Upgrading Safety Systems

Safe-Shutdown Analyses Identify Upgrades to Reduce Fire Risks

A safe-shutdown analysis identifies ways to reduce the most dangerous fire risks at a nuclear power plant. It concentrates on areas where fire could damage the safety systems needed to shut down a reactor safely.

A nuclear power plant relies on safety systems to control the reactor during an emergency. For example, if the nuclear fuel begins to overheat, an emergency core cooling pump will send cooling water to the reactor core. If fire damages an essential safety system, however, operators may be unable to shut down the reactor safely. The result could be damage to the reactor core and the release of radioactive material.

Fire-retardant materials were applied to cables and wall openings at the Russian reactor in Smolensk. Should the cables catch fire, the retardant prevents fire from traveling along cables and damaging other systems, including those used to safely shut down a reactor.

To ensure safe shutdown in the event of fire, international standards call for fire zones and redundant safety systems. Each fire zone has barriers to prevent the spread of fire to other areas of the plant. Each essential safety system has a redundant—or backup—system located in a different fire zone. If fire damages one safety system, such as the emergency core cooling pump, a backup pump can be used for cooling while operators shut down the plant.

Soviet-designed nuclear power plants were not designed with fire zones to prevent the failure of redundant safety systems. For example, an emergency core cooling pump and its backup pump might be located in the same area or have power cables located in the same cable tray. A fire could disable both pumps. The result could be overheated nuclear fuel and the release of radioactive material.

To address these hazards, the United States Department of Energy sponsored the development of the *Reactor Core Protection Evaluation Methodologies for Fires at RBMK and VVER Nuclear Power Plants*. This document provides a systematic methodology for performing safe-shutdown analyses at the two principal models of Soviet-designed reactors, called RBMK and VVER. With text published in English and Russian, the methodologies have been endorsed by Russian and Ukrainian teams as well as international nuclear experts.

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The U.S. Department of Energy assembled a team of U.S. and Russian specialists to conduct a safe-shutdown analysis of the Smolensk nuclear power plant. U.S. nuclear and safety experts from the Pacific Northwest National Laboratory (PNNL), Brookhaven National Laboratory (BNL), University of Maryland (UM), Engineering Planning and Management (EPM) Inc. and Bechtel are providing training and technical review. The United States also has provided necessary computer equipment and a computer code called REVEAL_W. This computer program develops a model of the plant, showing its fire zones and the safety systems within each zone. Looking at each zone in turn, the program assumes that a fire has disabled all the safety systems within that zone. The program then determines whether backup systems in other fire zones could perform all the functions necessary to shut down the plant safely. If not, equipment modifications or procedure changes can be made, such as separating cables or erecting fire barriers, to resolve the problem.

Upon completion in December 1999, the Smolensk analysis will list prioritized recommendations for plant upgrades, so the most urgent and cost-effective changes can be implemented first. The United States already has supplied fire doors and fire-retardant materials to Russia's Smolensk plant to help ensure safe shutdown in the event of a fire. Russia's Leningrad plant, Ukraine's Zaporizhzhya and Chornobyl plants, Bulgaria's Kozloduy plant, and the Armenia Nuclear Power Plant also have received fire safety equipment. Supporting the efforts at Zaporizhzhya are U.S. nuclear and safety experts from PNNL, BNL, UM, EPM and Burns and Roe.

Ukrainian, Russian, and Armenian plant managers have participated in training on the safe-shutdown methodologies. Ukrainian specialists are conducting a safe-shutdown analysis at the Zaporizhzhya plant.

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