	8280
2325	8300
2326	8320
2327	8350
2328	8380
2329	8400
2330	8420
2331	8450
2332	8480
2333	8500
2334	8520
2335	8550
2336	8580
2337	8600
2338	8620
2339	8650
2340	8680
2341	8700
2342	8720
2343	8750
2344	8780
2345	8800
2346	8820
2347	8850
2348	8880
2349	8900
2350	8920
2351	8950
2352	8980
2353	9000
2354	9020
2355	9050
2356	9080
2357	9100
2358	9120
2359	9150
2360	9180
2361	9200
2362	9220
2363	9250
2364	9280
2365	9300
2366	9320
2367	9350
2368	9380
2369	9400
2370	9420
2371	9450
2372	9480
2373	9500
2374	9520
2375	9550
2376	9580
2377	9600
2378	9620
2379	9650
2380	9680
2381	9700
2382	9720
2383	9750
2384	9780
2385	9800
2386	9820
2387	9850
2388	9880
2389	9900
2390	9920
2391	9950
2392	9980
2393	10000
2394	10020
2395	10050
2396	10080
2397	10100
2398	10120
2399	10150
2400	10180
2401	10200
2402	10220
2403	10250
2404	10280
2405	10300
2406	10320
2407	10350
2408	10380
2409	10400
2410	10420
2411	10450
2412	10480
2413	10500
2414	10520
2415	10550
2416	10580
2417	10600
2418	10620
2419	10650
2420	10680
2421	10700
2422	10720
2423	10750
2424	10780
2425	10800
2426	10820
2427	10850
2428	10880
2429	10900
2430	10920
2431	10950
2432	10980
2433	11000
2434	11020
2435	11050
2436	11080
2437	11100
2438	11120
2439	11150
2440	11180
2441	11200
2442	11220
2443	11250
2444	11280
2445	11300
2446	11320
2447	11350
2448	11380
2449	11400
2450	11420
2451	11450
2452	11480
2453	11500
2454	11520
2455	11550
2456	11580
2457	11600
2458	11620
2459	11650
2460	11680
2461	11700
2462	11720
2463	11750
2464	11780
2465	11800
2466	11820
2467	11850
2468	11880
2469	11900
2470	11920
2471	11950
2472	11980
2473	12000
2474	12020
2475	12050
2476	12080
2477	12100
2478	12120
2479	12150
2480	12180
2481	12200
2482	12220
2483	12250
2484	12280
2485	12300
2486	12320
2487	12350
2488	12380
2489	12400
2490	12420
2491	12450
2492	12480
2493	12500
2494	12520
2495	12550
2496	12580
2497	12600
2498	12620
2499	12650
2500	12680
2501	12700
2502	12720
2503	12750
2504	12780
2505	12800
2506	12820
2507	12850
2508	12880
2509	12900
2510	12920
2511	12950
2512	12980
2513	13000
2514	13020
2515	13050
2516	13080
2517	13100
2518	13120
2519	13150
2520	13180
2521	13200
2522	13220
2523	13250
2524	13280
2525	13300
2526	13320
2527	13350
2528	13380
2529	13400
2530	13420
2531	13450
2532	13480
2533	13500
2534	13520
2535	13550
2536	13580
2537	13600
2538	13620
2539	13650
2540	13680
2541	13700
2542	13720
2543	13750
2544	13780
2545	13800
2546	13820
2547	13850
2548	13880
2	

Deflection in inches			
Top	Lower Hull	Lower Sellar	Lower Pri
0:00	1/4	1/16	1/8
0:35	1/4	0	1/8
0:40	7/16	1/4	1/4
0:51	7/16	1/4	3/8
1:03	13/16	1/8	1 3/8

All deflections were in the direction away from the furnace fires.

4.3 Results from Supplementary Tests

The experiments to determine the vapor permeabilities of various components of the walls require a considerable period of time and have not been completed. Therefore, no results are available but will be reported separately when ready.

