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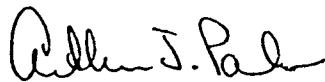
CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
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FIRE PERFORMANCE EVALUATION OF WALL ASSEMBLY CONSTRUCTED USING 12-IN. CMU BLOCK FILLED WITH CORE-FILL-500 FOAM INSULATION AND LOADED TO 4000 LB/FT

FINAL REPORT
SwRI Project No. 01-5920-305
March 1994

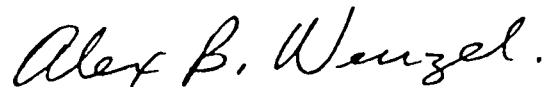
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ABSTRACT

The distinct loaded wall assembly described herein was tested in accordance with the standard procedures outlined in ASTM E119-88, "Standard Test Methods for Fire Tests of Building Construction and Materials" and UBC 17-5, "Room Fire Test Standard for Interior of Foam Plastic Systems." The wall assembly was constructed using standard 12-in. Concrete Masonry Units (CMU) block filled with Core-Fill-500 Foam Insulation manufactured by Tailored Chemical Products, Inc. located in Hickory, North Carolina. The wall was loaded to 4,000 lb/ft by controlling the pressure in six hydraulic jacks on the "floating" I-beam located on top of the wall assembly. The loaded wall assembly successfully resisted a 4-hour fire exposure without allowing excessive temperature rise, or the passage of flame or gases hot enough to ignite cotton waste. Having also successfully resisted the application of the water stream, the wall assembly achieved a 4-hour fire resistance rating.

Additionally, the wall assembly successfully resisted the fire exposure described in UBC 17-5 for a 15-minute fire test without allowing flaming of the assembly to the 8-ft extremities or generating excessive levels of smoke.

1.0 INTRODUCTION

This report describes the testing and analysis of a distinct wall assembly, and includes descriptions of the test procedure followed, assembly tested, and the results obtained. The results presented in this report apply only to the material tested, in the manner tested, and not to any similar materials or material combinations. All test data are on file and are available for review by authorized persons.

1.1 ASTM E119-88 Loaded Wall Test

The ASTM E119-88, "Standard Test Methods for Fire Tests of Building Construction and Materials" is intended to evaluate the duration for which the described assembly will contain a fire, or retain its structural integrity, or display both properties dependent upon the type of assembly involved, during a predetermined fire test exposure.

The test exposes a wall assembly to a standard fire exposure controlled to achieve specified temperatures throughout a specified time period. The fire exposure may be followed by a standard hose stream test which subjects the specimen to impact, erosion, and cooling effects of the water stream. Points on the standard time/temperature curve are shown in Table 1 and are used to control the fire exposure.

Table 1. Points On The Time/Temperature Curve

TIME	TEMPERATURE
0 minutes	Ambient
5 minutes	1000°F (538°C)
10 minutes	1300°F (704°C)
30 minutes	1550°F (843°C)
45 minutes	1638°F (892°C)
60 minutes	1700°F (927°C)
2 hours	1850°F (1010°C)
3 hours	1925°F (1052°C)
4 hours	2000°F (1093°C)

This test measures the assembly's response to exposure in terms of the transmission of heat and hot gasses through the assembly during the fire exposure.

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment, which takes into account all the factors that are pertinent to an assessment of the fire hazard of a particular end use.

1.2 UBC 17-5 Room Corner Test

The UBC 17-5, "Room Fire Test Standard for Interior of Foam Plastic Systems" is intended to evaluate the duration for which the described assembly will prevent flame spread and will not generate excessive smoke during a predetermined fire test exposure. The test exposes an assembly to a standard fire exposure to evaluate the burning characteristics of foam plastic assemblies in a standard room configuration.

2.0 TEST PROCEDURE

2.1 ASTM E119-88 Loaded Wall Test

The SwRI vertical furnace is capable of exposing a maximum test specimen of 12-1/2 ft high and 12-1/2 ft wide. The 30-in. deep furnace is equipped with nine flat-flame burners symmetrically placed across the back wall, and controlled by a variable air-gas ratio regulator. Viewports are located on both sides of the furnace to allow observation of the surface exposed to flame.

The conduct of the fire test is controlled according to the standard time/temperature curve, as indicated by the average temperature obtained from the readings of nine thermocouples symmetrically located across the face of the specimen, 6 in. away from the specimen surface. The thermocouples are enclosed in protection tubes of such material and dimensions that the time constant of the thermocouple assembly lies between 5.0 and 7.2 minutes, as required by the standard. The furnace temperature during a test is controlled such that the area under the time/temperature curve is within 10% of the corresponding area under the standard time/temperature curve for test of 1 hour or less, 7.5% for those tests less than 2 hours, and 5% for those tests of 2 hours or more duration.

