U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

Sandia National Laboratories (SNL)

Electric Power Research Institute (EPRI)

Information Sheet: **"DESIREE-FIRE" - Direct Current Electrical Shorting In Response to Exposure-Fire,**
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Background

The Individual Plant Examinations of External Events program results and actual fire events indicate that fire can be a significant contributor to nuclear power plant (NPP) risk. The question of how to determine risk resulting from fire damage to electrical cables in NPPs has been of concern since the Browns Ferry NPP fire in 1975. In earlier years, it was generally believed that any system that depended on electric cables passing through a compartment damaged by fire would be unavailable for its intended safety function. The Browns Ferry fire and recent testing have prompted wider realization that short circuits involving an energized conductor can pose considerably greater risk. The resultant "hot shorts" can cause systems to malfunction in such ways as inadvertently repositioning motor-operated valves and starting or stopping plant equipment. This risk should be accounted for in plant safety analyses.

A consensus regarding the likelihood of hot shorts given fire-damaged cables didn't exist in the late 1990s. The Nuclear Energy Institute (NEI) and the Electric Power Research Institute (EPRI) conducted a testing program in 2001, and NRC conducted one via its CAROLFIRE program in 2006. NUREG/CR-6931, Volumes 1-3, documents the CAROLFIRE results. These programs produced a "gold mine" of data and knowledge related to fire-induced circuit failures of alternating current (AC) circuits. However, none of the previous testing explicitly explored the fire-induced circuit failure phenomena for direct current (DC). Both current operating plants and the proposed new reactor designs use DC circuits to operate numerous safety-related systems.

Some recent testing performed by industry has indicated that the results for AC circuits may not be fully representative of what might occur as a result of fire-induced damage to DC circuits. Due to the differences in the operating voltages and circuit design between AC and DC, the previous data gathered for AC circuits is unlikely to be applicable to DC circuits. The DESIREE-FIRE testing of risk-significant DC circuits will allow the fire protection community to better understand DC circuit failure characteristics.

Approach

The NRC staff decided to perform fire testing of DC circuits using configurations that are representative of safety-significant circuits and components used in NPPs to better understand the probability of spurious actuations and the duration of those actuations in DC circuits.

The DESIREE-FIRE program will use intermediate- and small-scale fire testing to evaluate the response of DC circuits to fire conditions. Several different circuits will be tested, including:

- DC motor starters.
- Pilot solenoid-operated valve coils.
- Medium voltage circuit breaker control.
- Instrumentation circuit.

The DESIREE-FIRE project is unique to the Fire Research Branch due to its collaborative research agreement with EPRI. This agreement has provided various components and cabling to the DESIREE-FIRE testing program at little to no cost to NRC. It also has allowed for expert advice on the various aspects of the DC power system and circuit design.

Figure 1. Electrical Cable Fire Damage.

Program Management	
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For More Information
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