The experiments to determine the ignition temperature of the Dexolite gave the following results:

Self ignition temperature (no outside ignition source)

..... 707°F (375°C)

Flash temperature (small pilot flame)

..... 671°F (355°C)

Several strips of Dexolite, each about 2 by 3 inches, were held in the open flame of a gas burner and removed. The Dexolite, with and without adhesive, burned freely while in the flame but went out quickly when removed, unless over oil consumed before being removed. A residue of the blackened glass fabric remained from the burned over areas.

5. BURNING OF DEXOLITE

In each experimental test, the Dexolite on the exposed surface burst into flame at set over intervals. Large quantities of black smoke were produced from the burning Dexolite. The glass fabric backing remained in place for several minutes and appeared to prevent flaming of the plywood beneath. The exposed, the plywood burned off quickly. The glass fiber insulation in the panels turned white as the plaster burned out of it. As the tests progressed, the glass fiber insulation surface and some of it lost its fibrous texture. As soon as a hole burned through the exposed side panels of the fire areas

TABLE 1. - SUMMARY OF DATA FOR 1964			
Area	Area	Area	Area
Area	Area	Area	Area
Area	Area	Area	Area

1. The first two columns show the area in square miles and the population in thousands.

2. The third column shows the area in square miles and the population in thousands.

3. The fourth column shows the area in square miles and the population in thousands.

4. The fifth column shows the area in square miles and the population in thousands.

5. The sixth column shows the area in square miles and the population in thousands.

6. The seventh column shows the area in square miles and the population in thousands.

7. The eighth column shows the area in square miles and the population in thousands.

8. The ninth column shows the area in square miles and the population in thousands.

9. The tenth column shows the area in square miles and the population in thousands.

wall, the vermiculite loose fill poured out. Exposure of the unexposed surface was ignited where the wall burned through and burned up the wall but ignition did not spread laterally.

The vigorous burning of the largely combustible walls added much heat to that given off by the gas flames from the burners. This caused the furnace temperatures to be higher than intended during part of each test. The fire resistance of each wall was limited by a temperature rise of 325°F above the initial at a single thermocouple on the unexposed surface. The limits, as corrected for the high furnace temperatures, for the individual specimens tested were: 44 min for the exterior wall; 37 min for the fire-break double wall. Each wall remained a barrier to the passage of flame for slightly over 1 hour. The deflections, although not large during the fire exposure periods, were increasing rapidly at the end of each, indicating that load failure was imminent.

Figure 1. Construction and mounting details
of prefabricated wooden exterior
wall.

