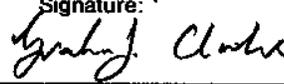
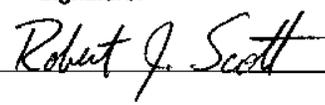


# Raychem Energy Division

# Report

<b>Title</b>		<b>Pages:</b>
FLAMMABILITY TESTING OF HEAT SHRINKABLE FIELD SPlicing SYSTEM FOR CLASS 1E ELECTRIC CABLES TYPE WCSF-N		16
<b>Report Number:</b> EDR 5009		<b>Date:</b> March 7, 1980
<b>Tested by:</b> Ronald A. Strombom	<b>Signature:</b> 	<b>Date:</b> 3/07/80
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<b>Approved by:</b> Graham J. Clarke for Technical Operations	<b>Signature:</b> 	<b>Date:</b> 3/10/80
<b>Approved by:</b> Robert Scott for Product Management Raychem Corporation Energy Division	<b>Signature:</b> 	<b>Date:</b> 3/10/80

## I. INTRODUCTION

This report documents a program of vertical tray flame testing. The program constitutes a Type Test for qualification of a heat shrinkable field splicing system (Type WCSF-N) for Class 1E electric cables for nuclear power generating stations.

Testing was conducted in the flame chamber of the Raychem Corporation in accordance with IEEE Standard 383-1974, "IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations," Section 2.5, "Flame Tests."

## II. CONCLUSIONS

Both spliced and unspliced cable samples were self-extinguishing when subjected to the vertical tray flame test with a 70,000 BTU/hour propane burner heat source as required in IEEE 383-1974, Section 2.5. In addition, all samples were self-extinguishing when tested in accordance with IEEE 383-1974 procedures and a 210,000 BTU/hour propane burner heat source. On the basis of the test results, heat shrinkable WCSF-N components are flame test qualified as a field splicing system for Class 1E electric cables in accordance with IEEE Standard 383-1974.

### III. SAMPLE DESCRIPTIONS

Field splices were installed on eight foot lengths of seven conductor, 12 AWG Raychem Flamtrol™ insulated and jacketed control cable utilizing appropriate WCSF-N heat shrinkable splicing sleeves. A detailed sample description is given in Appendix I. The splices were installed in accordance with Raychem Installation Guide, Number IG-1060 for WCSF Type In-Line Multiconductor Field Splices.

Each test run consisted of three spliced cables and four identical unspliced cables to produce the tray fill required by the specification.

A 12 inch cable tray with 6 inch rung spacing was used to support the samples. The spliced cables for a given test were positioned either at the center of the tray or alternated with unspliced cables across the tray. In all cases an unspliced cable was placed at each side of the group of samples.

### IV. TEST PROCEDURE

A propane burner, as described in the Standard was utilized as the heat source. Flow meters calibrated by weight and gas consumed were utilized to achieve either 70,000 or 210,000 BTU/hour gas consumption. The burner was positioned approximately two feet above the bottom of the vertical tray with the splices located so that the point of flame impingement was located at the lower end of the splice area. The burner-on time for all tests was 20 minutes.

Separate 240/120 volt failure detection circuits were provided for the spliced and unspliced cable samples. Both wire-to-wire and wire-to-tray failures were indicated by the circuits.

Three separate tests were run at each burner setting utilizing different samples of cable and splicing components (Appendix I) to demonstrate reproducibility as required by Section 2.5.4.3 of the Standard.

## V. TEST RESULTS

Data for the 70,000 BTU/hour tests (461, 462, 463) are shown in Table 1.

TABLE 1

70,000 BTU/hour Flame Test Data

	Test No.	461	462	463
Time to initial electrical failure (Min.-Sec.)	Spliced	6-40	9-15	7-30
	Unspliced	7-45	8-20	8-10
Time to complete electrical failure (Min.-Sec.)	Spliced	7-00	11-20	7-30
	Unspliced	8-45	10-35	8-10
Time to self extinguish (Sec.)		12	23	7
Insulation Damage Distance (In.)		18	16	17
Jacket Char Distance (In.)		36	32	35

Test data for the 210,000 BTU/hour tests (464, 465, 466) are shown in Table 2.

