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DOW CORNING U.S.A.
Midland, Michigan 48640

FIRE AND HOSE STREAM TESTS OF CABLE TRAY SEALS - DOW TEST NO. 4

by

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Submitted by

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PENETRATION SEALS - DOW TEST NO. 4

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INTRODUCTION

At the request of Dow Corning U.S.A. (DOW) and as authorized by Purchase Order No. 17262-N, Construction Technology Laboratories (CTL) performed a series of five fire and hose stream tests on penetration seal systems. This report describes results of the fourth test in the program, performed on two cable tray penetration seals.

The penetration seal systems consisted of Dow Corning 3-6548 Silicone RTV Foam. The 12-in. thick foam seal systems were cast around two cable tray assemblies installed in a 30x30-in. opening within a 48x48x12-in. concrete slab. The 30x30-in. opening was divided into two 14-1/2x30-in. areas by a 1-in. thick piece of insulation board, as shown in Fig. 1. Slabs were constructed by CTL personnel. Seal systems and cable trays were installed by DOW personnel with construction assistance provided by CTL.

The fire and hose stream tests were performed at the fire research facilities of CTL on October 19, 1984. The slab containing the two cable trays and penetration seals was subjected to a 3-hr fire exposure in accordance with the time temperature

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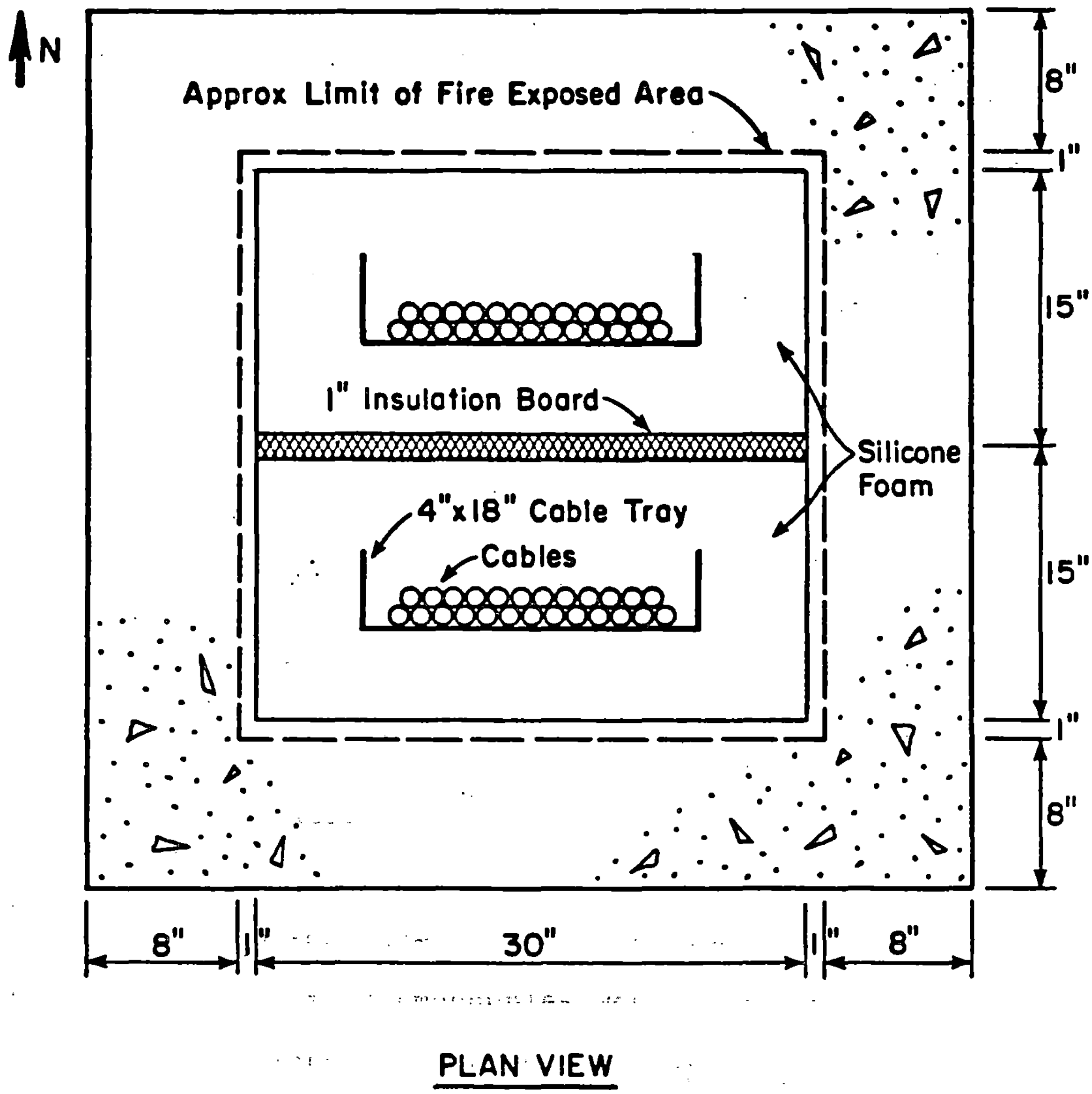

