



# UNDERWRITERS LABORATORIES INC.

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*an independent, not-for-profit organization testing for public safety*

March 13, 1987

Korfil Inc.  
Mr. Dave Nickerson, Vice President - Research  
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Chicopee, MA 01014

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Our Reference: File No. R10326, Project No. 86NK28219

Subject: Report On Preliminary Investigation Consisting Of  
Full-Scale Fire And Hose Stream Tests On Wall  
Assembly Constructed Of 8 In. Thick Concrete  
Blocks With Insulation Inserts

Dear Mr. Nickerson:

This Letter Report describes the results of the February 10, 1987 fire endurance and hose stream tests conducted on your 8 in. wide load bearing Hi-R wall system made of concrete blocks with molded polystyrene inserts.

The tests conducted in accordance with Standard for Fire Tests of Building Construction and Materials, UL 263 (ASTM E119, NFPA No. 251, ANSI A2.1).

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D E S C R I P T I O N

DESCRIPTION OF TEST ASSEMBLY:

MATERIALS

Concrete Masonry Units - The lightweight concrete masonry units used in the wall assembly were nominal 8 in. wide by 8 in. high by 16 in. long. The units were manufactured from a concrete mix design consisting of 2135 lb of expanded shale aggregate and 470 lb of Portland cement. The blocks were constructed to accommodate molded polystyrene insulation inserts and had an average equivalent thickness of 3.4 in. The general details of the Hi-R masonry units are shown on ILL. 1.

Insulation - The nominal 1-1/4 in. thick molded polystyrene insulation was supplied by Korfil, Inc. The insulation was molded and pre-cut to fit along the inner surface of the outer face shells. The polystyrene inserts had a nominal density of 1.0 lb/ft<sup>3</sup>.

Mortar - The ready-mixed mortar was Type N in accordance with the Standard Specifications of ASTM C270.

Masonry Reinforcement - Consisted of 10 ft long, 6 in. wide, 3/16 in. diameter steel rod reinforcement, Type "Heavy Duty" manufactured by AA Wire Products Co., Chicago, IL for 8 in. wide concrete block walls.

CONSTRUCTION

The wall assembly was constructed within a 10 ft wide by 10 ft high masonry lined steel test frame. Two each molded polystyrene inserts of masonry insulation were placed in core holes of each concrete block along the face shells on the unexposed side (side opposite fire exposure) of the assembly. A first course of masonry units having one insert per each concrete block was laid on a bed of mortar placed on the concrete sill of the test frame. All other courses of the units had two inserts per each concrete block with a total insulation thickness of 2-1/2 in.

All concrete block courses were laid with the core holes vertical and with the joints staggered. The mortar bed approximately 1/2 in. thick was placed along the face shells and the tongue and groove end joining.

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The prefabricated steel masonry reinforcement was embedded into every other horizontal mortar joint starting from the joint between second and third block courses.

A clearance of about 3/4 in. was provided at the vertical edge on each end of the wall which was filled with mineral wool.

Before the wall was erected, moisture sensing elements were sealed in two representative blocks installed in the second course of the wall. The recorded moisture condition of the blocks were:

<u>Block No.</u>	<u>Relative Humidity, Percent</u>
1	59
2	67

The general appearance of the exposed surface of the assembly before the fire and hose stream tests is shown on ILL. 2.

T E S T   R E C O R D   N O.   1

FIRE ENDURANCE TEST:

The fire test was conducted in accordance with the Standard of Underwriters Laboratories Inc. for Fire Tests of Building Construction and Materials, UL 263 (ANSI A2.1, NFPA No. 251, ASTM E119).

DESCRIPTION OF WALL ASSEMBLY

The concrete masonry wall was constructed in the test frame opening as described in the preceding section of this Letter Report titled "Construction" and as shown on ILL. 2.

METHOD

The standard equipment of Underwriters Laboratories Inc. for the fire test were conducted in accordance with Standard UL 263.

