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FIRE PERFORMANCE EVALUATION OF A LOADED WALL ASSEMBLY CONSTRUCTED USING 8-IN. CMU BLOCK FILLED WITH CORE-FILL-500 FOAM INSULATION, TESTED IN ACCORDANCE WITH ASTM E119, "STANDARD TEST METHODS FOR FIRE TESTS OF BUILDING CONSTRUCTION AND MATERIALS"

FINAL REPORT
SwRI Project No. 01-6740-711
August 1995

Prepared for:
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Director
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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." The wall assembly, similar to U.L. Design Nos. U901 and U905, was constructed using standard 8-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.

The loaded wall assembly successfully resisted a 4-hr fire exposure without allowing excessive temperature rise or the passage of flame or gases hot enough to ignite cotton waste. At the end of the 4-hr fire exposure period, the average temperature of the unexposed face was 206°F, with the highest single thermocouple measuring 207°F. The standard test method allows the average temperature measured on the unexposed face to rise no more than 250°F above ambient (340°F) and limits any single thermocouple reading to 325°F above ambient (415°F). Having also successfully resisted the application of the water stream, the wall assembly achieved a 4-hr fire resistance rating.

1.0 INTRODUCTION

This report describes the testing 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.

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 is followed by a standard hose stream test which subjects the specimen to the 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 response of the assembly 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.

2.0 TEST PROCEDURE

Southwest Research Institute's (SwRI) large-scale vertical furnace, located in San Antonio, Texas, is capable of exposing a test specimen measuring up to 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, controlled by a variable air-gas ratio regulator. View ports 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 tests of 1 hr or less, 7.5% for those tests less than 2 hr, and 5% for those tests of 2 hr or more duration.

At the client's direction, 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.

Immediately after the fire exposure period, the specimen is subjected 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 ft^2 (Min/9.3 m^2) 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

3.0 TEST ASSEMBLY

The ASTM E119 wall assembly had overall dimensions of 12 ft wide x 10 ft high and was constructed on June 21, 1995, with 8-in. CMU block utilizing Type S mortar at all joints, similar to U.L. Design Nos. U901 and U905. The cells of the CMU block were filled with mortar as shown in Figure A-3 of Appendix A. The wall was allowed to cure for 1 day and was filled with Core-Fill-500 insulation material through a series of horizontal holes drilled into the cavities at the joint between the 3rd and 4th, 5th and 6th, 9th and 10th, and 12th and 13th level of block from the bottom. After the filling was completed, the holes were patched using Type S mortar. The completed wall assembly was allowed to cure for 28 days prior to testing.

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 a small amount of caulking under two opposite 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.

4.0 TEST RESULTS

On July 26, 1995, Mr. Jack Temple III representing Tailored Chemical Products, Incorporated, and Mr. Rex Ryan and Mr. Steve Bussey representing Southern States Tailored Foam were present to witness the fire test. At approximately 7:53 a.m., the pressure to the hydraulic jacks was increased to 720 psi, corresponding to an applied load of 4,000 lb/ft. The thermocouple connections were verified and the burners ignited to begin the 4-hr fire exposure. The ambient temperature at the beginning of the test was 90°F. Visual observations taken during the test are shown in Table 3.

Table 3. Visual Test Observations

TIME (min:sec)	OBSERVATIONS
160:00	Vertical crack at center of wall forming on left third of wall.
240:00	Test Terminated.

At the end of the 4-hr exposure period, the furnace was shut down and the fire exposure test terminated. At this time, the average temperature on the unexposed face was 206°F, and the maximum single temperature was 207°F. The test method allows for the average temperature on the unexposed surface to be a maximum of 250°F above ambient temperature (340°F), and no single thermocouple can exceed 325°F above ambient (415°F).

The wall assembly was immediately subjected to the erosive, cooling, and impact forces of the hose stream for a period of 5 min 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 taken.

Photographic documentation of the fire exposure and hose stream tests appears in Appendix B, Photographic Documentation. Temperature data in both tabular and graphical form obtained during the 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." The wall assembly, similar to U.L. Design Nos. U901 and U905, was constructed using standard 8-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.

The loaded wall assembly successfully resisted a 4-hr fire exposure without allowing excessive temperature rise or the passage of flame or gases hot enough to ignite cotton waste. At the end of the 4-hr fire exposure period, the average temperature of the unexposed face was 206°F, with the highest single thermocouple measuring 207°F. The standard test method allows the average temperature measured on the unexposed face to rise no more than 250°F above ambient (340°F) and limits any single thermocouple reading to 325°F above ambient (415°F). Having also successfully resisted the application of the water stream, the wall assembly achieved a 4-hr fire resistance rating.

