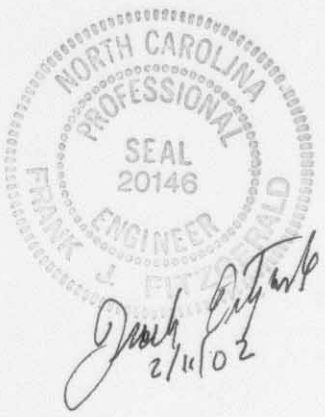
Energy Report



EDR-5348

Flammability Testing Report
According to IEEE-1202
(IEEE-383)

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1. 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 WCSF made of the new formulation for Class 1E electric cables for nuclear power generating stations.

Testing was conducted in the flame chamber of the Northbrook Testing Facility of the Underwriters Laboratories Inc. (UL) in accordance with IEEE Standard 1202-1991, "IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies", called for in the IEEE Standard 383-1980 "IEEE Standard for Qualification of Class 1E Electrical Cables and Field Splices for Nuclear Power Generating Stations.

2. SUMMARY

Both spliced and un-spliced cable samples were self-extinguishing when subjected to the vertical tray flame test with a 70,000 BTU/hour propane burner heat source. The specimens did not exhibit jacket damage higher than 150 cm as required in IEEE-1202-1991, Section 7.2.

In addition, all samples were self-extinguishing when tested in accordance with IEEE 1202-1991 procedures and a 210,000 BTU/hour propane burner heat source and the specimens did not exhibit jacket damage higher than 150 cm as required in Section 7.2.

On the basis of the test results, heat shrinkable WCSF components made out of the new compound are flame test qualified as a field splicing system for Class 1E electric cables in accordance with IEEE Standard 383-1980.

3. SAMPLE DESCRIPTION

Field splices were installed on eight-foot lengths of seven conductor, 12 AWG insulated and jacketed control cable utilizing appropriate WCSF heat shrinkable splicing sleeves. A detailed sample description is given in Appendix I. The splices were installed in accordance with

Raychem Installation Guide for WCSF Type In-Line Multi-conductor Field Splices. Each test run consisted of three spliced cables and four identical un-spliced 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 alternated with un-spliced cables across the tray. In all cases an un-spliced cable was placed at each side of the group of samples.

For cables 13 mm (0.51") and larger in diameter, each specimen was individually attached to the cable tray with a separation of one-half diameter between specimens. The number of cables was sufficient to fill at least the center 250 mm (9.8") of the cable tray.

4. TEST PROCEDURE

A propane burner, as described in the Standard was utilized as the heat source. Flow meters calibrated by weight and the 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. Four separate tests were run at 70,000 BTU/hour and two at 210,000 BTU/hour, utilizing different samples of cable and splicing components (Appendix I) to demonstrate reproducibility. In the first test (Sample A-1 – 70,000 BTU/hour) the splices were positioned 24 inches above the burner. For all the other tests, the splices were positions so that the point of burner flame impingement was located at the lower end of the splice.

5. RESULTS AND DISCUSSION

The maximum flame propagation height along the 2.3 m (8') lengths of cable specimens, as measured from the lower edge of the burner face, was determined by visual observation. After each test, the maximum damage heights of the splice, cable jacket and conductor insulation were obtained. The flame height versus time were recorded and tabulated (Table 2). A summary of the test results is shown in Table 3.

Time (min.)	Flame Height (cm)					
	Test A-1	Test A-2	Test A-3	Test A-4	Test A-5	Test A-6
1	40	40	40	40	60	75
2	50	50	50	50	75	75
3	50	50	50	50	75	75
4	50	50	50	50	75	75
5	50	50	50	50	75	75
6	50	50	50	50	100	75
7	50	40	50	50	100	100
8	50	50	50	50	125	100
9	50	50	50	50	125	100
10	50	50	50	50	125	100
11	50	50	50	50	150	150
12	50	50	50	50	150	150
13	50	50	50	50	150	150
14	50	50	50	50	125	150
15	50	50	50	50	125	150
16	50	50	50	50	100	150
17	50	50	40	50	75	150
18	50	40	40	40	75	100
19	50	40	40	40	75	100
20	50	40	40	40	60	60
Afterburn out (min:sec)	23:20	20:27	21:04	20:06	N/A	20:10

Table 2: Flame height during test

Cable specimens exhibiting jacket damage of not more than 150 cm (4’ 11”) are considered to be in compliance with requirements of the IEEE – 1202 Standard.

Cable damage is determined by measuring the distance of charring or the affected portion above the horizontal line form the lower edge of the burner face. On cable constructions that do not

have charring, the limit for the affected portion is defined as the point where the overall diameter is visibly reduced or increased.

Sample – Test No.	Burner power (BTU/h)	Maximum flame height (cm)	Maximum damage height (cm)			
			Jacket			Conductor
			Melt	Char	Ash	
A-1	70,000	50	59	49	40	46
A-2	70,000	50	59	44	35	37
A-3	70,000	50	58	44	38	40
A-4	70,000	50	59	48	41	45
A-5	210,000	150	160	140	112	128
A-6	210,000	150	166	137	113	122

Table 3: Test results

The following observations can be made with reference to the above test data and typical test sequence photographs (Appendix II):

- All samples self-extinguished and were classified as non-propagating.
- The WCSF splices had no effect on either jacket char or insulation damage lengths.
- Portions of splicing sleeves remained intact on the cable above the flame impingement point.
- The 210,000 BTU/hour burner setting caused greater jacket char and insulation damage length due to the greater quantity of burning gases surrounding the cables.