FIG. 1 LAYOUT OF CONCRETE SLAB WITH TWO SILICONE FOAM SEALS AND PENETRATING CABLE TRAY ASSEMBLIES

relationship and procedures specified in ASTM Designations: E119[1]* and E814.[2] Immediately after the fire test, the specimen was removed from the furnace and subjected to two hose stream tests in accordance with provisions of IEEE 634[3] and ASTM Designation: E119.

SUMMARY OF RESULTS

The test assembly, consisting of two cable trays and penetration seal systems slab, was subjected to a 3-hr fire test and subsequent hose stream tests. Seals were installed in two 14-1/2x30-in. openings penetrating through the 12-in. thick concrete slab. The openings were separated by a 1-in. thick piece of insulation board. The seals consisted of 12-in. thicknesses of Dow Corning 3-6548 Silicone RTV Foam.

The following are significant test results:

1. No passage of flame occurred through either of the two seal systems during the 3-hr fire test.
2. Limiting end point temperature criterion defined by ASTM Designation: E814 was not exceeded on the unexposed surface of either of the two seal systems during the 3-hr fire test. Limiting end point temperature rise defined by ASTM Designation: E814 was exceeded at several measuring points on cables in both Tray Nos. 1 and 2. Limiting end point temperature criterion defined by IEEE 634 was exceeded at one measuring point on a power cable in Tray No. 1.

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*Numbers in parentheses designate References on Page 18.

3. No water projected beyond the unexposed surface of either of the two penetration seals during the 14 second IEEE 634 hose stream test.

4. No water projected beyond the unexposed surface of the penetration seal containing Tray No. 1 during the 24 second ASTM Designation: E119 hose stream test. Water did project beyond the unexposed surface of the penetration seal containing Tray No. 2 during the ASTM Designation: E119 hose stream test.

TEST ASSEMBLY

A 48x48x12-in. thick concrete slab specimen containing a 30x30-in. square opening was fabricated by CTL personnel. The opening was located in a nominal 32x32-in. area in the central area of the slab. The slab was allowed to cure for approximately one week following casting and subsequently force-dried at elevated temperature to reduce internal moisture content of the concrete.

Seal materials installed in the slab openings were provided by Dow Corning, U.S.A. Seal materials consisted of Dow Corning 3-6548 Silicone RTV Foam.

INSTALLATION PROCEDURES

Installation of cable tray assemblies and seal systems are described in the following sections.

Cable Trays Assemblies

Two cable tray assemblies were installed in the concrete test slab, as shown in Fig. 1. Cable trays were nominal 18-in. wide x 4-in. high 16 ga. galvanized steel ladder-back trays. Trays were Model No. PLMS-SS12-1800-4-12 manufactured by U.S. Gypsum Company. Certification for trays is provided in Appendix A. Trays were cut to 5-ft lengths.

Two types of cables were installed in each cable tray: 600v single conductor MCM350 copper power cable with insulation Type XHHW and 600v AWG10/3C cable with XLP neoprene jacket. Cables were cut into 5-ft lengths prior to installation in the cable trays. Cable fill in each tray consisted of 14 lengths of MCM350 power cable and 40 lengths of AWG10/3C cable. Cables were secured to trays with nylon tie-wraps.

Completed cable tray assemblies were installed so that ends of trays extended 12 in. below the exposed surface of the test slab and 3 ft above the unexposed surface of the test slab. Trays were bolted at two locations to a steel angle framework on the unexposed side of the concrete slab to provide rigid support and minimize tray movement during seal construction and testing.

Seals

Seals were installed in openings in the concrete slab by DOW personnel with construction assistance provided by CTL. The concrete test assembly was placed in a horizontal position and 1-in. thick pieces of ceramic fiber damming board were attached to the unexposed surface of the slab. The ceramic fiber board was M-Board manufactured by Johns-Manville. The damming board was cut to fit tightly around projecting cable tray assemblies. Small gaps between the ceramic fiber board and cables were filled with pieces of CeraFiber ceramic fiber blanket manufactured by Johns-Manville.

The 30x30-in. opening was subdivided into two 14-1/2x30-in. openings using a 12-in. wide x 30-in. long piece of 1-in. thick insulation board. The insulation board was M-Board. The board was installed in the opening as shown in Fig. 1.