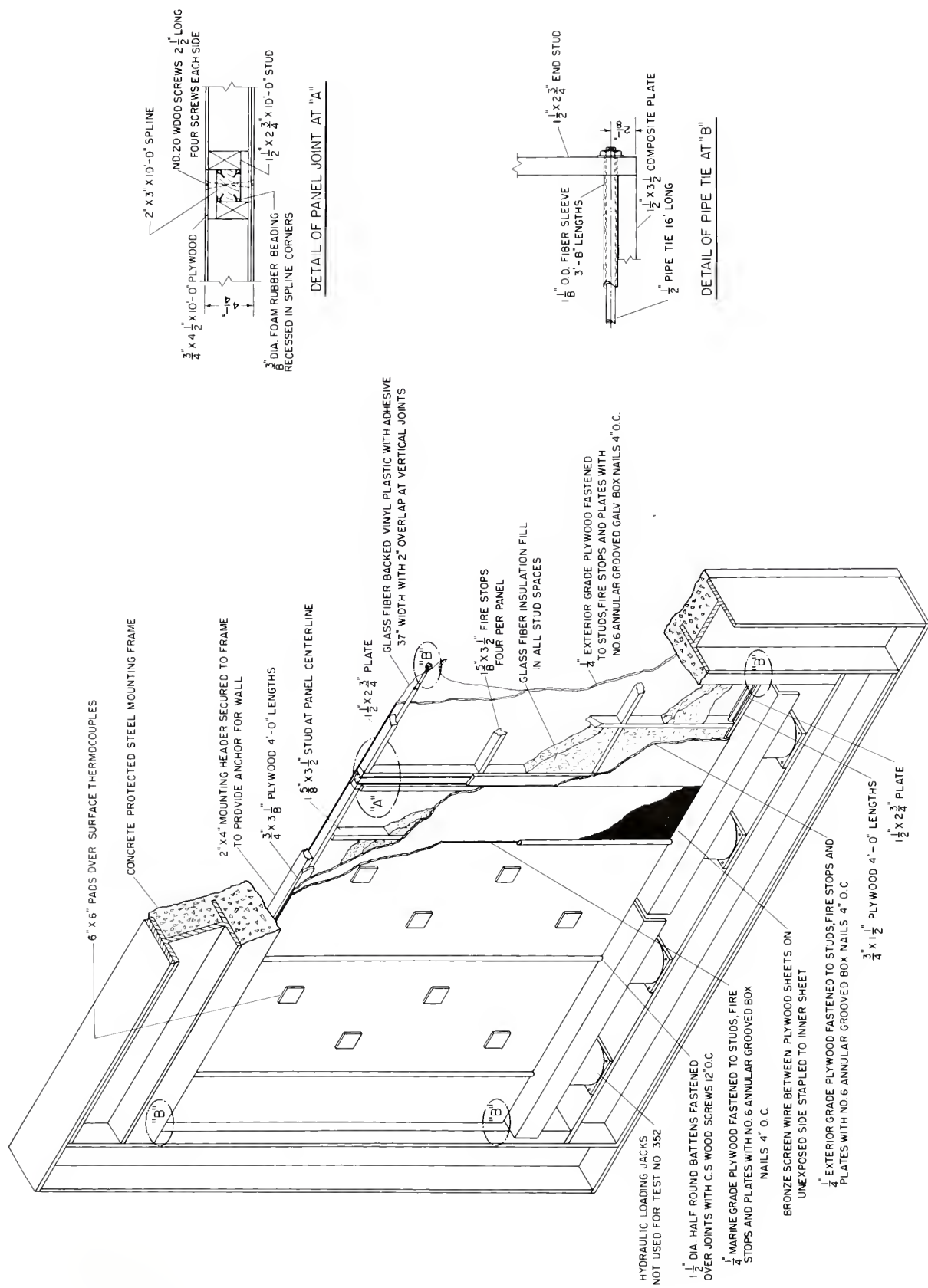


FIG 1 CONSTRUCTION AND MOUNTING DETAILS OF PREFABRICATED WOODEN EXTERIOR WALL