A constant load of 4,000 lb/ft was applied to the wall assembly by means of controlling the pressure in six hydraulic jacks placed above the "floating" I-beam of SwRI's specially designed load frame. Figure A-1 of Appendix A shows the placement of the six hydraulic jacks, the wall orientation, and the makeup of the I-beam load frame.

Temperatures of unexposed surfaces are measured with No. 20 B&S gauge, type K (Chromel-Alumel) welded thermocouples, placed under flexible, dry, felted mineral fiber pads. The wire leads of each thermocouple terminate under the pad and are in contact with the unexposed surface for not less than 3.5 inches. The pads are attached firmly to the surface to minimize any heat loss from the sides. Temperature levels are monitored continuously throughout the test and recorded with computer data acquisition equipment for subsequent data reduction. The location of the thermocouples on the unexposed face is shown in Figure A-2 of Appendix A.

Where required by conditions of acceptance, the specimen is subjected (immediately after the fire exposure period) to the impact, erosion, and cooling effects of a water stream directed first at the middle and then at all parts of the exposed face, with changes in direction being made slowly. The water stream is applied from a distance of 20 ft and delivered through a 2.5-in. (64 mm) hose discharging through a National Standard Playpipe of corresponding size equipped with a 1 1/8-in. (28.5 mm) discharge tip of the standard-taper, smooth-bore pattern. The water pressure and duration are outlined in Table 2.

Table 2. Conditions For Hose Stream Test

RESISTANCE PERIOD (hours)	WATER PRESSURE AT BASE OF NOZZLE psi (kPa)	DURATION OF APPLICATION Min/100 ft² (Min/9.3 m²) EXPOSED AREA
8 and over	45 (310)	6
4 and over, if less than 8	45 (310)	5
2 and over, if less than 4	30 (207)	2.5
1.5 and over, if less than 2	30 (207)	1.5
1 and over, if less than 1.5	30 (207)	1
Less than 1, if desired	30 (207)	1

2.2 UBC 17-5 Room Corner Test

The test room measured 8 ft wide x 12 ft long with an 8-ft high ceiling (internal dimensions) with a single doorway measuring 30 in. wide x 7 ft high. The 12-in. CMU filled block formed the 8-ft square walls joined to form the fire corner. The testing was performed in The Department of Fire Technology's conditioned high-bay test facility, which is 40-ft wide x 90-ft long with a 24-ft high ceiling. Eight No. 20 B&S gauge, type K (Chromel-Alumel) welded thermocouples were used for temperature measurements in the test room and placed as shown in Figure A-3 of Appendix A.

The ignition source consisted of a wood crib constructed of 1.5 x 1.5-in. sticks of Douglas Fir wood cut into 15-in. lengths. The crib had a dry wood weight of 30 lb and was 15 in. in plan. One 8 penny nail was driven at each intersection of two sticks. The crib was assembled in tiers of five sticks with each tier orientated 90° to the sticks in the adjacent tiers. Prior to the placement of the crib in the room, the moisture content was verified that it was below 8%.

The wood was placed in the test room on four brick pieces, one under each corner of the crib, to provide a 4-in. space between the floor and the lower surface of the crib. Ignition of the crib was accomplished by evenly distributing 1 lb of shredded and fluffed wood excelsior beneath the crib over a 21 x 21-in. area, and soaking with 4 ounces of absolute alcohol.

3.0 TEST ASSEMBLY

The E119 loaded wall and the UBC 17-5 Room Corner walls were constructed on February 7 and 8, 1994, respectively, by the client. On February 10, 1994, the cells in all the walls were filled with Core-Fill-500 insulation, and the walls were allowed to cure for 28 days prior to testing.

The ASTM E119 wall assembly had overall dimensions of 12 ft wide x 10 ft 4 in. high. The wall consisted of 12-in. CMU block utilizing Type S mortar at all joints. Additionally, one cell was fully packed with mortar every 4 ft. The wall was allowed to cure for approximately 3 days and was filled with the insulation material through a series of horizontal holes drilled into the cavities at the joint between the 3rd and 4th level of block from the bottom and at the joint between the 12th and 13th level. After the filling was completed, the holes were then patched using Type S mortar.

Thermocouples (TC's) were placed on the unexposed surface of the wall in accordance with ASTM E119-88. Each individual TC was placed under a dry, felted pad which was adhered to the wall assembly with dabs of Dow Corning Firestop Caulking in each of the four corners. Additionally, lead anchors were set in the mortar joint, placed at diagonal corners with the felted pad, with a piece of stainless steel wire providing a secondary means of insuring contact of the TC with the test wall. The wall was exposed to the heating conditions for the prescribed time period. After the fire exposure was completed, the hose stream test was performed. Construction drawings of the loaded wall assembly can be found in Appendix A, Construction Drawings.