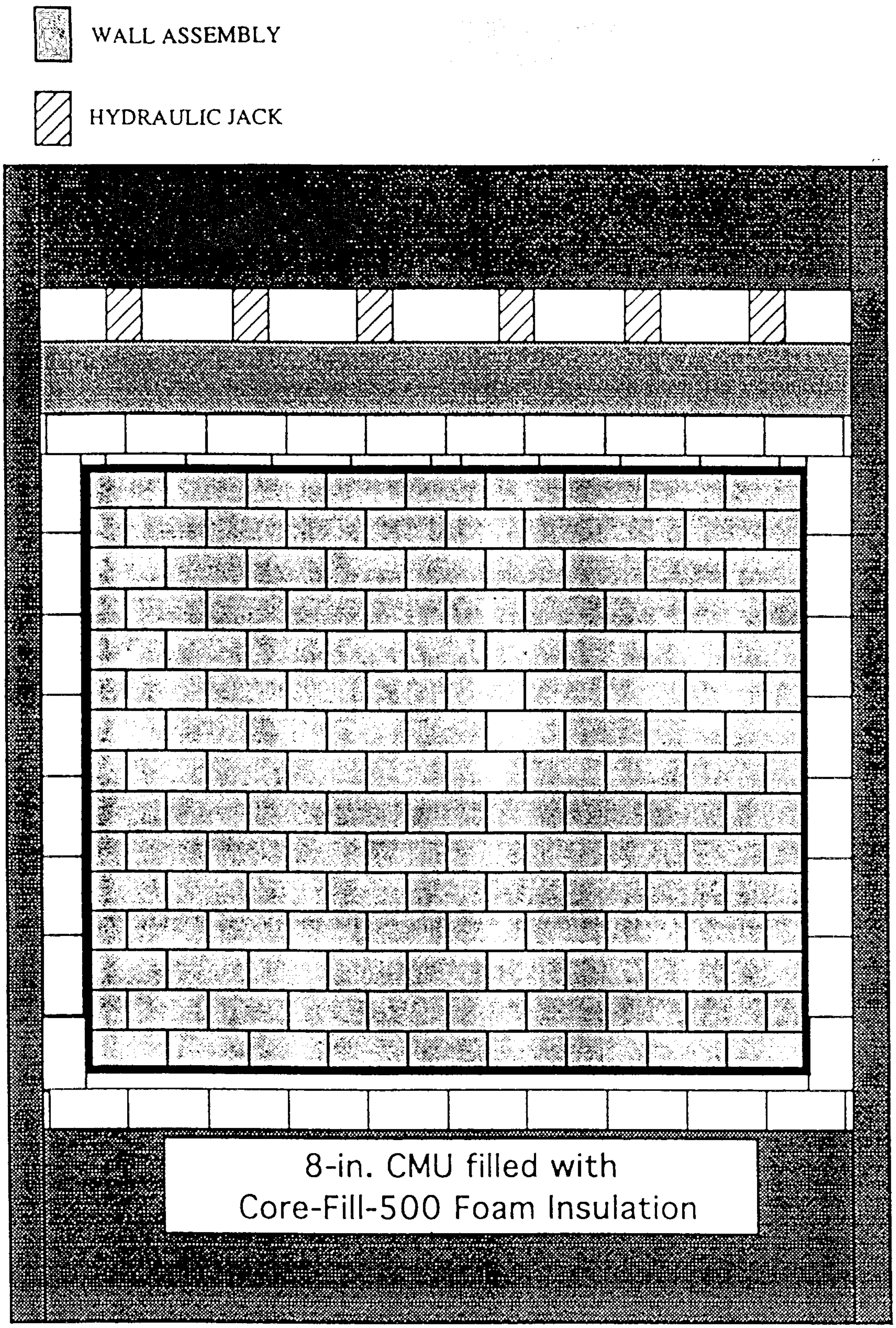

Figure A-1. Wall Assembly in Load Frame.