TABLE 2  
210,000 BTU/hour Flame Test Data

	<u>Test No.</u>	464	465	466
Time to initial electrical failure (Min.-Sec.)	Spliced	5-45	5-55	6-10
	Unspliced	3-20	5-55	5-50
Time to complete electrical failure (Min.-Sec.)	Spliced	5-45	5-55	6-10
	Unspliced	6-10	6-10	6-10
Time to self extinguish (Sec.)		0	0	0
Insulation Damage Distance (In.)		36	43	40
Jacket Char Distance (In.)		56	46	53

## VI. EVALUATION OF RESULTS

The following observations can be made with reference to the above test data and typical test sequence photographs (Appendix 2 - Test 462, Appendix 3 - Test 464):

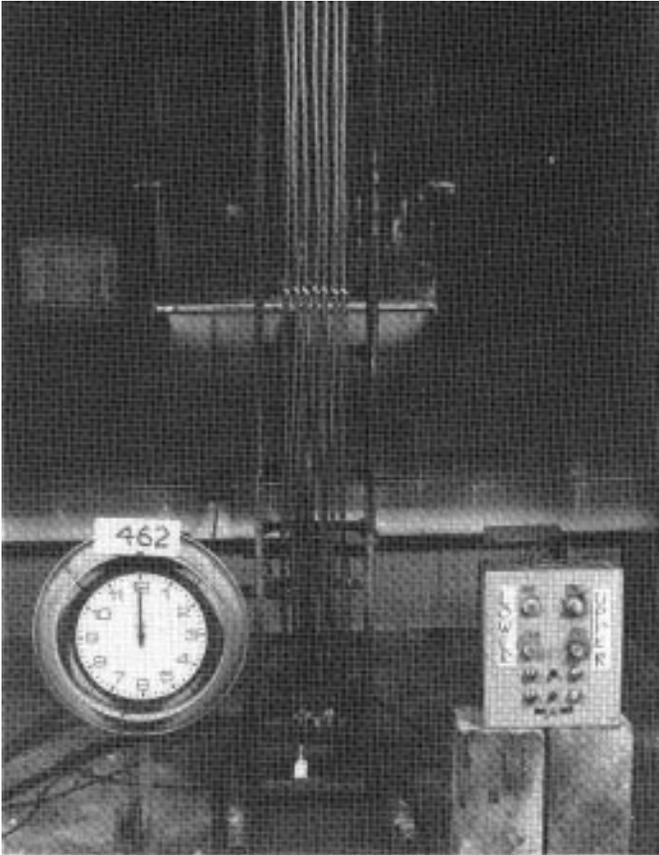
- All samples self-extinguished and were classified as non-propagating.
- The WCSF-N splices had no effect on either jacket char or insulation damage lengths.

- The splices had no measurable effect on circuit failure times.
- Portions of splicing sleeves remained intact on the cable below the flame impingement point as shown in close-up photographs in Appendices 2 and 3.
- The 210,000 BTU/hour burner setting caused more rapid circuit failure on both spliced and unspliced cables and greater jacket char and insulation damage length due to the greater quantity of burning gases surrounding the cables.