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Prior to the fire exposure, as requested by Korfil, Inc., the wall was loaded to 70 psi of gross cross-sectional area. This compressive strength allowable with Type N mortar per American Standard Building Code Requirements for Masonry was maintained throughout the fire exposure and during the subsequent hose stream test. The horizontal deflections of the wall were measured throughout the test at the center and the quarter points. The vertical movement of the loading beam was not measured.

The temperatures in the furnace were measured with twelve thermocouples placed 6 in. away from the exposed surface and symmetrically located in the furnace chamber as shown in ILL. 3.

The temperatures on the unexposed side of the wall were measured by nine thermocouples (Nos. 1-9) located on concrete blocks positioned either directly over a web or a core hole area.

Throughout the test, observations were made of the character of the fire and its control, the condition of the exposed and unexposed faces and all developments pertinent to the performance of the wall as a fire barrier with reference to stability, heat transmission and passage of flame and hot gases.

## RESULTS

Observations During Application of Load - During application of the load, no cracks developed in the wall. An 1/2 in. movement away from the furnace was noted after the full load of 70 psi was applied during the period prior to the start of the test.

Character and Distribution of Fire - The furnace fire was luminous and well distributed throughout the test period. The furnace temperatures recorded during the fire test are shown on ILL. 3.

Observations of the Unexposed Surface During Fire Exposure - The following notes and observations were taken during the fire test and were edited for clarity. All references to dimensions are approximate.

<u>Test Time,</u> <u>h:min</u>	<u>Observations</u>
0:20	A hairline crack had developed at the center of the wall along Thermocouple Nos. 11 and 14. The concrete blocks became lighter in color. Slight smoke had appeared at the top and sides of the assembly.
0:35	Wet spots had developed at the top of the wall.
0:60	No changes in appearance of the blocks.
1:15	The polystyrene inserts were beginning to melt and consume as noted by a specific smell and dark smoke emanating from the perimeter of wall assembly.
1:40	The dark smoke appeared to be most intense.
2:00	No other apparent physical changes were noted throughout the test. The vertical crack occurred at 20 min did not increase in width and length. An approximate 1/8 in. total wall movement during the fire test was toward the furnace. The test was terminated.

Temperature of the Unexposed Surface - The thermocouple locations are shown on ILL. 1, App. A. The temperatures that developed on concrete blocks during the test are shown on Pages 1 through 6, App. B. The initial average temperature of the unexposed surface was 67°F. The limiting average temperature was 317°F based on a temperature rise of 250°F. The limiting individual temperature was 392°F based on a temperature rise of 325°F.

The limiting individual temperature was reached at 113.5 min (Thermocouple No. 1). The limiting average temperature was reached at 114.5 min based upon the temperatures recorded by Thermocouple Nos. 1-9.

Plots of the average and maximum unexposed surface temperatures are shown by ILL. 4.

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HOSE STREAM TEST:

DESCRIPTION OF SAMPLE

The hose stream was applied to the exposed surface of the wall assembly approximately 2 min after the fire endurance test. The appearance of the exposed surface immediately after the fire test and prior to the application of the hose stream is shown on ILL. 5.

METHOD

The test was conducted in accordance with the Standard for Fire Tests of Building Construction and Materials, UL 263. Because the wall assembly was subjected to a 2 h fire exposure, the assembly was subjected to the action of a 30 psi hose stream applied with 1-1/8 in. nozzle at a perpendicular distance of 20 ft from the center of the test assembly and on a line approximately normal to the center of the test assembly. The hose stream was applied to wall assembly for 150 s.

RESULTS

The exposed surface of the wall was uniformly incandescent when the assembly was withdrawn from the furnace and before application of the hose stream. No cracks were apparent from the exposed side.

The wall withstood the hose stream test, while under load, without developing through openings or penetration of the water stream. Slight erosion of the blocks and, especially, mortar joints to a depth of about 1/4 in. maximum resulted.

OBSERVATIONS AFTER TESTS:

Aside from the slight pitting of the exposed side and approximately 1/4 in. washing away of mortar in joints during the hose stream test, the assembly appeared in good condition. From the unexposed side, the masonry wall contained one 5-6 ft long vertical hairline crack. As viewed during the disassembly, all polystyrene inserts had melted completely.

