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USNRC SEVENTH WATER REACTOR SAFETY RESEARCH INFORMATION MEETING

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Status of the Fire Protection Research (FPR) Program*

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The objective of the Fire Protection Research (FPR) Program, under the sponsorship of the Office of Water Reactor Safety Research, USNRC, is to confirm the capability of safety features in use or planned for use in nuclear power plants. This objective is to be achieved by full scale testing and experimental and analytical evaluation of fire phenomenology. The specific major tasks of the research during this past year were to:

1. Modify fire research facility for corner effects tests.
2. Perform corner effects tests on full scale cable tray fires.
3. Scope replication fire test chosen by NRC Fire Protection Review Group.
4. Develop work scope and test plan for penetration fire stop testing.
5. Perform preliminary penetration fire stop testing.
6. Formalize a quality assurance (QA) plan for the fire protection research program.
7. Modify facility and construct new room for fire suppression testing.

*This report documents part of the Fire Protection Research (FPR) Program being conducted by Sandia Laboratories for the United States Nuclear Regulatory Commission under Interagency Agreement DOE 40-550-75.

BACKGROUND

Previous activities in this program included a survey of architect engineering firms, utility companies, and electrical cable manufacturers to determine cable constructions, cable tray constructions, cable loading, and types of cable assignments in cable trays. Screening tests were performed to select two typical, qualified (IEEE-383) cable types most likely to propagate a fire. The relative ranking of the cable types was based on three different evaluations. They were: (1) a small scale electrically initiated cable insulation fire test, (2) Underwriters Laboratories FR-1 flame test, and (3) a pyrolizer and thermal chromatograph test (measure of insulation outgasing as a function of temperature).

Using the IEEE-383 qualified cable selected from the screening tests, three phases of full scale electrically initiated fire tests were performed. The tests show that for electrically initiated fires in IEEE-383 qualified cable a margin of safety exists in the spatial separation distances of Regulatory Guide 1.75 [1-8].

However, an exposure fire test at Sandia on July 6, 1977 confirmed that the separation guidelines and IEEE-383 fire retardancy standards for safety cables are not sufficient, in themselves, to protect against such fires [9]. The exposure fire was propane-fueled from two ribbon burners. It ignited a donor tray which then was exposed to the remaining trays.

Small scale and full scale testing was performed on fire retardant coatings on cable tray [10, 11]. Full scale testing of the coatings consisted of both propane and diesel-fueled exposure fires. Propane-fueled exposure fires were used to test the ability of various fire shields to prevent fire propagation between horizontal cable trays. Results show that all coatings and barriers offer a measure of additional protection but that there is a range of relative effectiveness of the different fire retardant coatings tested.

A full-scale fire test was conducted on vertically oriented cable trays, using a configuration of cable-tray protective barriers and an automatic sprinkler system [12]. This test raised questions with regard to the effectiveness of both the automatic sprinkler system and the protective barrier used to protect against a flammable liquid spill.

REPORT OF CURRENT WORK

Full-scale fire tests were performed on horizontally oriented cable trays to determine the effects of a ceiling and wall corner configuration for various distances from cable trays [13]. The same experimental procedures used in the previous exposure fire initiation tests were used in the corner effects tests. IEEE-383 ribbon burners (Figure 1) were used for the fire source. The effect of reradiation from corners was quantified for both IEEE-383 qualified and unqualified cable in terms of equations relating insulation weight loss (Figure 2) and heat flux (Figure 3) to the separation distance between a cable tray and corner. As expected and confirmed by testing, the inverse of the square of the separation distance between the corner and tray dominates the expression of cable damage severity.

The work scope was developed for a replication test of a particular makeup pump room. This test was eliminated from consideration when plant modifications were made which removed the presence of redundant safety cables from the room. A new work scope is being developed for a replication test of a corridor with cables from both safety divisions.

A work scope was developed and a test plan written for penetration fire stop testing. Preliminary testing at the University of California has revealed the importance of two characteristics not modelled in the present E-119 testing procedure. These characteristics are: 1) maintainance of positive pressure within the furnace; and 2) presence of excess pyrolysates in the area of the seals.