6. CONCLUSION

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 1202-1991. In addition, all samples were self-extinguishing when tested in accordance with IEEE 1202-1991 procedures and a 210,000 BTU/hour propane burner heat source. On the basis of the test results, heat shrinkable WCSF components are flame test qualified in accordance with IEEE Standard 383-1980.

APPENDIX 1

TEST STAMPLES

Cable Specifications:

Manufacturer:	Rockbestos
Real Number:	93A1418G
Insulation material:	XLPE
Jacket Material:	Hypalon
Insulation diameter:	0.14”
Insulation Thickness:	0.03”
Jacket diameter:	0.5”
Wire gauge:	14 AWG
Number of conductors:	7

WCSF Specifications:

Tubing	Lot Number
WCSF-500 (38/13)S	PT 00003 / EC20051-16 & EC20051-17
WCSF-070 (6/2)S	MSE9558-1-2-3-9-99
WCSF-500 (38/13)U	MSE95441-0-2-1-2
S1119/144 Adhesive	NA16077

APPENDIX 2

TEST PHOTOGRAPHS

Before test	During the test	After the test
		

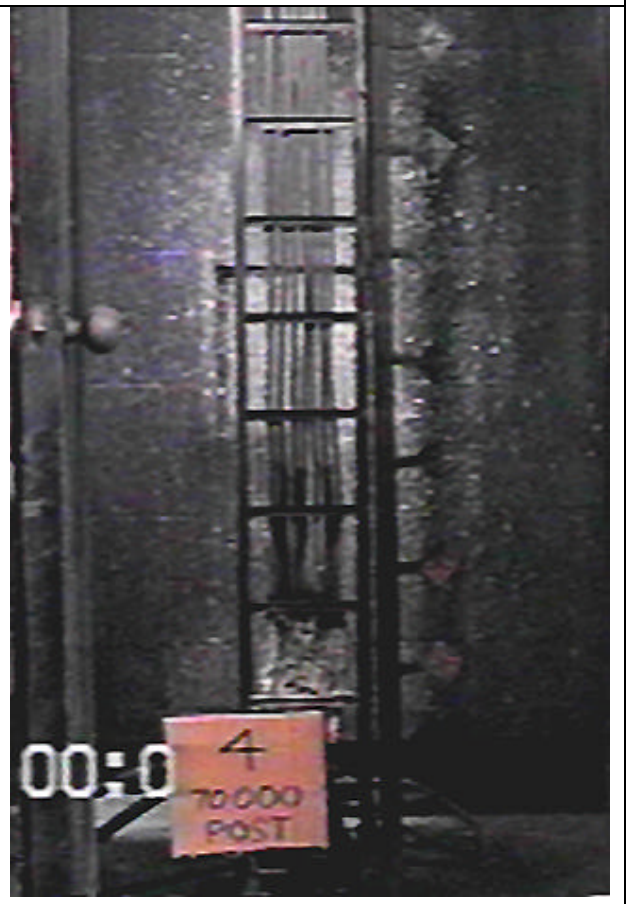
Test #A-1

Before the test	During the test	After the test
		

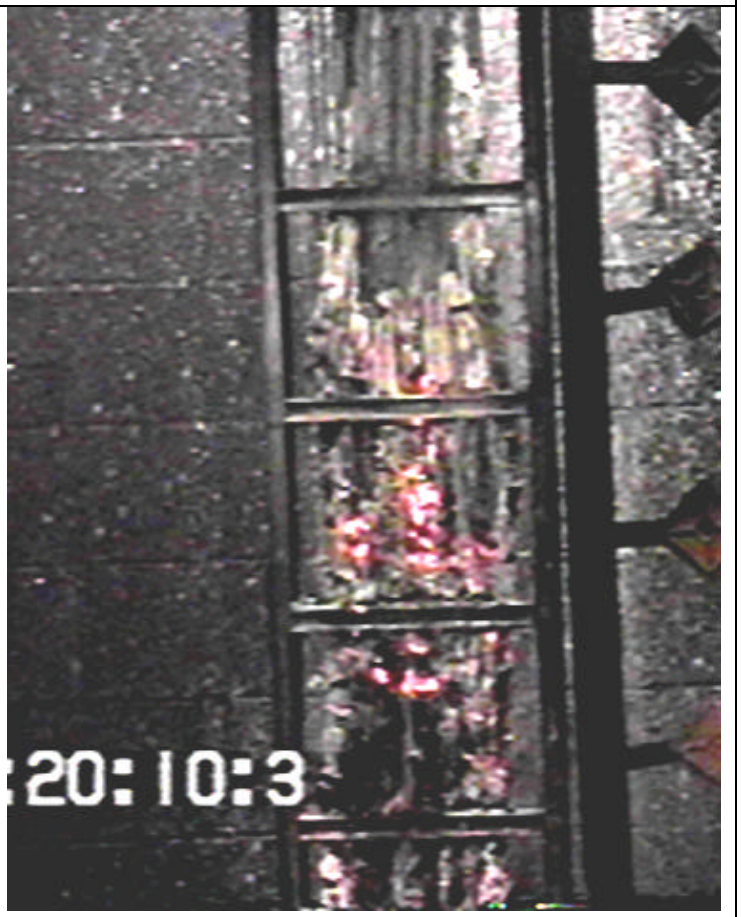
Test #A-2

Before the test	During the test	After the test
		

Test #A-3

Before the test	During the test	After the test
		

Test #A-4

Before the test	During the test	After the test
		

Test #A-5

Before the test	During the test	After the test
		

Test #A-6