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

Electric Power Research Institute (EPRI)

National Institute for Standards and Technology (NIST)

Information Sheet: **Fire Modeling Activities,** Jason Dreisbach, David Stroup *(NRC/RES/DRA)*

The Risk

The results of the Individual Plant Examinations of External Events (IPEEE) program and actual fire events indicate that fire can be a significant contributor to nuclear power plant risk, depending on design and operational conditions. Fire models are often used to evaluate fire scenarios in risk assessments. The models are used to determine damage to cables and other systems and components important to safety. They are also used to characterize the progression of fire beyond initial targets. Used in these ways, fire models are important tools to determine the contribution of fire to the overall risk in nuclear power plants (NPPs).

The Needs

The NRC recently amended its fire protection requirements to allow existing reactor licensees to voluntarily adopt the fire protection requirements contained in NFPA 805. NFPA 805 allows licensees to use fire models to evaluate their fire protection program. However, the fire models that are used must be verified and validated and acceptable to the NRC. To this end, the NRC's Office of Nuclear Regulatory Research, along with the Electric Power Research Institute (EPRI) and the National Institute of Standards and Technology (NIST), conducted an extensive verification and validation (V&V) study of fire models used to analyze NPP fire scenarios. This study has resulted in the seven-volume report, "Verification and Validation of Selected Fire Models for Nuclear Power Plant Applications," NUREG-1824.

There is a need in fire risk assessments to determine when cables fail during a fire in NPPs. In the past, cable damage models have been crude and have not been validated. Recently, as part of the Cable Response to Live Fire (CAROLFIRE) program, NRC and NIST have developed a simple cable damage model called Thermally-Induced Electrical Failure (THIEF). This model uses empirical information about cable failure temperatures and calculations of the thermal response of a cable to predict the time to cable damage. The THIEF model was benchmarked and validated against real cable failure and thermal data acquired during the CAROLFIRE program.

The Applications

The results in NUREG-1824 are designed to be used by licensees and the NRC to provide insights into the predictive capabilities of the various models evaluated. For example, although engineering calculations have limited capabilities, they provide reasonable estimates of certain phenomena when used within limitations. These insights are valuable to fire model users who are developing analyses to support transition to NFPA 805, to justify exemptions from existing prescriptive regulatory requirements, and to conduct reviews under the Reactor Oversight Process.

The THIEF model will be implemented into both two-zone and computational fluids dynamics models at NIST. Additionally, the NRC is evaluating the implementation of the THIEF model into its Fire Dynamics Tools (FDTs) spreadsheets (NUREG-1805). This would be useful for inspectors and licensees to quickly determine the likelihood of cable damage given a fire, or indicate the need for further analysis.

The Future

The NRC has been conducting a Phenomena Identification and Ranking Table (PIRT) study of fire modeling. This effort will identify important fire modeling capabilities that need to be developed to improve our confidence in the results. This study will help define future research priorities in fire modeling.

The NRC is currently working with EPRI and NIST again to develop technical guidance to assist users of fire models who conduct fire modeling analyses of NPPs. This guidance will continue to expand on the effort of NUREG-1824 by providing users with best practices from experts in fire modeling and NPP fire safety.

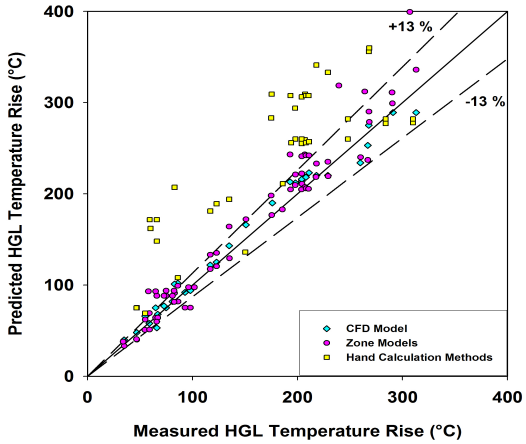

Figure 1: Measured vs. Predicted Hot Gas Layer Temperature Rise. The models evaluated provide reasonable estimates of actual temperature rise.

For More Information
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