APPENDIX I

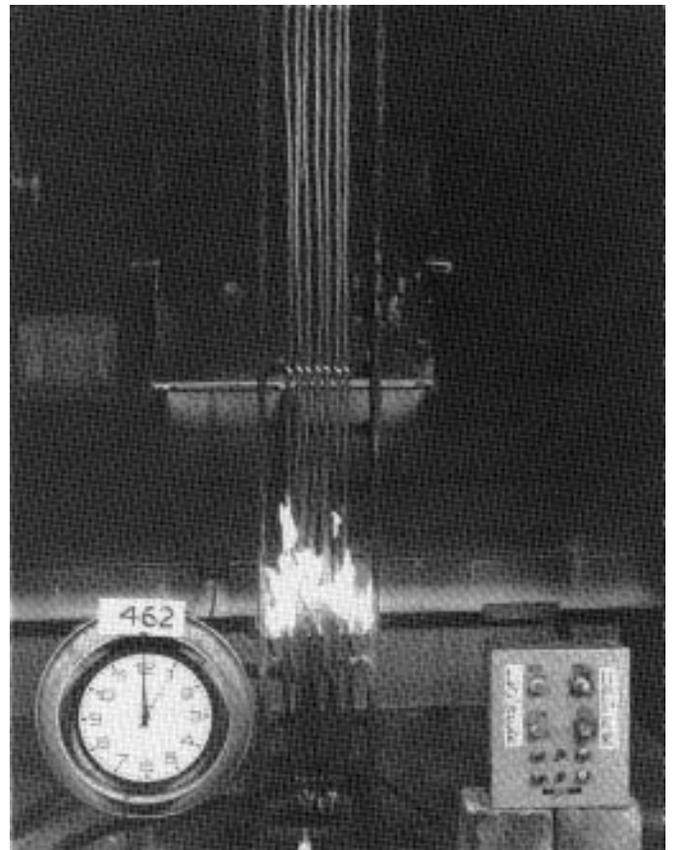
TEST SAMPLE DESCRIPTIONS

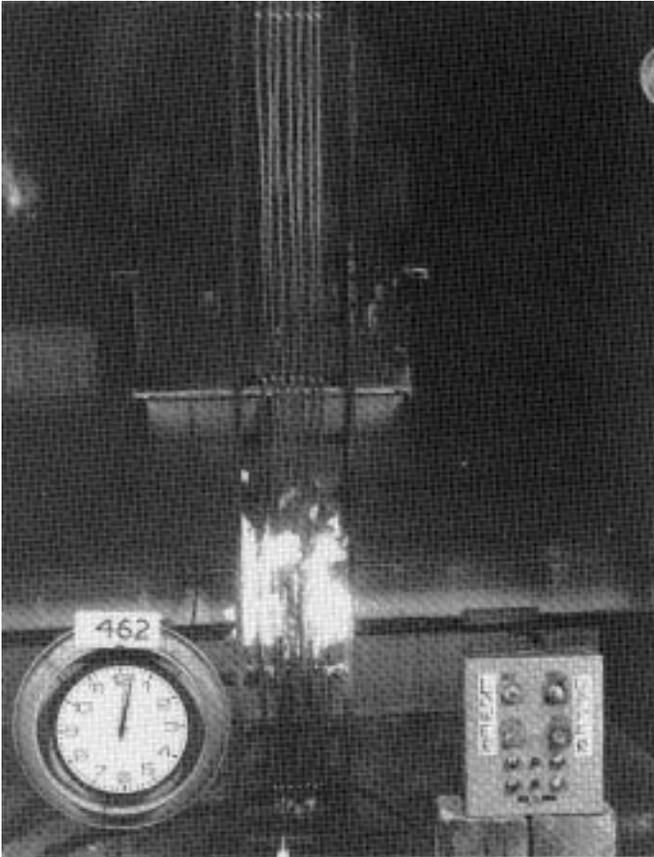
RAYCHEM FLAMTROL CABLE		HEAT SHRINKABLE FIELD SPLICE COMPONENT	
<u>Test No.</u>	<u>Part No.</u>	<u>Run No.</u>	<u>Run No.</u>
461	J7TC12B10-K1	J14-08-19-74-07	E202(2)/K072(1)
462	J7TC12B10-C1	J14-08-19-74-06	E202
463	J7TC12B10-C1	J14-07-15-74-02	K072
464	J7TC12B10-C1	J14-07-15-74-02	K072
465	J7TC12B10-C1	J14-08-19-74-06	E202
466	J7TC12B10-C1	J14-08-19-74-07	E202(1)/K072(2)
			K182
			E102
			A093
			A093
			E102
			K182



