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Success Story

Chubu Electric Safely Manages Reactor Seawater Intrusion Event with EPRI Support

Rapid-response technical expertise related to water chemistry management helps Japanese utility ensure safe shutdown and minimize damage.

Hamaoka-5 Nuclear Power Station

During the process of putting the Hamaoka-5 Advanced Boiling Water Reactor into cold shutdown in May 2011, debris from the failure of feedwater pump piping within the main condenser led to the failure of some condenser tubing, enabling seawater to enter the reactor water system. To cope with this event, Chubu Electric Power Company worked with EPRI experts to successfully diagnose and manage water chemistry issues. The collaboration helped ensure safe shutdown and minimize damage to reactor components.

EPRI's rapid response and ongoing technical support enabled Chubu to:

- Ensure a safe shutdown
- Reduce the concentration of chloride and other impurities in the reactor water to acceptable levels
- Apply lessons learned from seawater intrusion events at other nuclear power plants
- Assess and monitor reactor water chemistry
- Perform a detailed review of systems, fuel, and materials impacts
- Manage the situation using industry best practices and expert technical support.

Timely Technical Support, Expert Knowledge

Japan's prime minister ordered Hamaoka-5 to shut down in May 2011 as a precautionary measure in the wake of the devastating tsunami that damaged the Fukushima Daiichi nuclear complex. The shutdown was proceeding normally until a recirculation piping end cap failed from fatigue due to a manufacturing defect. The dislodged end cap struck and damaged condenser tubes, allowing seawater used for cooling to rapidly enter the reactor. The intruding seawater raised the levels of chloride and other impurities in the reactor, which needed to be reduced as quickly as possible to avoid corrosion damage to reactor internal components.

At the time of the end cap failure, EPRI staff happened to be visiting Hamaoka to review their post-Fukushima safety enhancements. Chubu requested EPRI's assistance in evaluating technical options for responding to the seawater intrusion. Information from the Hamaoka event was sent back to the United States that evening and a preliminary response was received less than 15 hours later addressing potential impacts on fuel, materials and water chemistry.

"EPRI's practical recommendations on cleanup of chloride and other impurities in the reactor water were instrumental in verifying the relevance of our cleanup strategy."

~ Yoshihiro Ichikawa, General Manager, Chubu Electric

For example, as part of its ongoing BWR Chemistry Monitoring and Assessment effort, EPRI collects and maintains a vast amount of information on plant design, operating practices, chemistry control, corrosion mitigation and control strategies, and chemistry and dose rates. This information provides input to the EPRI *BWR Water Chemistry Guidelines*. EPRI also tracks seawater intrusion events, documenting their severity and impacts on fuel and materials. The Hamaoka seawater intrusion event will contribute significantly to the state of knowledge around the impacts of such events.

Recommendations and Results

EPRI's recommendations and results include the following:

Reducing chloride levels. EPRI provided recommendations for operation of cleanup water filter demineralizers and resin mixtures to reduce reactor water chloride levels below 100 parts per billion, per the *BWR Water Chemistry Guidelines*. When chloride levels increased again, EPRI identified the source as the residual heat removal/shutdown cooling system, whose piping contained some salt water from the suppression pool. Combining these recommendations with its own findings, Chubu was able to implement countermeasures to prevent further seawater inputs to the reactor.

Reducing crud and impurities. To reduce the levels of corrosion products (crud) in the reactor coolant, EPRI recommended using optimized resin mixtures that had been applied successfully for shutdown crud cleanup at U.S. nuclear plants experiencing seawater intrusions. EPRI also recommended that the cleanup water filter demineralizer system remain in service to clean up impurities in the reactor water and to gradually clean up the crud in the reactor coolant.

As a result of these and other actions, Chubu successfully reduced the reactor water impurity levels to levels within the chemistry specifications. "The seawater intrusion at Hamaoka-5 was unprecedented in Japanese nuclear history," said Yoshihiro Ichikawa, general manager of the operations and maintenance group at Chubu. "EPRI's rapid response helped us collect the necessary information so we could organize and implement appropriate countermeasures. Among other things, EPRI's practical recommendations on cleanup of chloride and other impurities in the reactor water were instrumental in verifying the relevance of our cleanup strategy."

Condenser saltwater cleanup. EPRI also recommended the temporary installation of a portable reverse osmosis system and a mixed-bed processing system to clean up the salt water inventory in the main condensers; and suggested approaches for recycling or discharging the reverse osmosis permeate.

Suppression pool water cleanup. EPRI further suggested that cleanup could be achieved in steps by pumping water to radwaste and processing the water either for recycle or discharge.

Continuing Support

EPRI continues to work with Chubu to monitor and assess the reactor chemistry and resolve remaining issues.

For more information, contact the EPRI Customer Assistance Center at 800.313.3774 (askepri@epri.com)

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