A formal quality assurance plan has been developed for the fire protection research programs. It has been written for a general application to other research programs at Sandia and is flexible enough to cover different aspects of each program.

Accomplishments on the fire suppression portion of our program are being reported at this information meeting by F. R. Krause of Sandia Laboratories.

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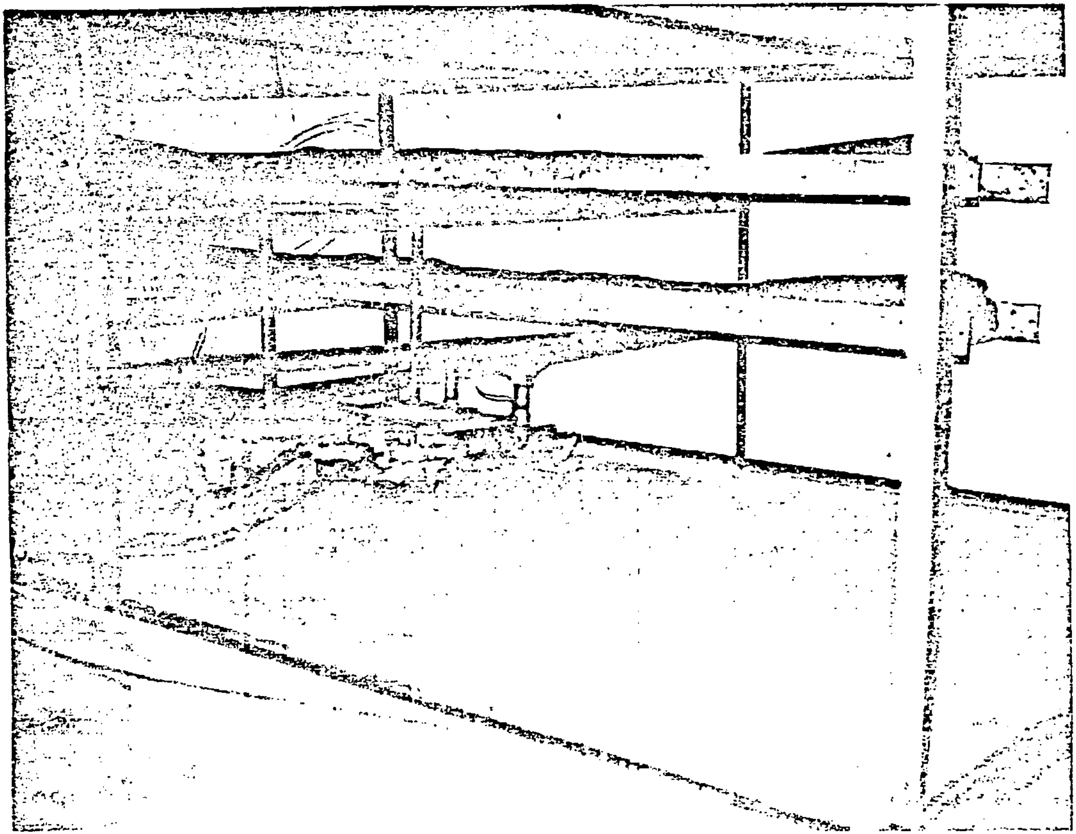