Test Facility

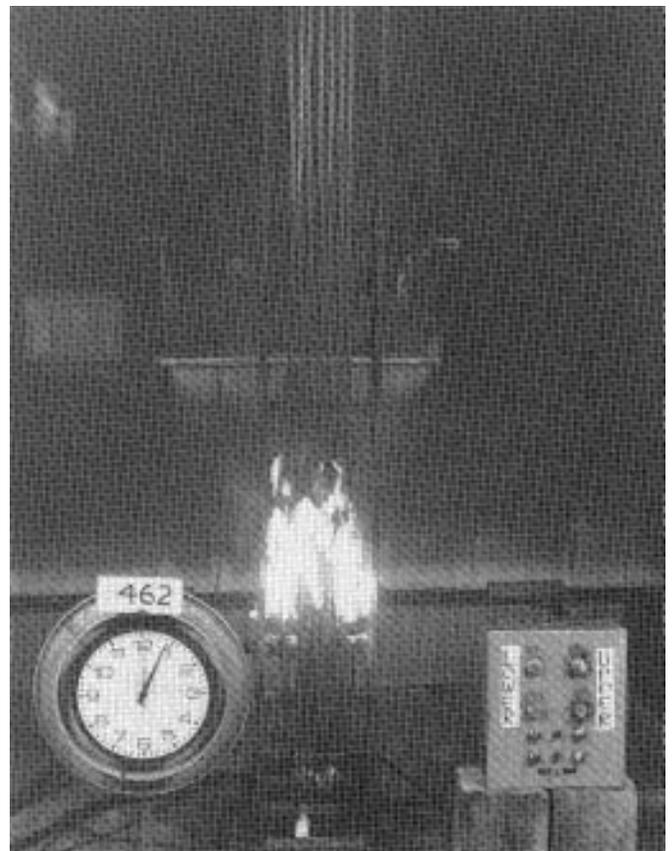
Burner Ignition





Two minutes

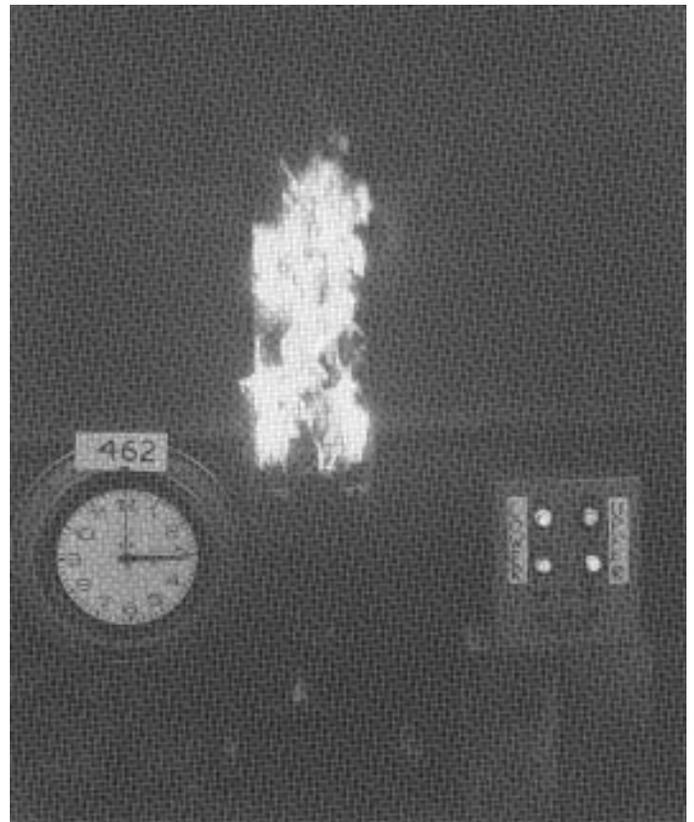
Four minutes

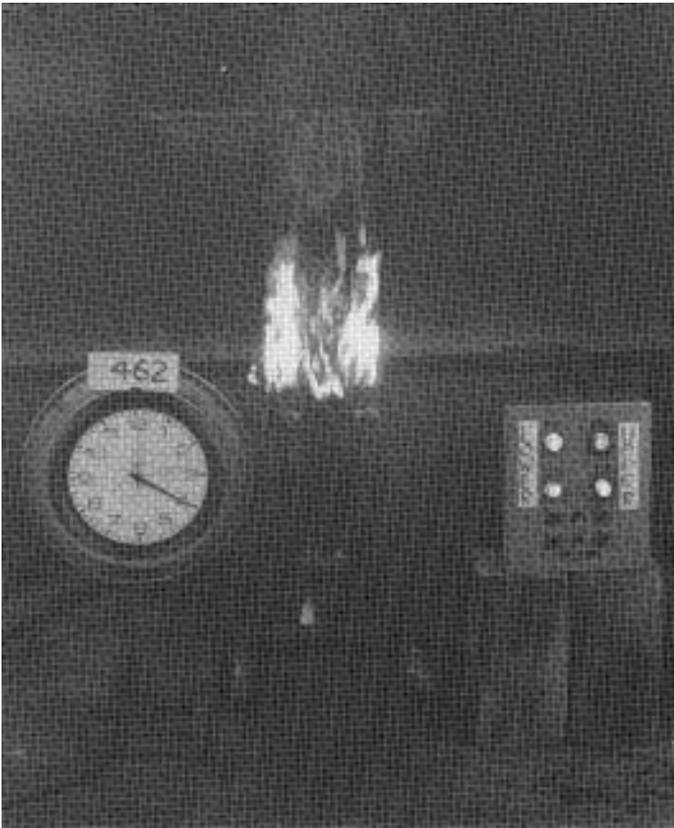