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The appearance of the exposed surface after the hose stream test is shown on ILL. 6.

S U M M A R Y

Since this Letter Report completes our work for Project 86NK28219 we have instructed our Accounting Department to close the assignment and bill you for the charges incurred.


If you have any questions or comments concerning the subject, please contact us.

Report by:



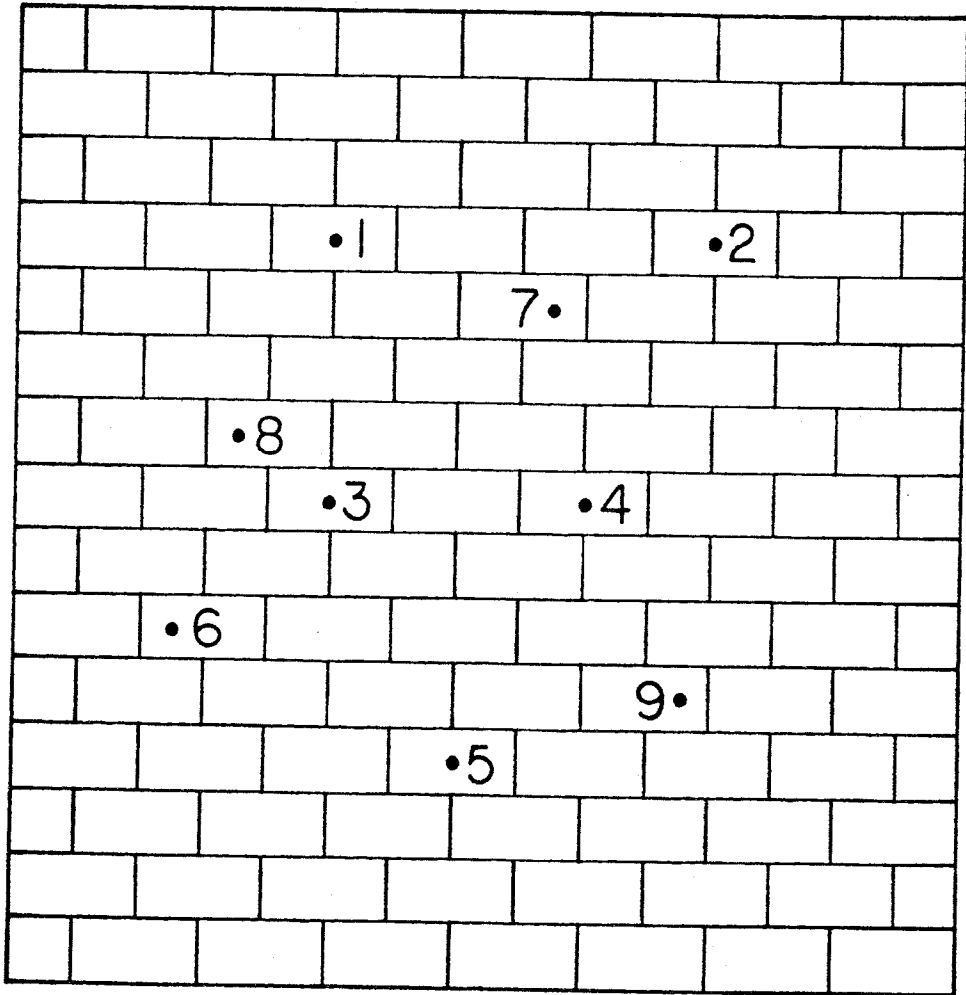
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THERMOCOUPLE LOCATIONS

File R10326-3  
APP. A  
ILL. 1



KORFIL  
 UNEXPOSED SURFACE TEMPERATURES OF WALL  
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## T.C. AT CORE HOLES

