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Information Sheet: Cable Heat Release Rate, Ignition and Flame Spread, David Stroup *(NRC/RES/DRA)*

Background

The results of the Individual Plant Examinations of External Events program and actual fire events show that fire can be a significant contributor to nuclear power plant (NPP) risk, depending on design and operational conditions. Electrical cables have been responsible for a number of fires in NPPs over the years. In 1975, a serious fire involving electrical cables occurred at the Browns Ferry Nuclear Power Plant operated by the Tennessee Valley Authority (NUREG-0050). Electrical cables perform numerous functions in NPPs. Power cables supply electricity to equipment, control cables connect plant equipment to remote initiating devices, and instrumentation cables transmit low-voltage signals between input devices and readout display panels. NPPs typically contain hundreds of miles of electrical cables. The in situ fire fuel load in a NPP is clearly dominated by electrical cable insulating materials. In a postulated fire scenario, these materials can be an ignition source, intervening combustible, and/or part of the target set.

These cables are made up of a variety of thermoplastic and thermoset materials. The burning behavior of cables in a fire depends on a number of factors, including their constituent materials and construction as well as their location and installation geometry. Burning cables can propagate flames from one area to another or they can add to the amount of fuel available for combustion. Burning cables also produce smoke containing toxic and corrosive gases. The lower the heat exposure required to ignite the electrical cables, the greater the fire hazard in terms of ignition and flame spread. Electrical cables exposed to fire can lose physical integrity (i.e., melting of the insulation) and insulation resistance, leading to electrical breakdown or short-circuiting or spread of fire to other cables or combustibles.

The amount of experimental evidence and analytical tools available to calculate the effects of cable tray fires is relatively small when compared to the vast number of possible fire scenarios. Many of the large-scale fire tests conducted with cables are qualification tests in which the materials are tested in a relatively realistic configuration and qualitatively ranked on a comparative basis. This type of test typically does not address the details of fire growth and spread and does not provide any useful data for model calculations.

Approach

The CHRISTI-FIRE (Cable Heat Release, Ignition, and Spread in Tray Installations during FIRE) experimental program is an effort to quantify the mass and energy released from burning electrical cables. The objective of this program is to perform fire tests on grouped electrical cables to better understand the fire hazard characteristics, including heat release rate (HRR) and flame spread. This type of quantitative information will be used to develop more realistic models of cable fires for use in fire probabilistic risk assessment (PRA) analyses, such as those performed using the methods of NUREG/CR-6850 “Fire PRA Methodology for Nuclear Power Facilities” in NFPA 805 applications.

The experimental program has two main thrusts—bench-scale measurements of small samples of burning cables and full-scale measurements of the heat release and fire-spread rates of cables burning within typical ladder-type trays. CHRISTI-FIRE involves mainly horizontal tray configurations. Fires do not spread as rapidly over horizontal trays, but the rates can greatly depend on the proximity of a given tray to others or surrounding walls or ceiling.

Figure 1. Demonstration of Cable Tray Fire Test.

Program Management

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For More Information

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