Six minutes

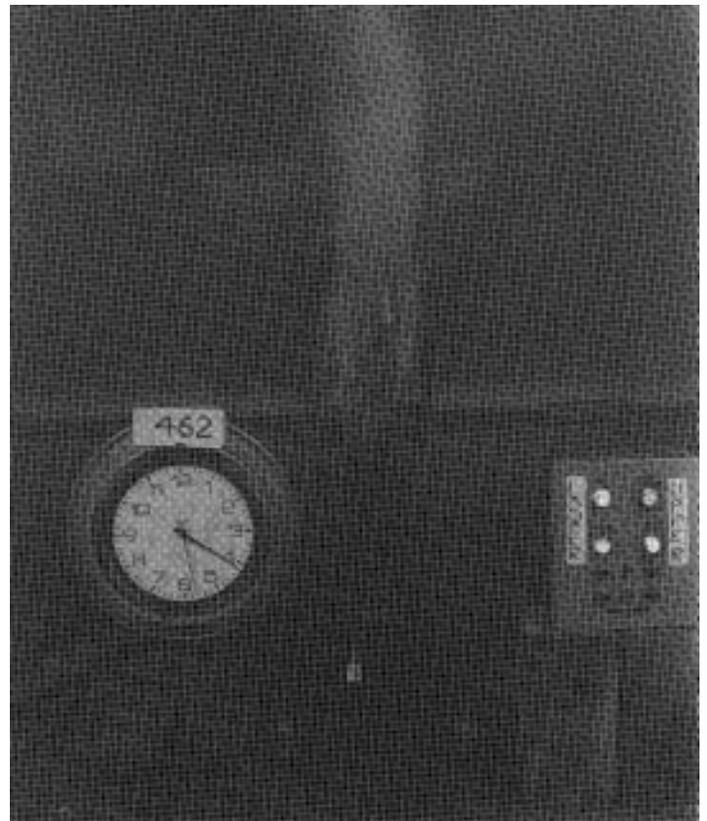
15 minutes

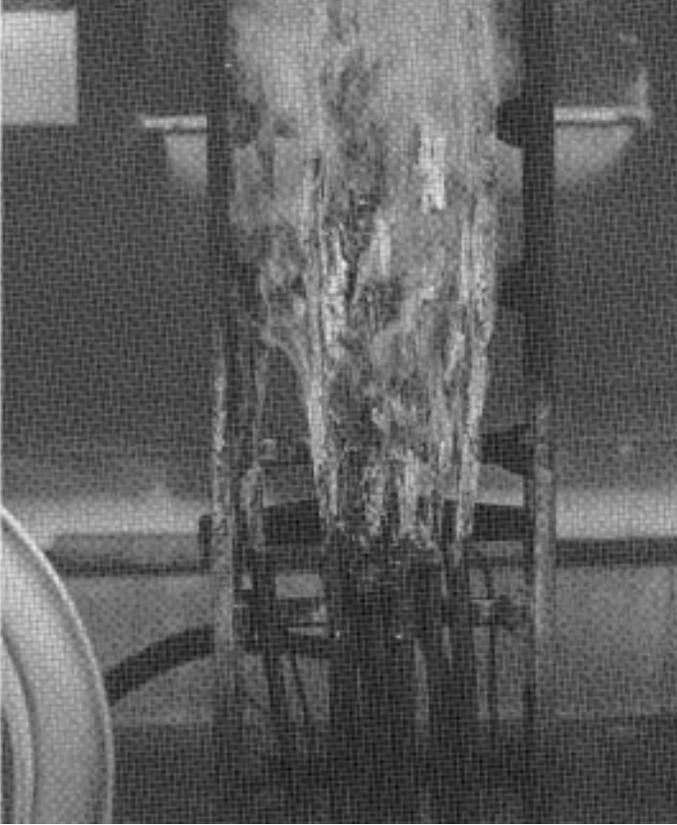




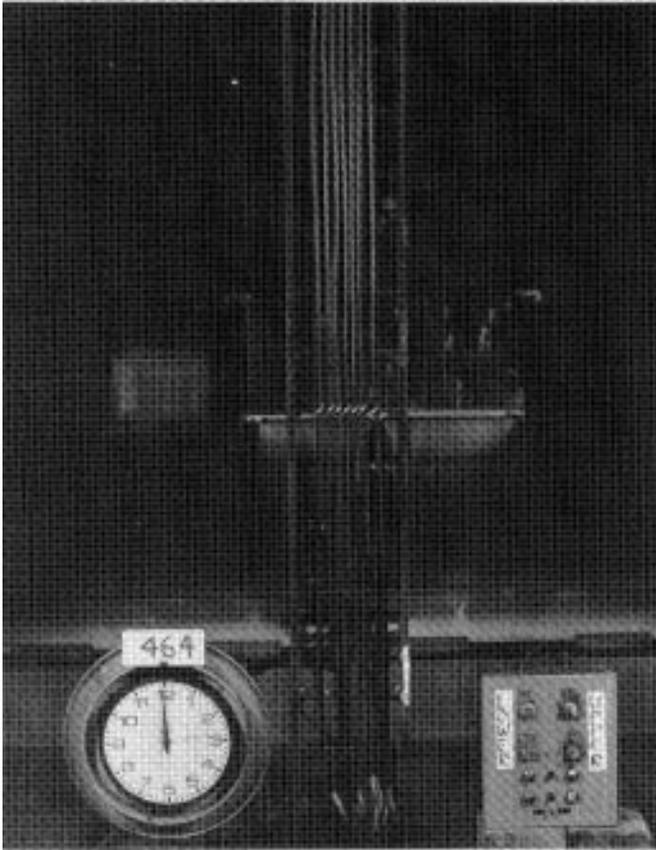
20 minutes

Samples extinguished  