1-91416

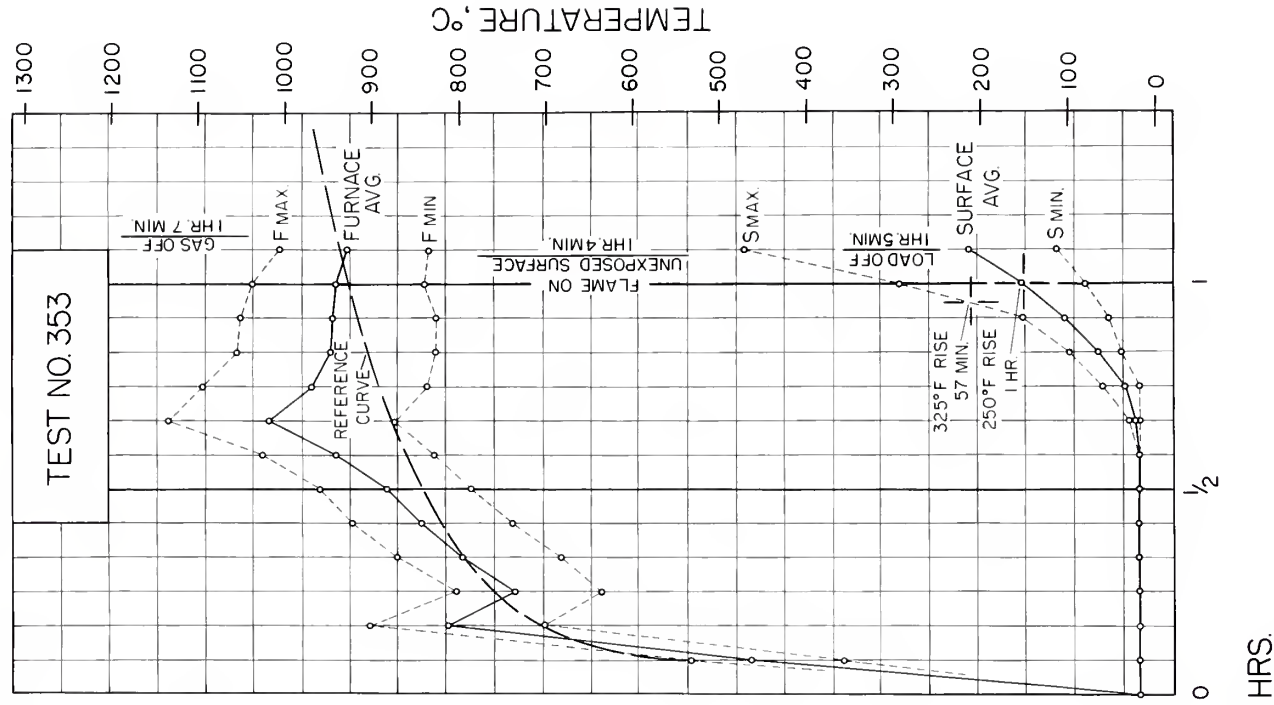
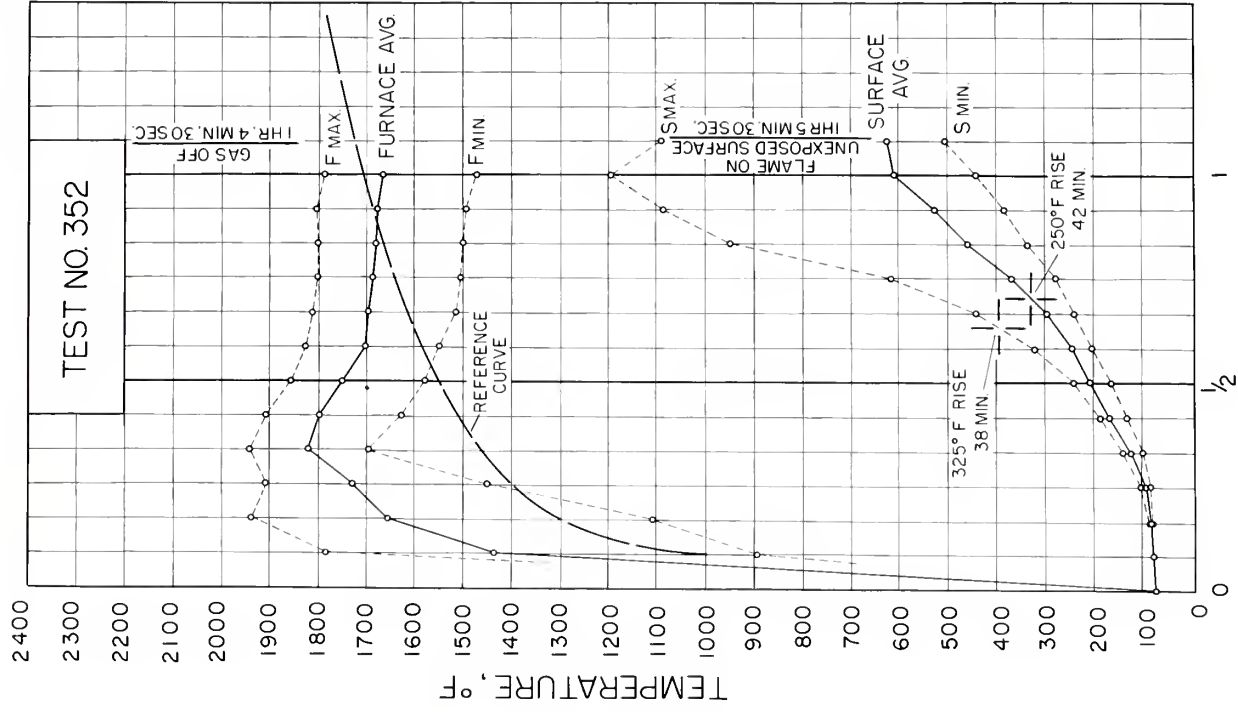


