Improving the Safety of Day-to-Day Operations

Instructions for Responding to Emergencies Can Prevent Reactor Core Damage

During an emergency, nuclear power plant operators must stabilize the reactor quickly to prevent damage to the reactor core and preclude the release of radioactive material. Symptom-based instructions for rapid emergency response were developed in the United States after the 1979 accident at Three Mile Island.

Previously, operators could not respond to abnormal conditions until they first identified the problem or event—such as a steam-generator tube rupture or loss of cooling water. They then followed procedures designed to correct the specific problem and mitigate its consequences. These procedures, still used at most Soviet-designed nuclear power plants, are called event-based emergency operating instructions.

New emergency operating instructions are being developed and implemented at Soviet-designed nuclear power plants. The instructions allow reactor operators to rapidly respond to emergency conditions without first determining the cause of the accident.

Symptom-based emergency operating instructions, now used at all U.S. plants and many others around the world, enable operators to respond to emergencies without first determining the specific cause. These instructions provide responses to emergency symptoms—crucial changes in plant parameters such as reactor pressure, water level, or temperature. Operators immediately can stabilize the reactor by responding to these symptoms, regardless of the cause. The time saved can prevent damage to the reactor core.

Symptom-based procedures also inform operators which actions to take first when two or more problems occur simultaneously. This increases operators' ability to resolve the problems before reactor core damage occurs.

In the countries where Soviet-designed reactors are located, U.S. experts have completed efforts to train local specialists in the methodology for developing the instructions. Host-country personnel now are developing symptom-based emergency operating instructions for the four major types of Soviet-designed reactors--VVER-440, VVER-1000, RBMK and BN. The reactors include Balakovo, Kola, Novovoronezh and Smolensk in Russia; Chornobyl, Rivne and Zaporizhzhya in Ukraine; Kozloduy in Bulgaria; and Ignalina in Lithuania. Specialists at several additional sites also have undertaken work to develop symptom-based instructions.

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In Russia, the Novovoronezh plant has implemented a complete set of instructions at one of its three reactors. Staff in Russia have drafted the required instructions for plants at Balakovo, Kola and Smolensk. In Ukraine, the Chornobyl plant has implemented its emergency operating instructions. Instructions have been drafted but not yet implemented the Ukrainian plants at Rivne and Zaporizhzhya. Lithuania's Ignalina plant is in the process of validating its instructions. Six reactors are located in the Kozloduy plant in Bulgaria, where instructions are in draft form awaiting the completion of supporting analyses.

U.S. experts are working with specialists in each host country to validate instructions before they are implemented. The specialists develop calculations and use computer models of accident scenarios to test the instructions, ensuring that they will mitigate the consequences of an accident and prevent damage to the reactor core.

U.S. participation in this project will be complete when host-country specialists have validated the instructions for each type of plant and implemented them at the pilot plants. At this point, specialists in each country will have the capabilities to develop, validate, and implement instructions for the remaining reactors within their borders.

An example from the Zaporizhzhya plant in Ukraine demonstrates that the training is having the desired effect. Even before management formally implemented emergency operating instructions at Zaporizhzhya, training in their use on a simulator in the United States made a difference for Chief Engineer Yuri Kovorskin during a 1996 crisis. During routine testing of a pressurizer safety valve, the valve failed in the open position and could not be closed. The plant rapidly depressurized, and the core began heating up. Approved methods to restore core cooling failed. Calling into play his simulator training, or symptom-based emergency operating instructions, Yuri Kovorskin drafted a temporary procedure that initiated actions to cool the reactor core. The forced cooling stabilized plant conditions. Operators were then able to cool down the plant, close the safety valve, and restore the plant to a stable shutdown condition.

Another example of the value of symptom-based emergency operating instruction training is reported, in his own words, by a shift supervisor at the Novovoronezh plant in Russia. "On June 18, 1997, the emergency feedwater supply of the primary circuit was actuated. As a result, for the first time the control room #3 personnel under my charge have used the emergency operating instructions to restore safety, including monitoring of critical safety functions. Thus, we can claim a significant help to the personnel due to use of the emergency operating instructions."

In a related project, the United States is working with Ukraine and Russia to develop safety parameter display systems, which work hand-in-hand with the symptom-based emergency operating instructions. The display systems quickly provide control room operators with the status of key plant conditions. When an emergency occurs, the system allows the operator to rapidly determine which conditions—or symptoms—within the plant are abnormal. The operators then use the symptom-based emergency operating instructions to stabilize the plant.

Safety parameter display systems developed with U.S. cooperation are operating at Russia's Kursk and Novovoronezh plants, and at Ukraine's Chornobyl plant. Scheduled to come on line in 1999 are systems in Ukraine (Khmelnytskyy, Zaporizhzhya and South Ukraine). Six more systems are scheduled for installation in the years 2000 to 2003.

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