23 seconds after  
removal of flame



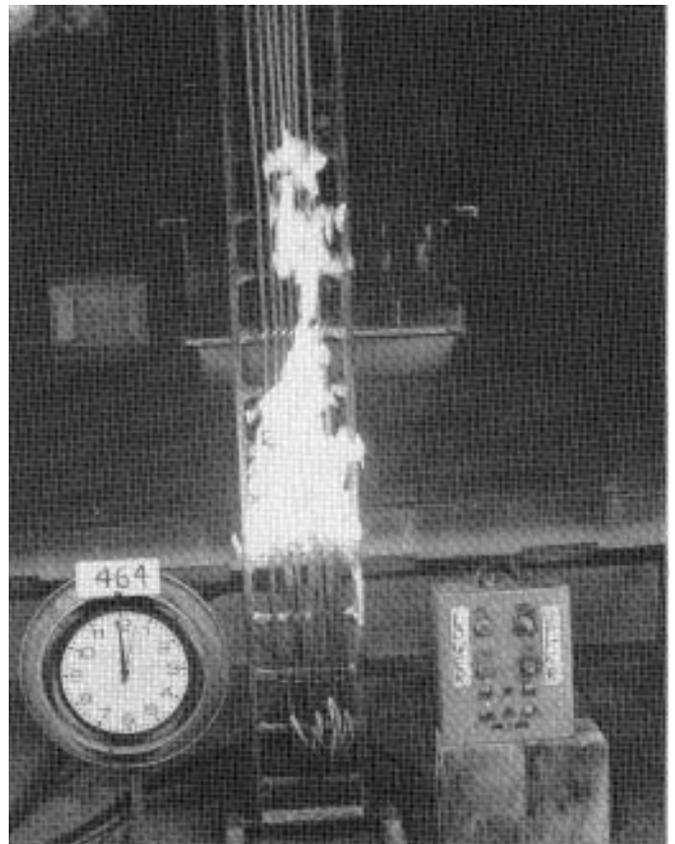


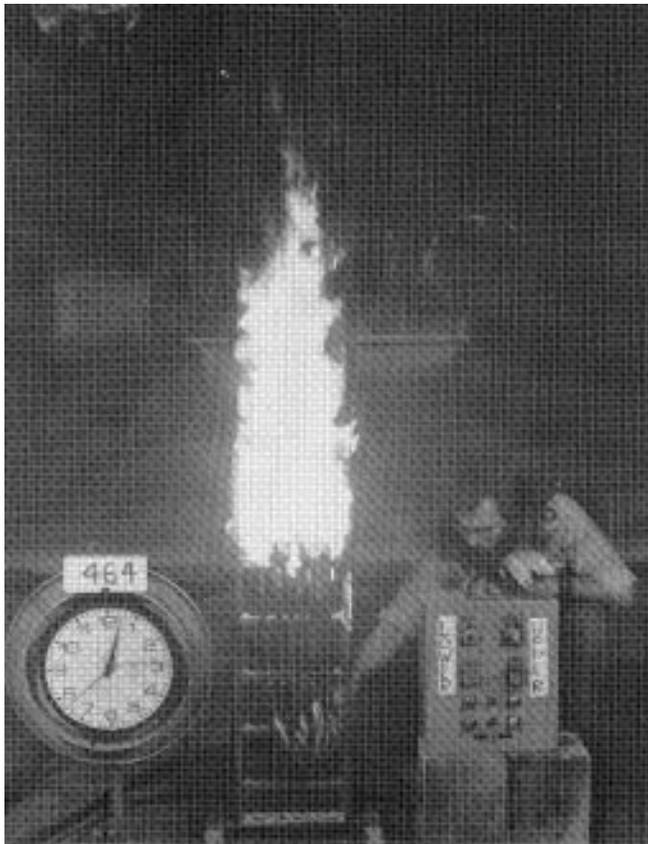
Sample post-test



Test Facility

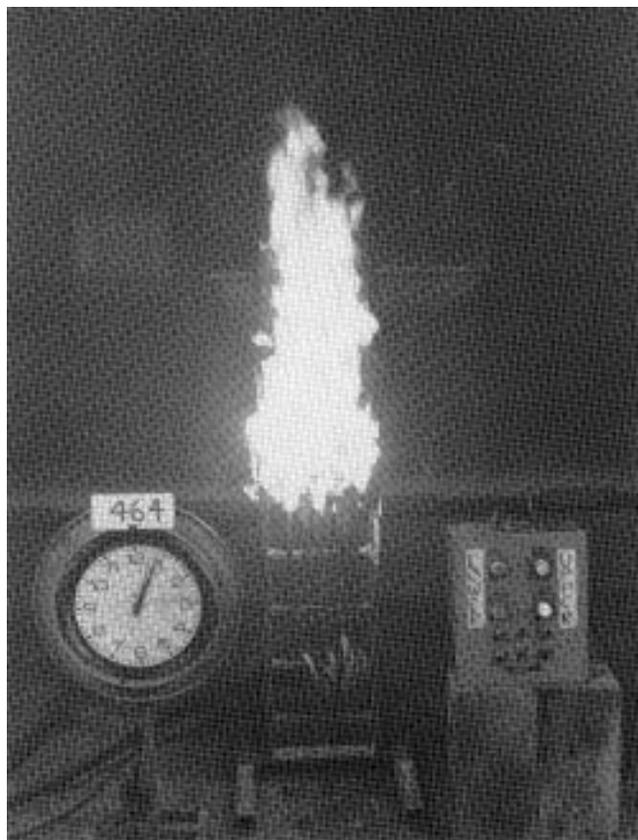