FIG 2 TEMPERATURES OBSERVED DURING FIRE-ENDURANCE TESTS

24762

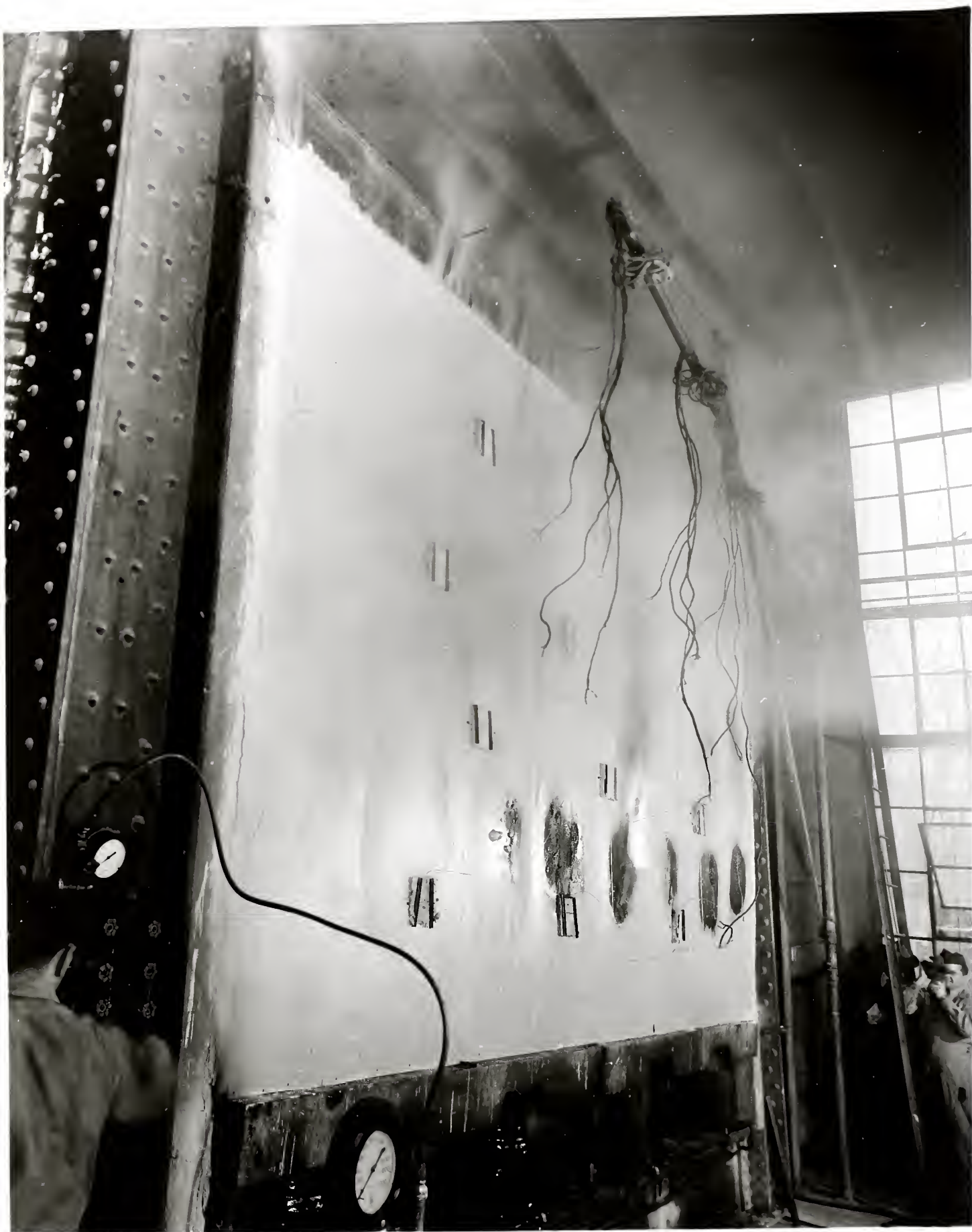


Figure 3. Exposed surface of exterior wall after
fire endurance test 37a.





Figure 4. Exposed surface of fire-break wall
as flames started at 1 or 2 m of
fire entrance to it.



E-68976

Figure 5. Section of fire-break wall from fire
side after test 11.



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