The UBC 17-5 Room Corner walls measured 8 ft square and were joined at the corner. The walls were constructed using 12-in. CMU block utilizing Type S mortar at all joints. All the cells were left hollow for the fire exposure test. After the 3-day cure time, the cells of the wall were filled with the insulation material by inserting a nozzle inside the wall assembly from the top and filling from the bottom up.

4.0 TEST RESULTS

On March 14, 1993, Mr. Jack Temple representing Tailored Chemical Products, Incorporated, and Mr. Rex Ryan and Mr. Steve Bussey representing Southern States Tailored Foam were present to witness both fire tests.

4.1 ASTM E119-88 Loaded Wall Test

At approximately 9:45 a.m., the pressure to the hydraulic jacks was increased to 720 psi, which corresponded to an applied load of 4,000 lb/ft. The thermocouple connections were verified and the burners were ignited to begin the 4-hour fire exposure. The ambient temperature at the beginning of the test was 73°F. Visual observations taken during the test are shown in Table 3.

At the end of the 4-hour exposure period, the furnace was shut down and the fire exposure test terminated. At this time, the average temperature on the unexposed face was 208°F, and the maximum single temperature was 228°F. The test method allows for the average temperature on the unexposed surface to be a maximum of 250°F above ambient temperature (323°F), and no single thermocouple can exceed 325°F above ambient (398°F).

Table 3. Visual Test Observations

TIME (min:sec)	OBSERVATIONS
45:00	Vertical crack at center of wall. Steam escaping from top portion of crack and at spots on top of the wall.
120:00	Multiple small cracks with steam escaping from cracks.
180:00	Moderate amounts of steam still escaping through cracks in wall. Moisture spots observed over the unexposed face of the wall.
240:00	Amount of steam has significantly decreased. Test Terminated.

The wall assembly was immediately subjected to the erosive, cooling, and impact forces of the hose stream for a period of 5 minutes at a pressure of 45 psi. The wall successfully prevented the direct passage of water through the assembly. After the hose stream test was completed, the wall was inspected and documentary photographs were made.

4.2 UBC 17-5 Room Corner Test

At approximately 2:09 p.m., the thermocouple connections were verified and the wood crib was ignited to begin the 15-minute fire exposure test. The ambient temperature at the beginning of the test was 73°F, and the relative humidity was 56 %. Visual observations taken during the test are shown in Table 4.

At the end of the 15-minute exposure period, the wood crib was extinguished, and the fire exposure test terminated. Flaming did not extend to the 8-ft extremities from the crib corner at any time during the fire test. Smoke levels were negligible with all smoke coming from the gypsum wallboard. Upon inspection of the wall after the fire test, the foam insulation showed no signs of discoloration in the fire corner or at the 8-ft extremities. The foam filled wall assembly successfully passed the UBC 17-5 fire exposure test.

Table 4. Visual Test Observations

TIME (min:sec)	OBSERVATIONS
0:23	Flame height approximately at 5 ft level
3:25	Flame height approximately at 6 ft level
5:00	Flames reaching the ceiling
10:06	Paper of gypsum wallboard above wood crib discoloring
13:30	Paper on gypsum wallboard above wood crib flashing
15:00	Test Terminated

Complete photographic documentation of the fire exposures and hose stream test appears in Appendix B, Photographic Documentation. Temperature data in both tabular and graphical form obtained during the each test are provided in Appendix C, Temperature Data.

5.0 CONCLUSIONS

The distinct loaded wall assembly described herein was tested in accordance with the standard procedures outlined in ASTM E119-88, "Standard Test Methods for Fire Tests of Building Construction and Materials" and UBC 17-5, "Room Fire Test Standard for Interior of Foam Plastic Systems." The wall assembly was constructed using standard 12-in. CMU block filled with Core-Fill-500 Foam Insulation manufactured by Tailored Chemical Products, Incorporated located in Hickory, North Carolina. The wall was loaded to 4,000 lb/ft by controlling the pressure in six hydraulic jacks on the "floating" I-beam located on top of the wall assembly. The wall assembly successfully resisted a 4-hour fire exposure without allowing excessive temperature rise, or the passage of flame or gases hot enough to ignite cotton waste. Having also successfully resisted the application of the water stream, the wall assembly achieved a 4-hour fire resistance rating.

Additionally, the wall assembly successfully resisted the fire exposure described in UBC 17-5 for a 15-minute fire test without allowing flaming of the assembly to the 8-ft extremities or generating excessive levels of smoke.