Burner ignition

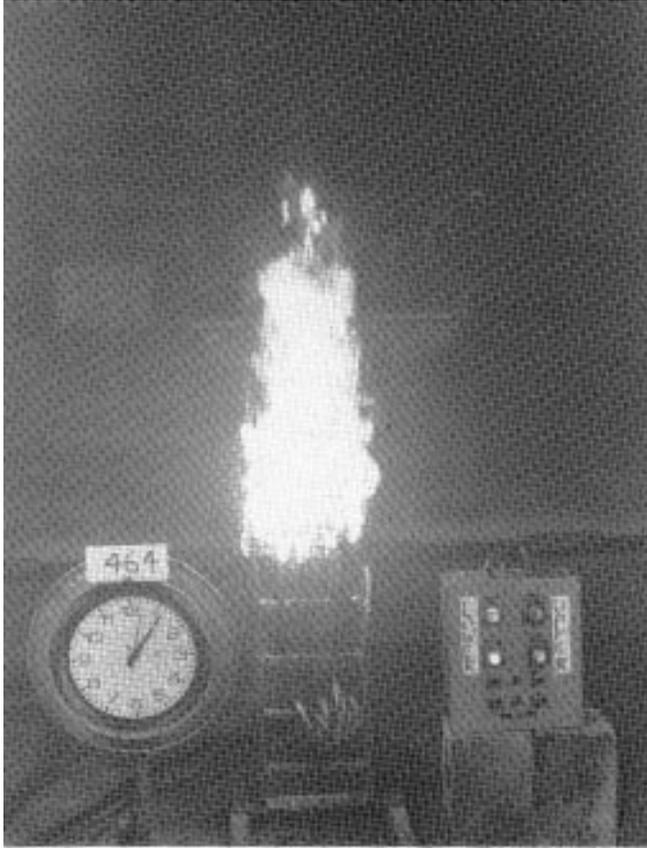




Two minutes

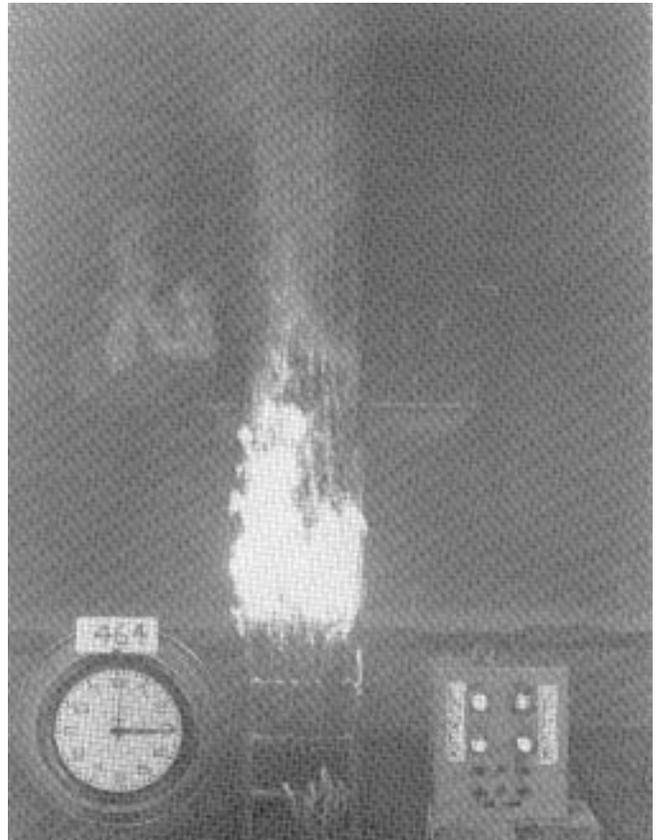
Four minutes

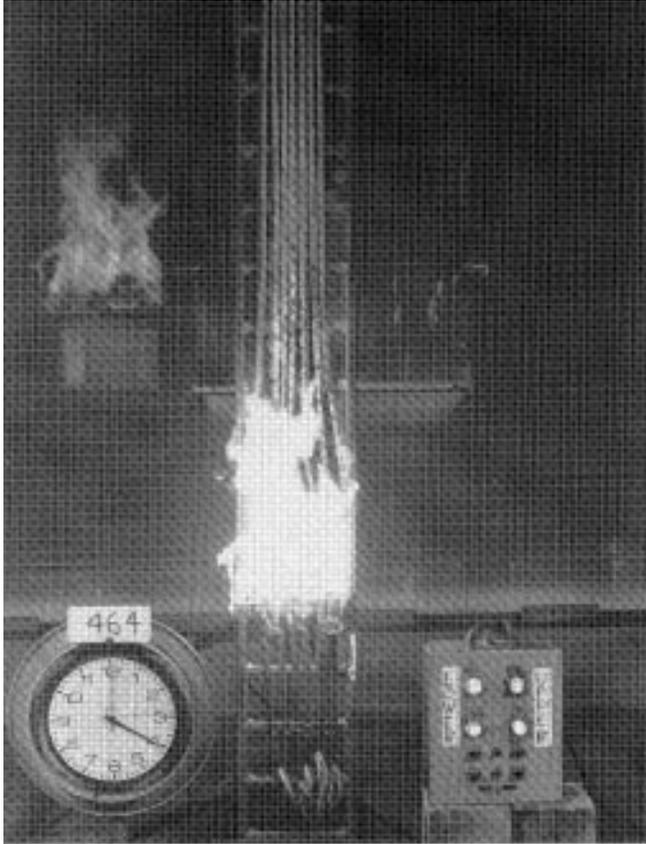




Six minutes