Silicone foam materials were mixed and placed both by hand and machine in approximately 1-1/2 to 2-in. lifts to a thickness of 12 in. in each opening. Lot numbers, densities, and snap times of foam materials installed in both penetrations are given

in Appendix A.

After foam had set, damming boards were removed from the exposed side of the slab. The foam in each opening was trimmed flush with the unexposed concrete slab surfaces.

Foam was allowed to cure for approximately 9 days prior to fire testing.

TEST EQUIPMENT & PROCEDURES

The following sections briefly describe equipment and procedures used to conduct fire and hose stream tests of the assembly containing the cable tray penetration seal systems.

Furnace

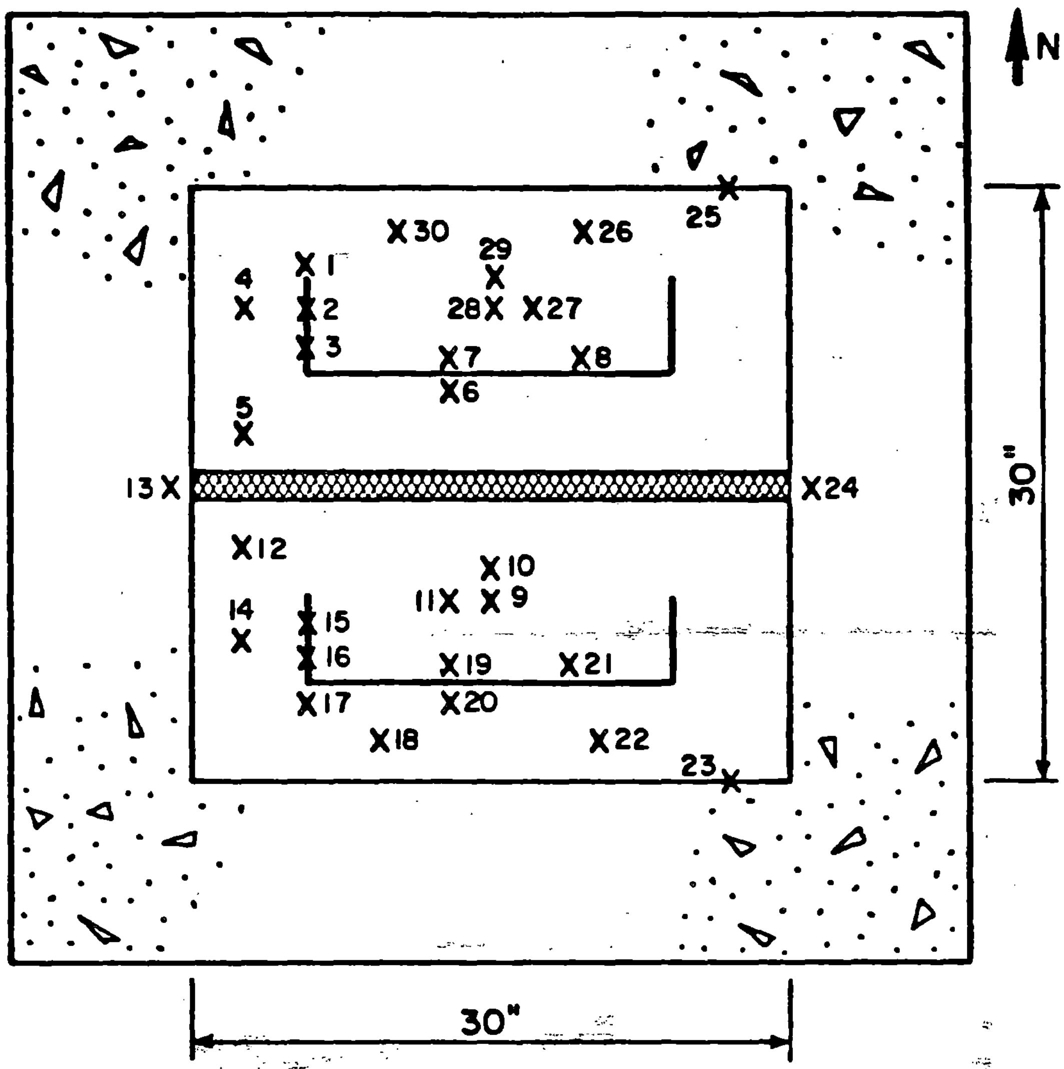
The test assembly containing the two cable tray penetration seal systems was subjected to a 3-hr fire exposure utilizing the small slab furnace at CTL's Fire Research Laboratory. This furnace provides for testing of small-scale specimens in a horizontal position. Approximate area of fire-exposure is 32x32 in., as shown in Fig. 1.