Fig. 1 Corner Effects Test, Experimental Arrangement

Fig. 2

CORNER EFFECTS TESTS
WEIGHT LOSS, TOP TRAY

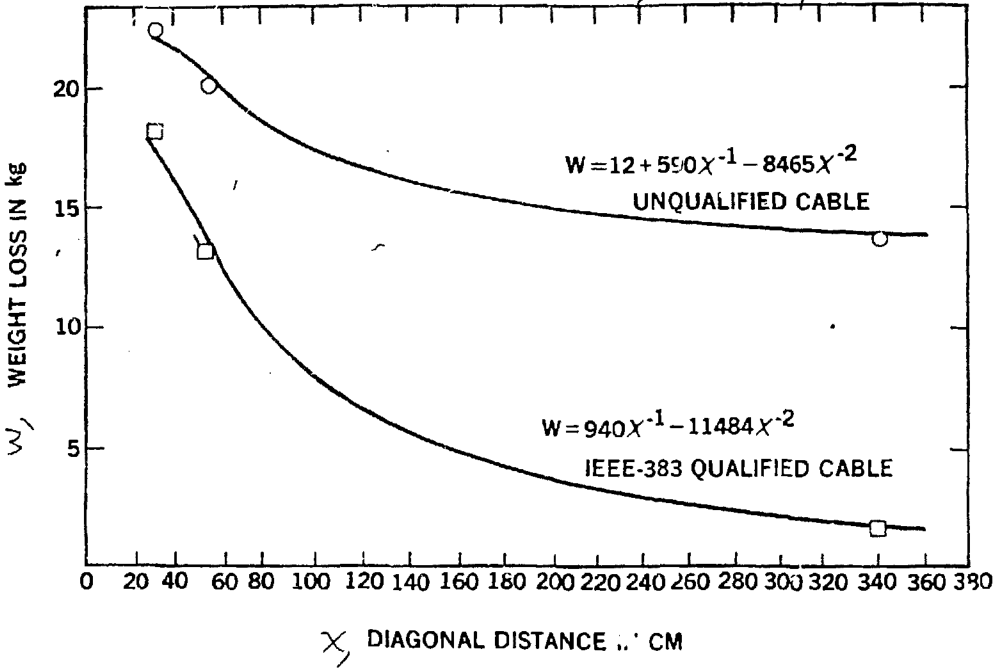
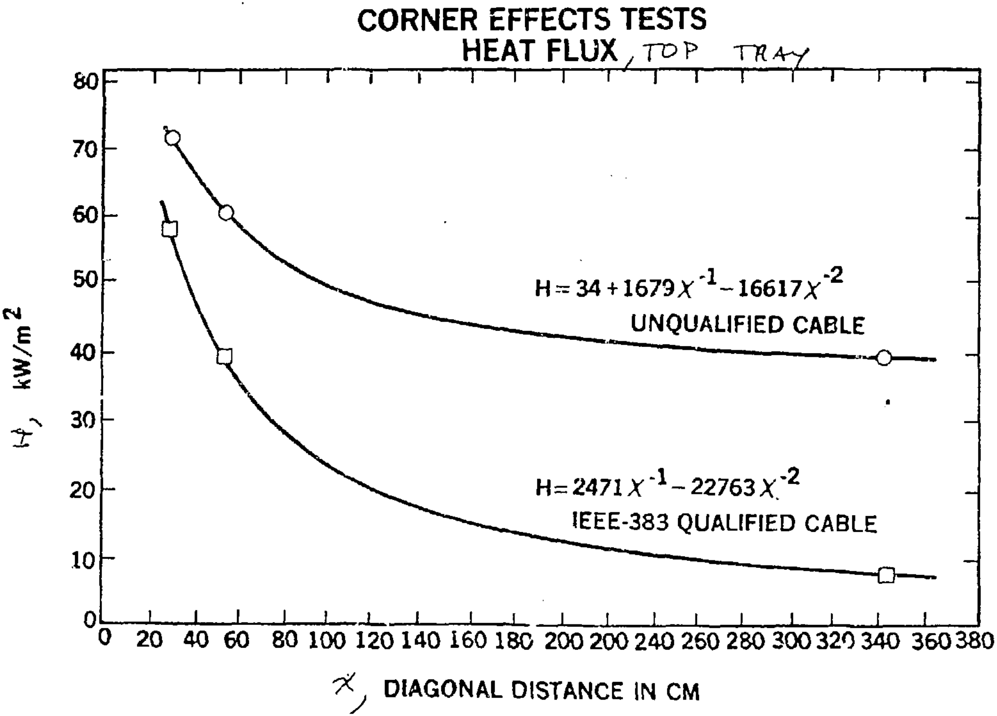


Fig. 2

Fig. 3


CORNER EFFECTS TESTS
HEAT FLUX, TOP TRAY
H, kW/m2
80
70
60
50
40
30
20
10
0
0 20 40 60 80 100 120 140 160 180 200 200 240 260 280 300 320 340 360 380
x, DIAGONAL DISTANCE IN CM
H = 34 + 1679 X-1 – 16617 X-2
UNQUALIFIED CABLE
H = 2471 X-1 – 22763 X-2
IEEE-383 QUALIFIED CABLE