EPRI Provides Input to Cancer Study Design

The U.S. Nuclear Regulatory Commission, through the National Academy of Sciences (NAS), is updating a 1990 report prepared by the National Cancer Institute on cancer in populations living near nuclear facilities. The NAS study is focused on public exposures from routine operation of nuclear facilities, as opposed to exposures from emergency operations or accident events.

In light of the difficulties in developing a sound design for this type of study, EPRI formed a committee of scientists and professionals in the fields of epidemiology, radiation biology, nuclear plant effluents, and environmental risk assessment to offer suggestions to the NAS committee responsible for scoping the report update. The technical considerations are largely related to the data challenges that exist and the statistical limitations inherent in epidemiological studies. The EPRI input provides key recommendations on epidemiological approaches that may yield more meaningful study results.

Earlier Studies and Confounding Factors

The 1990 study considered the mortality risk in populations around 52 nuclear power plants and 10 Department of Energy nuclear facilities. The results concluded that deaths from cancer were not more frequent in counties near nuclear facilities than in control counties. While pointing out that results were limited by the approach used to correlate releases and mortality and by the large size of the counties, the report authors stated that "if nuclear facilities posed a risk to neighboring populations, the risk was too small to be detected by a survey such as this one."

Subsequent studies of childhood cancers in the United Kingdom, Germany, and France also faced the problem of statistical limitations, primarily related to the fact that the monitored emissions from nuclear facilities are far smaller than natural background levels. In both the German and French studies, it was estimated that the exposures were 1,000 to 100,000 times smaller than natural background. If incremental dose increases are in fact this small, it will not be possible to discern a statistically significant increase in cancer risk.

Other result-confounding issues for the NAS update include outdated dosimetry models and parameter values (some of which were first published in 1959) and the use of distance from a facility as a surrogate for received dose, which fails to make use of actual facility release data and ignores the effects of local terrain and meteorology on effluent migration. To ensure realistic dose values, the NAS will need to develop an improved approach for linking emission measurements to the public dose received, including consideration of dose-rate and dose-distribution effects.

EPRI Recommendations

The EPRI committee's key recommendations, presented to the NAS during a public meeting, focused mainly on the dose issues, pointing out that an epidemiological study based on a small dose relative to annual background and medical exposures increases the difficulty of providing a definitive answer on cancer risks in populations near nuclear facilities. In recognition of this fact, and to make it clear to outside stakeholders, the committee said the NAS should develop an appropriate risk communication plan that explains the challenges associated with low-dose epidemiological studies, clearly articulates the study expectations, and describes how the results will be used.

The committee also recommended that any new epidemiologic study should closely coordinate the dosimetric efforts with the epidemiologic efforts and develop a comprehensive and consistent exposure assessment methodology for dose evaluation.

With respect to epidemiological studies, the EPRI committee submitted the following specific suggestions:

- Estimate actual dose for the study populations instead of using distance from a facility as a surrogate for dose.
- Conduct an analytic study (perhaps of a case-control design) focused on childhood cancer, with special attention given to leukemia and non-Hodgkins lymphoma in children under age 5. Use information from a child's full life span (including time in utero) about family history, personal illnesses, siblings, day care, places of residence, and possible exposures to radiation or environmental toxins.

For more information, contact Phung Tran, ptran@epri.com, 650.855.2158.

EPRI Develops Prototype Medium-Voltage Utility Direct Fast Charger

While recently commercialized plug-in electric vehicles offer sufficient battery capacity for typical daily driving, fast charging technologies have near-term potential to extend the range and versatility of such vehicles. To enhance this capability, engineers from EPRI, with financial and technical support from the Tennessee Valley Authority, have developed a prototype for an advanced direct-current (DC) fast charger system. The Utility Direct Fast Charger is being tested at EPRI's Knoxville laboratory in preparation for field demonstrations.

Advanced Transformer Boosts Efficiency

DC fast charging technology is expected to enhance the commercial appeal of plug-in electric vehicles. But widespread deployment of today's commercially available 208- or 480-volt alternating-current (AC) fast chargers has been inhibited by the high costs of power delivery infrastructure and hardware: three primaries and three secondaries, a three-phase 13.8-kilovolt (kV) AC line-to-line medium-voltage distribution transformer, and in many cases, an additional dedicated 60-hertz low-voltage isolation transformer to meet safety codes. Siting requirements and labor further add to the infrastructure cost. With high input current, the system loss in these DC fast chargers typically is greater than 10%. Conventional DC fast charging systems can attain efficiencies of 90%–92%, but additional losses in a three-phase supply transformer may reduce overall efficiency to 89%–91%.

The 2.4-kV/45-kVA (kilovoltampere) solid-state Utility Direct Fast Charger has fewer components than fast chargers used today, and its simple design is expected to result in lower installation costs. The unit also is more efficient than commercially available chargers, with an overall system efficiency of 96%–97%.

The charger's efficiency advantage comes from its key component—a solid-state transformer that can output a wide range of DC and AC voltages to tailor power to specific needs. For vehicle charging, the charger replaces both the independent power conversion units and the conventional transformer with a single interface system. The Utility Direct Fast Charger underwent successful proof-of-concept testing with an earlier, 2.4-kV/10-kVA fast charger prototype in March 2011. In these tests, the utility charger achieved efficiency greater than 96% in the 10%–90% operating range, a saving of more than 6% over the conventional approach, or a loss reduction of more than 50%.

In addition to its use in vehicle charging, the system has been proposed as a replacement for conventional transformers in regular medium-voltage power distribution. If a business installed the

Researchers at EPRI's Knoxville laboratory charge a Mitsubishi i-MiEV with the Utility Direct Fast Charger.

fast charger as its building transformer, it could not only conveniently add fast charging service but also integrate on-site solar, energy storage, and building energy management systems. This could help manage the high peak loads of the DC charger and reduce demand charges.

Utilities may consider providing fast charging capability directly from the distribution system—especially in cities, where fast chargers may not be hosted by a business. For such an application in which a DC-AC inverter function is not needed, the isolated DC-DC converter output can be used directly for fast charging, avoiding an additional 1.5% energy loss. Eliminating the conventional transformer also allows significant reduction in the size and weight of cabling and installation materials. A standard 50-kilowatt transformer weighs more than 800 pounds (363 kg)—more than 1,000 pounds (454 kg) with a charging station and low-voltage charger. The electronics for the entire EPRI Utility Direct Fast Charger weigh less than 150 pounds (68 kg).

Technology Demonstration

Recent testing at EPRI's Knoxville laboratory confirmed the 2.4-kV/45-kVA fast charger prototype's ability to provide a full charge to commercially available plug-in electric vehicles (two Nissan Leafs and one Mitsubishi i-MiEV). An important part of the demonstration was to confirm the communication compatibility of the fast charging technology with the electric vehicles' battery management systems by means of the industry standard CHAdeMO communication protocol. A user interface and web-based mobile data collection system were included in the Knoxville trials.

For more information, contact Arindam Maitra, amaitra@epri.com, 704.595.2646.