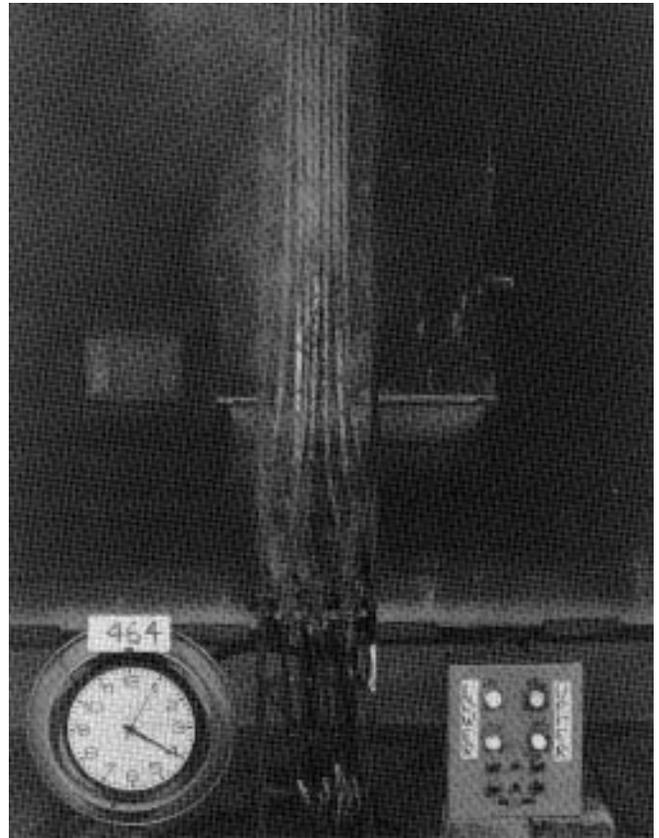
15 minutes

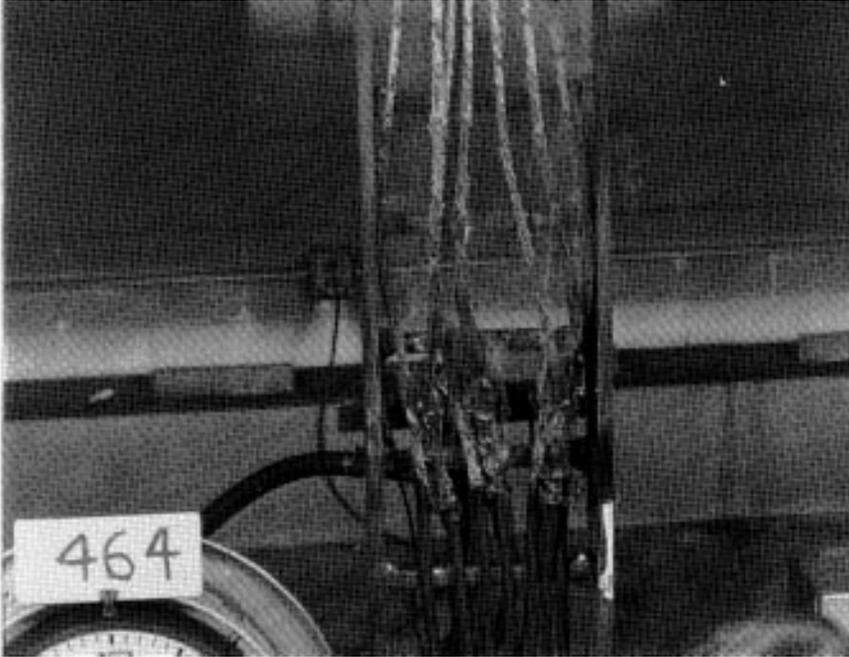




20 minutes

Samples extinguished  
0 seconds after  
removal of flame





Sample post-test