Furnace atmosphere temperatures were monitored by three Type K, Chromel-Alumel, protected thermocouples located 12 in. below the exposed face of the test assembly. The fire exposure was controlled according to the time-temperature relationship prescribed by ASTM Designation: E119, and is tabulated in Appendix B.

Furnace atmosphere pressure was maintained close to ambient laboratory air pressure or slightly negative (-0.02 to -0.08 inches of water). For this test, the average draft was -0.08 inches of water.

Specimen Instrumentation

A total of 30 thermocouples were used for measuring temperatures on the unexposed side of the test specimen at locations shown in Fig. 2. Six thermocouples were used for measuring temperatures of electrical cables and cable trays at a distance of 1-in. above the unexposed surface of the test assembly during the fire test. Twenty-two thermocouples were used to measure temperatures on seal surfaces, concrete/seal interfaces, cable/seal and tray/seal interfaces, and concrete surfaces on the unexposed side of the test assembly. Two



X- Thermocouple Locations

FIG. 2 UNEXPOSED SURFACE AND INTERFACE THERMOCOUPLE LOCATIONS thermocouples were used to measure foam temperatures at a depth of 2 in. below the unexposed surface of the seals. A list of thermocouple locations is provided in Appendix B.

Data Acquisition

Furnace atmosphere and specimen thermocouple temperatures were monitored at 5-minute intervals throughout the 3-hr fire test. The automated data acquisition system consisted of a Hewlett-Packard HP3455A digital voltmeter and a series of HP3495A data scanners. The data acquisition system controller was an HP9845T desktop computer.

Hose Stream Tests

Two hose stream tests were conducted after fire testing of the test assembly. Hose stream test procedures were those described in the IEEE 634 and ASTM Designation: E119 Test Standards. Equipment and procedures for these tests are as follows:

IEEE 634 - A 75 psi hose stream was delivered through a 1-1/2 in. diameter hose equipped with a fog nozzle set at a discharge angle of 30° from a distance of 10 ft. The spray was delivered over an exposed area of 36x36 in. for a duration of 14 seconds.

ASTM E119- A 30 psi solid stream was delivered through a 2-1/2 in. diameter hose equipped with a National Standard Playpipe with a 1-1/8 in. diameter discharge tip from a distance of 20 ft. The stream was delivered over an exposed area of 48x48 in. for a duration of 24 seconds.

TEST RESULTS

The test assembly containing the two cable tray penetration seal systems was subjected to a 3-hr fire exposure at the fire research facilities of CTL on October 19, 1984.

A listing of furnace atmosphere temperature measurements and variations from the standard are given in Appendix B. Variation of the measured furnace temperatures from the standard was approximately 0.03%, based on comparison of total area under the time-temperature curves. This was well within the 5.00% variation permitted by the Test Standard.(1) Average furnace draft pressure was -0.08 inches of water.

A listing of measured unexposed concrete, interfaces, cable, and seal temperatures is also given in Appendix B. The maximum allowable temperature rise of 325°F+ ambient as defined by ASTM Designation: E814(2) was not exceeded on the unexposed surface of either penetration seal during the 3-hr fire test. Limiting end point temperature rise defined by ASTM Designtaion: E814 was exceeded at several measuring points on cables in both seals. Limiting end point temperture criterion defined by IEEE 634 was exceeded at one measuring point on a power cable in Tray No. 1.

No passage of flame occurred through either penetration seal during the 3-hr fire test.

After the 3-hr fire exposure, the test assembly was removed from the furnace, as shown in Fig. 3, and subjected to the IEEE 634 and ASTM Designation: E119 hose stream tests. Views of exposed and unexposed surfaces of test assembly before hose stream testing are shown in Figs. 4 and 5. Views of hose stream tests are shown in Figs. 6 and 7.

No water projected beyond the unexposed surface of either of the two penetration seal during the IEEE 634 hose stream test. No water projected beyond the unexposed surface of the penetration seal containing Tray No. 1 during the ASTM Designation: E119 hose stream test. Water did project beyond the unexposed surface of the penetration seal containing Tray No. 2 during the ASTM Designation: E119 hose stream test. Views of exposed and unexposed surfaces of the test assembly after hose stream testing are shown in Figs. 8 and 9.

Following the hose stream tests, measurements were made of the thickness of remaining silicone seal material from each opening, as shown in Fig. 10. Remaining thicknesses of unburned materials are listed in Table 1.

TABLE 1 - THICKNESS OF UNBURNED SILICONE FOAM

Measurement Location*	Thickness, inches	
	Tray No. 1	Tray No. 2
West end of seal	6	5
West leg of tray	3-3/4	3-3/4
Mid-point of seal	4	3-3/4
East leg of tray	3-1/2	2-3/4
East end of seal	5	5

*See Fig. 1 for orientation.