CHAN(NOS.) TIME	1	2	3	4	5
0: 0	68.0	64.6	66.9	66.9	65.6
0:15	68.0	68.1	66.9	66.7	65.5
2:44	68.0	68.2	67.0	66.9	65.6
5:14	68.1	68.2	67.0	66.9	65.7
7:44	68.1	68.2	67.0	66.9	65.7
10:14	68.1	68.3	67.0	66.9	65.7
12:44	68.2	68.4	67.1	67.0	65.8
15:14	68.1	68.2	67.0	67.0	65.7
17:44	68.3	68.4	67.1	67.0	65.7
20:14	68.3	68.4	67.1	67.1	65.7
22:44	68.4	68.6	67.2	67.1	65.8
25:14	68.5	68.8	67.3	67.2	65.9
27:44	68.8	69.1	67.5	67.4	65.9
30:14	69.1	69.3	67.6	67.5	66.0
32:43	69.6	69.7	67.9	67.8	66.2
35:14	70.6	70.7	68.5	68.6	66.3
37:44	73.7	73.1	70.2	70.7	67.0
40:14	81.7	80.0	74.2	75.1	68.4
42:44	92.8	89.9	81.0	82.3	71.0
45:14	106.3	102.4	90.3	91.8	75.7
47:43	121.8	116.6	101.3	102.7	82.5
50:14	139.6	132.6	113.5	114.5	90.2
52:43	158.5	149.5	126.2	126.6	98.7
55:14	178.1	167.5	139.6	139.1	107.9
57:44	191.0	183.8	152.4	150.9	116.8
60:14	194.6	191.9	164.9	162.4	126.0
62:43	195.1	193.7	176.1	172.6	135.0
65:14	195.2	193.9	184.6	180.9	144.1
67:44	195.5	194.4	189.3	186.6	152.4
70:14	197.4	195.8	192.7	190.8	160.6
72:44	201.4	199.2	196.5	194.7	168.9
75:14	207.0	204.0	201.1	198.9	176.4
77:43	213.7	210.0	206.2	203.7	183.1
80:14	221.6	216.9	211.7	209.3	190.0
82:44	230.7	225.3	217.5	215.3	196.6

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## T.C. AT CORE HOLES

CHAN(NOS.)	1	2	3	4	5
TIME					
85:14	240.7	234.8	223.8	221.9	203.6
87:43	251.5	245.2	230.9	229.3	210.5
90:14	262.8	256.3	238.6	237.5	217.5
92:44	274.2	267.8	246.8	245.8	224.7
95:14	286.3	280.1	255.4	254.5	232.1
97:43	299.3	293.6	264.6	263.8	240.0
100:14	313.3	307.8	275.0	274.5	248.4
102:44	327.4	322.1	285.8	286.0	256.7
105:14	341.8	336.6	297.6	298.8	265.8
107:43	356.4	351.3	310.2	312.3	275.2
110:14	371.4	366.3	323.6	326.1	285.2
112:43	386.4	381.2	337.4	340.0	295.6
115:14	401.5	396.4	351.6	354.3	306.8
117:43	416.9	411.8	365.9	368.8	318.1
120:14	432.6	427.6	380.4	383.2	329.4

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## T.C. AT WEBS

CHAN(NOS.)	6	7	8	9
TIME				
0: 0	66.5	67.8	67.3	66.0
0:15	66.4	67.8	67.2	65.9
2:44	66.5	67.8	67.3	66.0
5:14	66.6	67.9	67.4	66.1
7:44	66.5	67.9	67.4	66.0
10:14	66.6	67.9	67.4	66.0
12:44	66.7	68.0	67.5	66.1
15:14	66.5	67.9	67.4	66.1
17:44	66.6	68.0	67.5	66.1
20:14	66.6	68.1	67.5	66.1
22:44	66.7	68.3	67.7	66.2
25:14	66.7	68.7	68.0	66.2
27:44	66.8	69.6	68.7	66.3
30:14	66.9	71.1	69.8	66.4
32:43	67.1	73.5	71.5	66.6
35:14	67.2	76.4	73.5	66.8
37:44	67.5	80.0	76.2	67.2
40:14	68.0	84.1	80.0	67.9
42:44	69.3	88.9	84.7	69.1
45:14	72.1	95.2	90.4	71.5
47:43	76.5	102.5	96.4	75.2
50:14	81.9	110.9	102.9	80.0
52:43	88.3	120.3	109.7	85.7
55:14	95.1	131.6	117.1	92.2
57:44	102.0	144.3	124.6	98.9
60:14	109.0	158.8	132.9	106.2
62:43	116.0	172.6	142.7	113.7
65:14	123.5	183.3	153.8	121.6
67:44	131.0	188.7	164.4	129.3
70:14	138.7	190.8	174.0	137.4
72:44	146.5	192.0	181.2	145.5
75:14	153.6	192.1	185.9	153.1
77:43	160.4	192.5	188.8	160.1
80:14	166.7	191.3	190.7	166.8
82:44	172.1	194.2	192.2	172.7