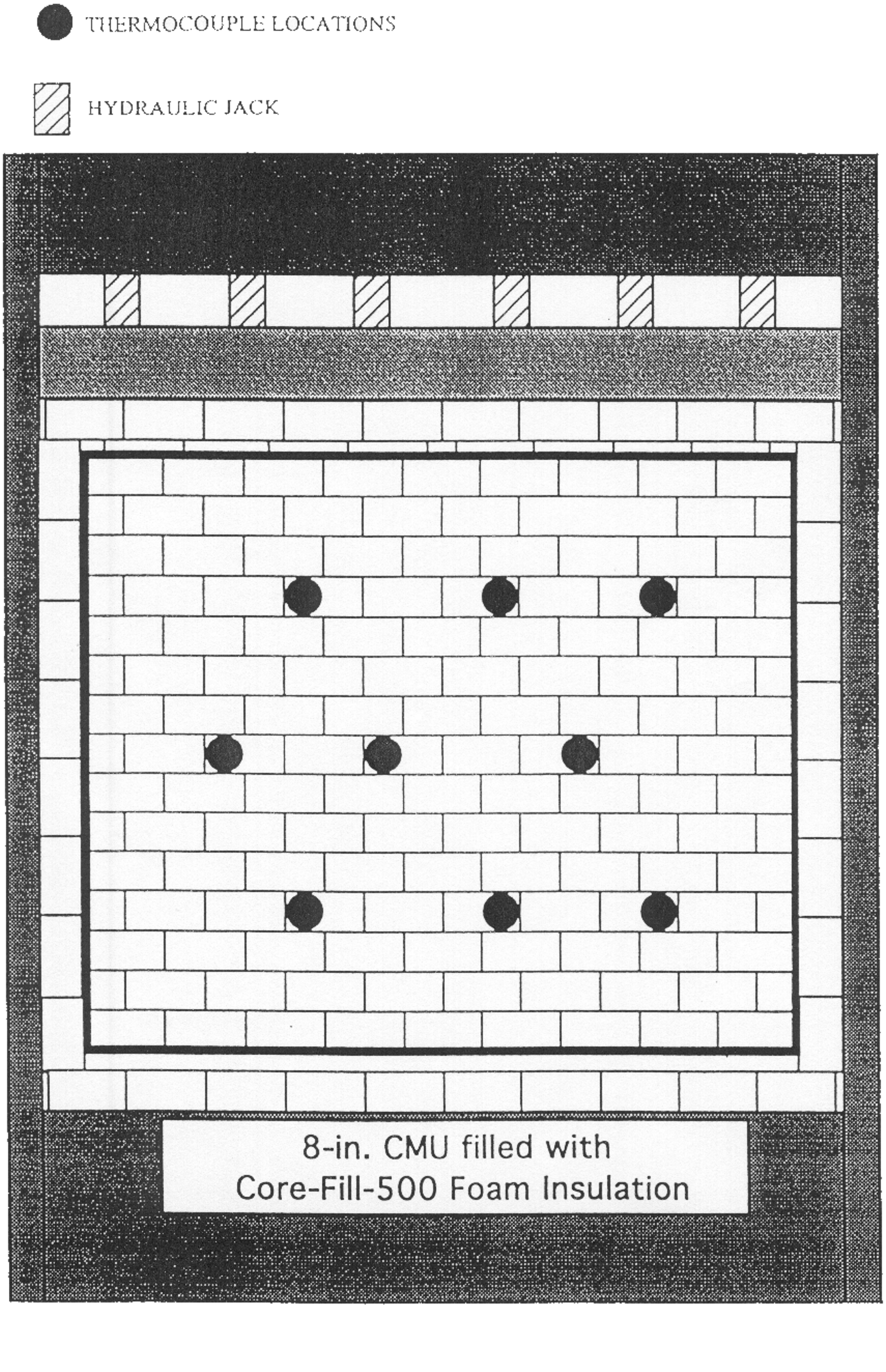

Figure A-2. Thermocouple Locations on Wall Assembly.

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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 construced 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.

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

Approved:

Alex B. Wenzel

Alex B. Wenzel
Director
Department of Fire Technology

JRG\lr

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SwRI's DEPARTMENT OF FIRE TECHNOLOGY ACCREDITATIONS

Southwest Research Institute (SwRI) is an independent, nonprofit, applied engineering and physical sciences research and development organization involving more than 2,400 research and support personnel. The Department of Fire Technology is a part of the Chemistry and Chemical Engineering Division, and has more than 35 years experience in fire research and product testing.

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

National Evaluation Service, Inc. (NES)
International Conference of Building Officials Evaluation Service, Inc. (ICBO-ES)
Building Officials and Code Administrators Int'L, Inc. Evaluation Services, Inc. (BOCAI-ES)
Southern Building Code Congress Int'L--Public Safety Testing and Evaluation Services, Inc. (SBCCI-PST&ESI)
National Evaluation Report--Testing Laboratory (NER-TL 351); Quality Assurance (NER-QA 409)
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