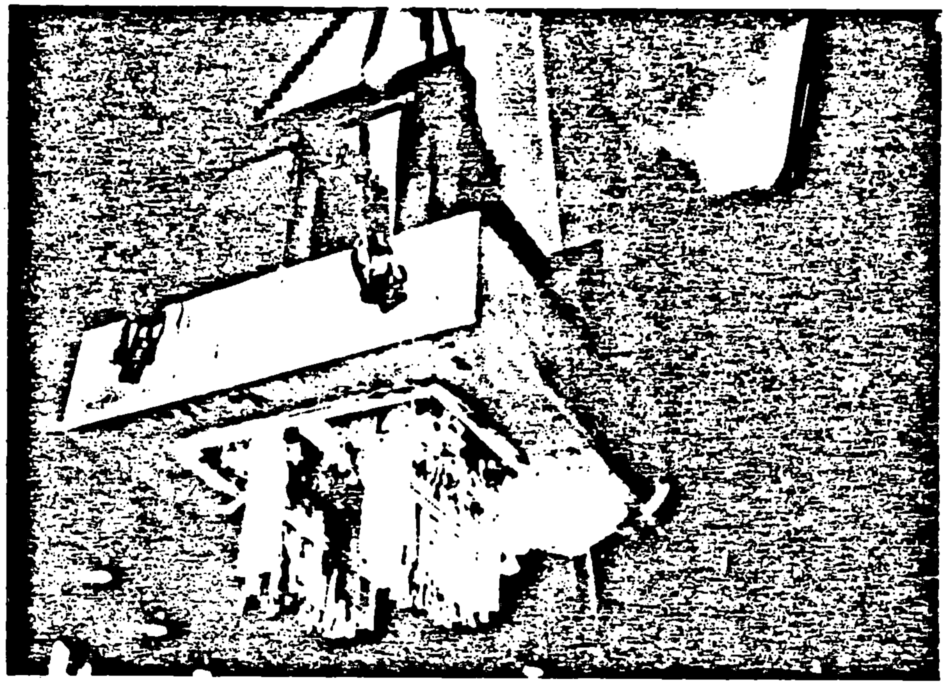


Fig. 3 Specimen Removed from Furnace After Fire Testing

Fig. 4 Exposed Surface of Test Assembly Prior to Hose Stream Testing

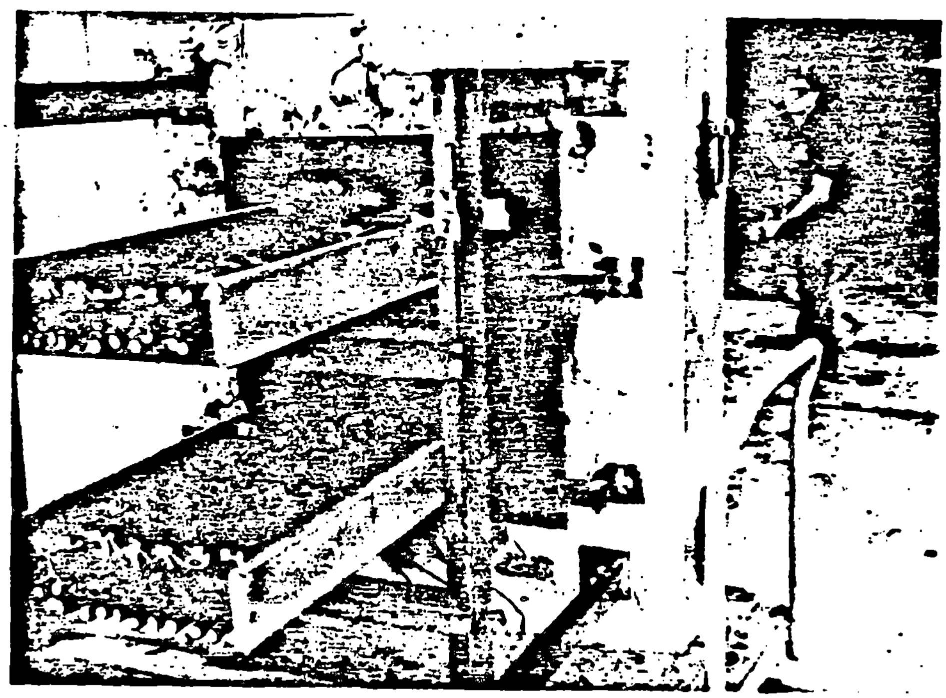


Fig. 5 Unexposed Surface of Test Assembly Prior to Hose Stream Testing

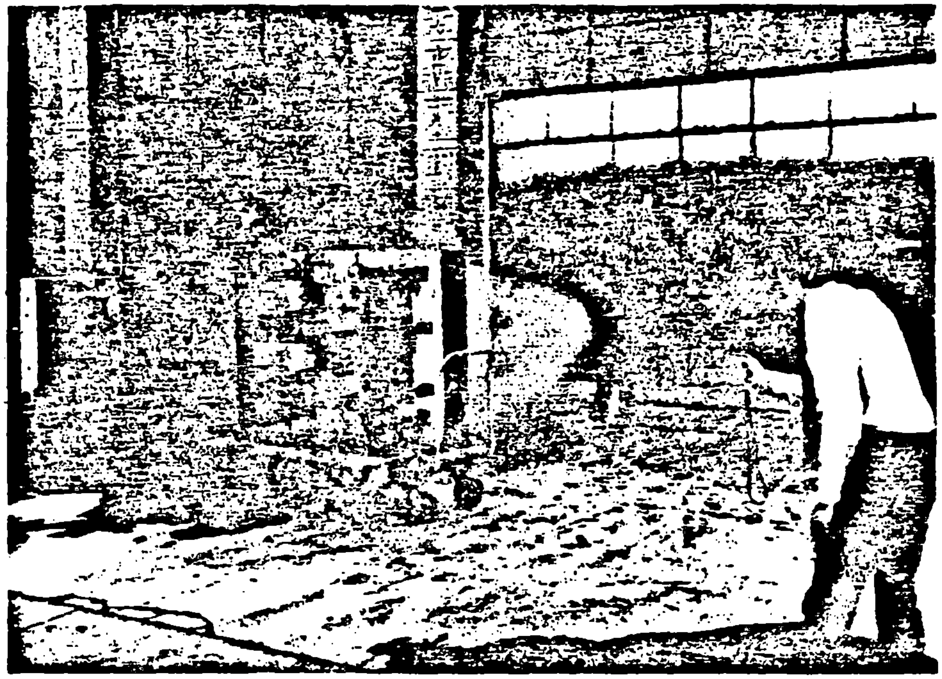


Fig. 6 IEEE 634 Hose Stream Test

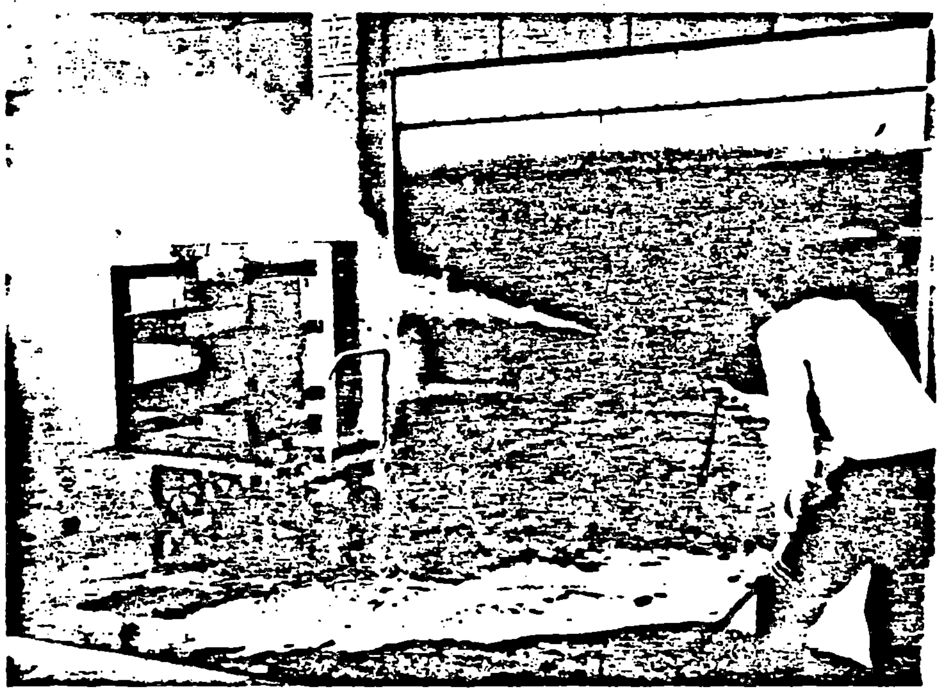


Fig. 7 ASTM E119 Hose Stream Test

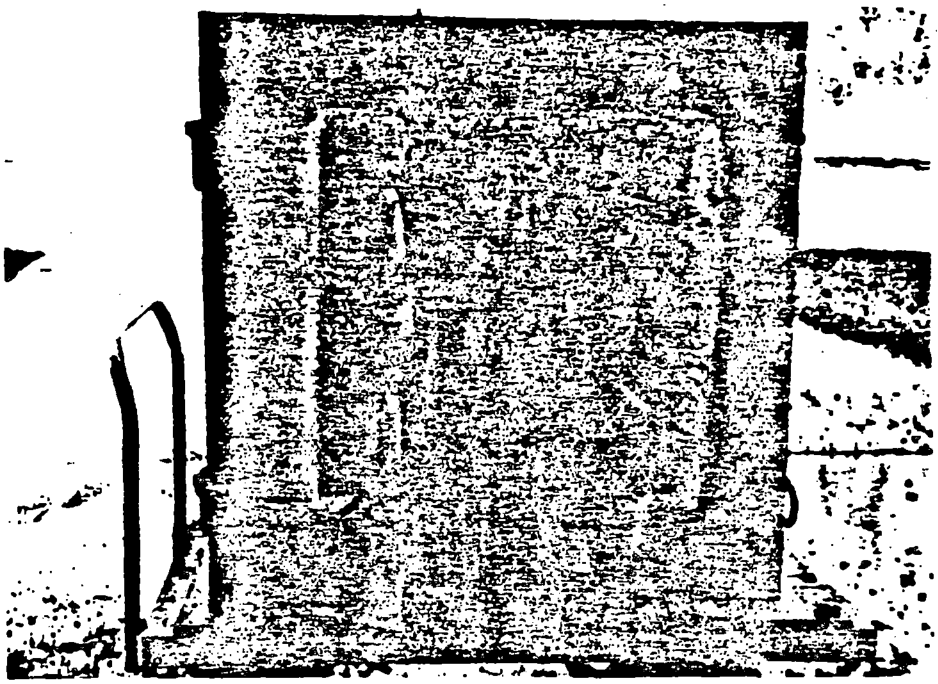