KORFIL  
UNEXPOSED SURFACE TEMPERATURES OF WALL  
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## T.C. AT WEBS

CHAN(NOS.)	6	7	8	9
TIME				
85:14	176.8	195.9	193.7	178.0
87:43	180.9	199.0	195.3	182.8
90:14	184.5	204.0	198.0	186.9
92:44	187.6	210.2	201.9	190.7
95:14	190.7	217.8	206.1	194.9
97:43	194.2	226.8	210.9	199.0
100:14	197.9	237.6	216.7	203.4
102:44	201.6	248.7	224.0	207.9
105:14	205.6	260.9	233.3	212.6
107:43	209.6	274.7	244.3	217.4
110:14	213.8	291.3	256.3	222.2
112:43	218.7	307.4	270.5	227.5
115:14	224.7	323.4	286.3	234.3
117:43	231.9	336.3	301.5	241.9
120:14	240.0	354.1	316.8	249.9

KORFIL  
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MAXIMUM INDIVIDUAL

TIME	TEMPERATURE	CHAN.	AVG.
0:0	68.0	1	66.6
0:15	68.1	2	66.9
2:44	68.2	2	67.0
5:14	68.2	2	67.1
7:44	68.2	2	67.1
10:14	68.3	2	67.1
12:44	68.4	2	67.2
15:14	68.2	2	67.1
17:44	68.4	2	67.2
20:14	68.4	2	67.2
22:44	68.6	2	67.3
25:14	68.8	2	67.5
27:44	69.6	7	67.8
30:14	71.1	7	68.2
32:43	73.5	7	68.9
35:14	76.4	7	69.8
37:44	80.0	7	71.7
40:14	84.1	7	75.5
42:44	92.8	1	81.0
45:14	106.3	1	88.4
47:43	121.8	1	97.3
50:14	139.6	1	107.3
52:43	158.5	1	118.2
55:14	178.1	1	129.8
57:44	191.0	1	140.5
60:14	194.6	1	149.6
62:43	195.1	1	157.5
65:14	195.2	1	164.5
67:44	195.5	1	170.2
70:14	197.4	1	175.4
72:44	201.4	1	180.7
75:14	207.0	1	185.8
77:43	213.7	1	190.9
80:14	221.6	1	196.1
82:44	230.7	1	201.8
Maximum & Average of Channel(s)-		1 2 3 4 5 6 7 8	

KORFIL  
 UNEXPOSED SURFACE TEMPERATURES OF WALL  
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MAXIMUM INDIVIDUAL

TIME	TEMPERATURE	CHAN.	AVG.
85:14	240.7	1	207.7
87:43	251.5	1	213.9
90:14	262.8	1	220.7
92:44	274.2	1	227.7
95:14	286.3	1	235.3
97:43	299.3	1	243.6
100:14	313.3	1	252.7
102:44	327.4	1	262.2
105:14	341.8	1	272.6
107:43	356.4	1	283.5
110:14	371.4	1	295.1
112:43	386.4	1	307.2
115:14	401.5	1	319.9
117:43	416.9	1	332.6
120:14	432.6	1	346.0
Maximum & Average of Channel(s)-		1 2 3 4 5 6 7 8	

# AVERAGE & MAXIMUM INDIVIDUAL TEMPERATURE

2/18/67 TEST PER UL288 CONCRETE BLOCKS