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
DEPARTMENT OF FIRE TECHNOLOGY
FAX (210) 332-3377

November 4, 1996

Mr. Jack Temple, Jr.
Tailored Chemical Products, Inc.
3719 1st Avenue SW
Hickory, NC 28601

Reference: Telecon of October 15, 1996, concerning fire performance ratings of concrete masonry block wall assemblies

Subject: Comparison of test results for SwRI Final Report No. 01-7522-607 with fire resistance rated wall assemblies

Dear Dr. Temple:

In accordance with your request for comparison of fire performance ratings of concrete masonry unit (CMU) block wall assemblies, I have reviewed UL Design Nos. U901 and U907, published in Underwriters Laboratories Inc. Fire Resistance Directory, Volume 1 (pp. 1166-1168) and the data from the above referenced report.

UL Design No. U901 states the CMU's classified as B-4 (4 hr) are 4-hr rated and CMU's classified as D-2 (2 hr) or C-3 (3 hr) will provide a 4-hr fire resistance rating when all core spaces filled with loose dry expanded slag burned clay or shale (rotary kiln process), water repellant vermiculite masonry fill insulation, or silicone treated perlite loose fill insulation.

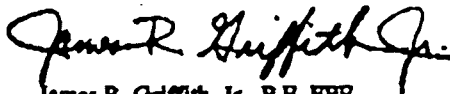
UL Design No. U907 states that the CMU's classified as B-4 (4 hr) are 4-hr rated and CMU's classified as C-3 (3 hr) will provide a 4-hr fire resistance rating when the entire core space is filled as described in UL Design No. 901.

SwRI final report No. 01-7522-607 states that the test wall assembly was constructed with 2-hr rated CMU's with all core spaces filled with either mortar or a proprietary formulation of Tailored Chemical Products, Inc. CORE-FILL 500 foam insulation was tested in accordance with ASTM E119-95 and achieved a 4-hr fire resistance rating.

Based on the information listed in the ULI Fire Resistance Directory and SwRI Final Report No. 01-7522-607, CMU wall assemblies constructed in accordance with UL Design Nos. U901 and U907 for 4-hour fire resistance ratings and CMU wall assemblies constructed as described in the referenced SwRI Report will provide 4-hour fire resistance ratings.

Thank you for the opportunity to be of service. If you should have any questions or comments, or if I may be of further assistance, please do not hesitate to contact me at 210/522-3716. I can be reached by fax at 210/522-3377.

Sincerely,



James R. Griffith, Jr., P.E. FPB
Program Manager
Engineering Services

Approved:



Alex B. Wenzel
Director
Department of Fire Technology

JRG:lr
WWW.SWRI.COM/017522-607.LTR



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Accreditation of our testing laboratories and Listing, Labeling, and Follow-up Inspections Program is an ongoing process. This is due to the ever-changing requirements of various federal agencies and increasing number of state agencies that are introducing formal local accreditation procedures.

At the **FEDERAL** level, SwRI now enjoys full accreditation under the formal programs established by the Federal Aviation Administration (FAA), the General Services Administration (GSA), the Department of Housing and Urban Development (HUD), the Nuclear Regulatory Commission (NRC) and the Defense Industrial Supply Center (DISC). SwRI has been accredited as a Nationally Recognized Testing Laboratory (NRTL) by the Occupational Safety and Health Administration (OSHA).

SwRI is fully accredited by the National Evaluation Services (NES) under NER TL-351 and NER QA-409. NES is the blanket organization which includes ICBO-ES, BOCA-ES, and SBCCI-Public Safety and ES.

At the **STATE** level, SwRI continuously maintains and updates individual state accreditations depending on the level of formality in any given state. SwRI has received formal notification of accreditation under the respective state programs listed below. Several other states are in the process of establishing formal programs. SwRI monitors such activity to ensure complete accreditations.

On an **INTERNATIONAL** level, SwRI and its Department of Fire Technology have tailored their Third Party Listing and Labeling Program to be in full compliance with ANSI Standard Z-34.1-1987 and follows the ISO/IEC Guides 25, 27, 28, 48, and 49. The program includes listing and labeling with follow-up inspections of products, components and materials for the continued assurance of consistent production quality and fire performance.

ACCREDITATIONS AND RECOGNITIONS

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International Conference of Building Officials Evaluation Service, Inc. (ICBO-ES)
Building Officials and Code Administrators Int'l, Inc. Evaluation Services, Inc. (BOCA-ES)
Southern Building Code Congress Int'l--Public Safety Testing and Evaluation Services, Inc. (SBCCI-PST&ES)
National Evaluation Report--Testing Laboratory (NER-TL 351); Quality Assurance (NER-QA 409)
Occupational Safety and Health Administration (NRTL-OSHA)
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