Fig. 8 Exposed Surface of Test Assembly After Hose Stream Testing

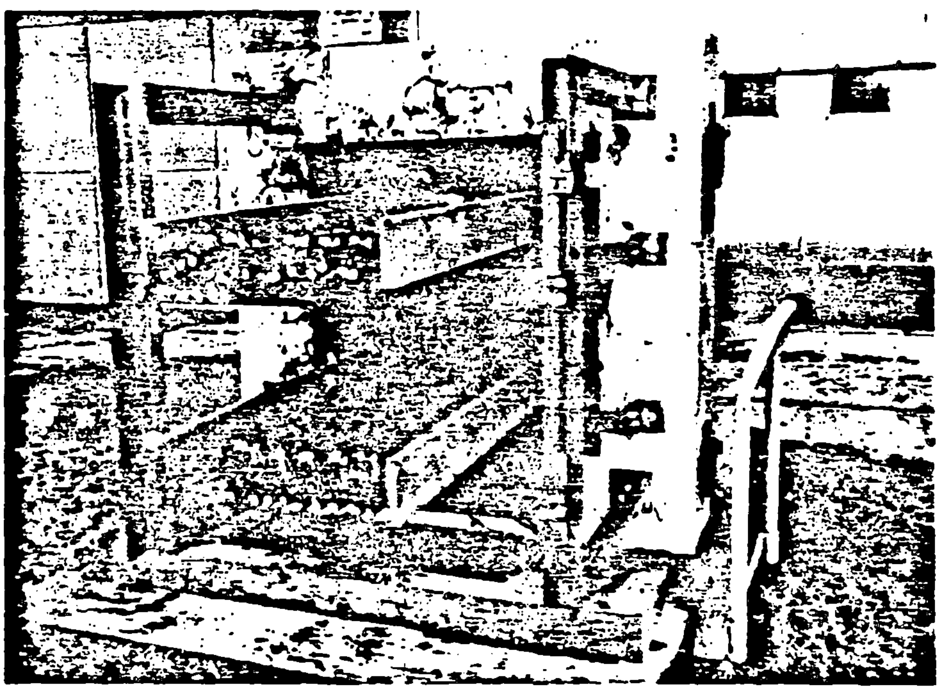
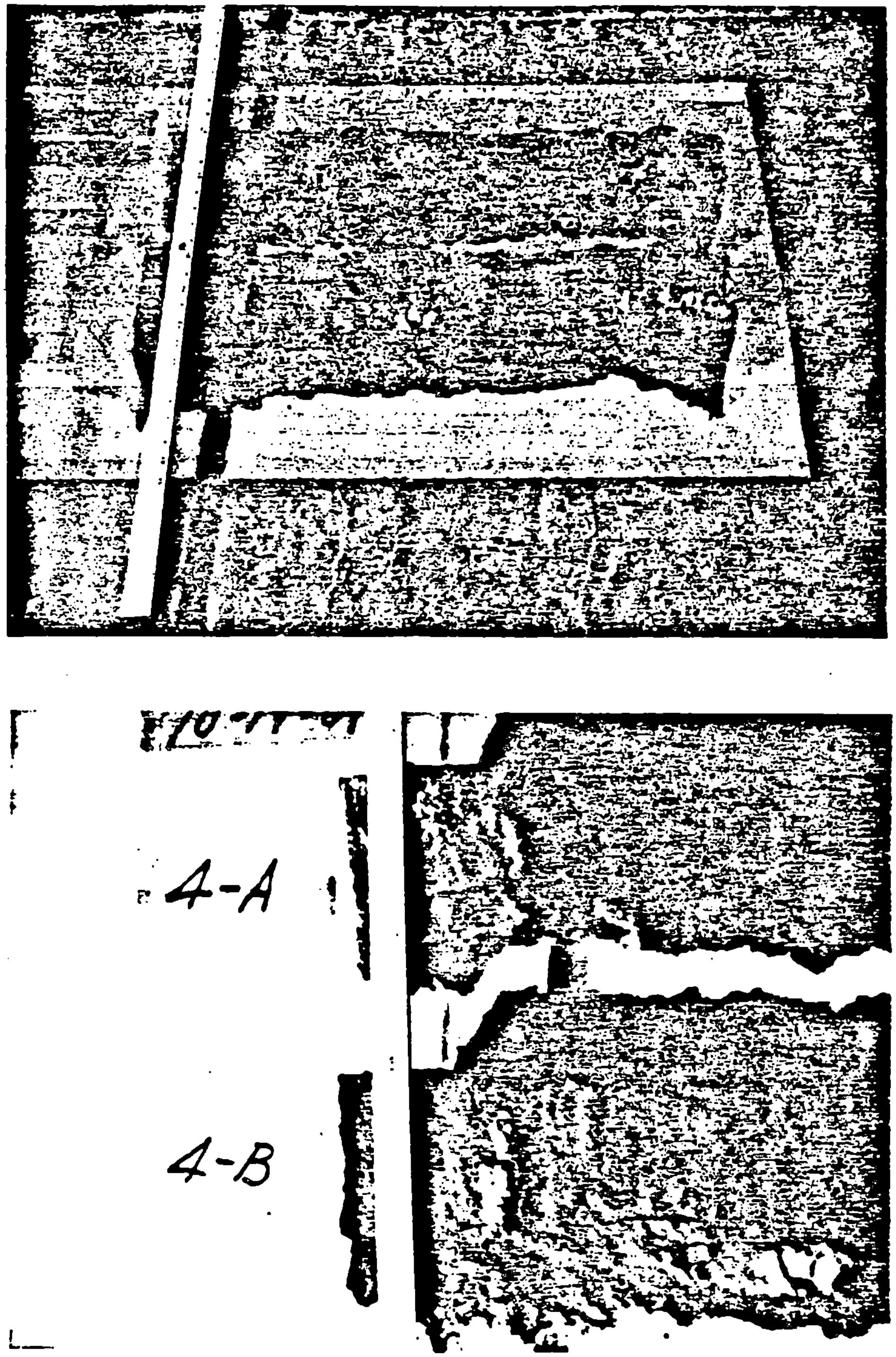


Fig. 9 Unexposed Surface of Test Assembly After Hose Stream Testing



(a)

(b)

Fig. 10 Unburned Silicone Foam Material from Penetration Seals

A = Tray No. 2
B = Tray No. 1

LABORATORY RESPONSIBILITY

The Construction Technology Laboratories is a Division of the Portland Cement Association and was not involved in the design of the Penetration Seal System. Personnel of the Construction Technology Laboratories make no judgment of the suitability of the materials or seal systems for particular end point uses. Acceptance of the test results for guidance for field installation is the prerogative of the authority having jurisdiction.

CONCLUDING REMARKS

This report described fire and hose stream tests conducted on two silicone penetration seal systems. Significant test results are presented in the section entitled SUMMARY OF RESULTS at the beginning of this report.

REFERENCES

1. ASTM Designation: E119, "Standard Methods of Fire Tests of Building Construction and Materials," American Society for Testing and Materials, Philadelphia, PA, 1983.

2. ASTM Designation: E814, "Standard Method of Fire Tests of Through-Penetration Fire Stops," American Society for Testing and Materials, Philadelphia, PA, 1983.

3. Standard IEEE 634-1978, "IEEE Standard Cable Penetration Fire-Stop Qualification Test," The Institute of Electrical and Electronic Engineers, Inc., New York, NY.