UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS REGARDING THE DRAFT FINAL REGULATORY GUIDE, DG-1137, "GUIDELINES FOR LIGHTNING PROTECTION OF NUCLEAR POWER PLANTS" JULY 6, 2005 ROCKVILLE, MARYLAND

- STATUS REPORT -

PURPOSE

The purpose of the meeting is to discuss the Draft Final Regulatory Guide DG-1137, "Guidelines for Lightning Protection of Nuclear Power Plants," with representatives of the Office of Nuclear Regulatory Research (RES) and Oak Ridge National Laboratory (ORNL). It is extremely important to note that this Draft Final Regulatory Guide only applies to new plants. This Draft Final Regulatory Guide offers guidance to NRC licensees and applicants for their use in developing and implementing practices that the staff finds acceptable for complying with the agency's regulatory requirements in Criterion 2, "Design Bases for Protection Against Natural Phenomena," as it appears in Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10, Part 50, of the Code of Federal Regulations (10 CFR Part 50). Also note, attached is a redline/strikeout version of the Draft Final Regulatory Guide with the changes from an earlier version e-mailed to the members as well as the abstract from NUREG/CR-6866, titled "Technical Basis for Regulatory Guidance on Lightning Protection in Nuclear Power Plants," by ORNL.

The staff is seeking ACRS endorsement of the Draft Final Regulatory Guide.

BACKGROUND

With the advent of digital and low-voltage analog systems in nuclear power plants (NPPs), lightning protection is becoming increasingly important. These systems have the potential to be more vulnerable than older, analog systems to the resulting power surges and electromagnetic interference (EMI) when lightning hits facilities or power lines.

Weather experts report that lightning strikes the Earth 100 times each second around the world and that 16 million thunderstorms occur worldwide each year. The regions most prone to this violent weather are those where very moist and unstable air masses move through year-round (e.g., regions in close proximity to the Gulf of Mexico and the Atlantic Ocean).

The following are facts regarding Lightning:

- Packs between 35,000 to 40,000 amps (A) of current,
- Can generate temperatures as high as 50,000ºC (90,032ºF),
- Travels as far as 40 miles,
- Can, and does, strike the same place twice,

- Kills nearly 100 people each year in the United States and injures hundreds of others, and
- Causes billions of dollars in property damage each year, many times resulting in fire and total property loss.

A draft regulatory guide had been written in 1979 entitled “Lightning Protection for Nuclear Power Plants.” The draft guide described criteria acceptable to the NRC staff for the design, application, and testing of Lightning Protection Systems (LPSs) to ensure that electrical transients resulting from lightning phenomena did not render systems important to safety inoperable or cause spurious operation of such systems. Specific practices on the use of lightning rods (air terminals) from National Fire Protection Association (NFPA) 78-1968, “Lightning Protection Code,” were endorsed. Note that this standard has been updated a number of times since 1968 and the latest version is NFPA 780-2004, “Standard for the Installation of Lightning Protection Systems.” The draft guide also endorsed practices on the use of surge arresters found in two American National Standards Institute (ANSI) standards. Issues such as common mode failures, surge protection of redundant systems, and surge protection of solid-state logic systems were mentioned but not discussed in great detail. The draft regulatory guide was never finalized and was subsequently terminated in 1981.

Petition for Rulemaking (PRM) 50-56 [5] was originated in 1991 by a former NRC staffer, petitioning the NRC to again address concerns related to lightning, as well as other sources such as electromagnetic pulses (EMP), EMI, geomagnetic currents, and ferromagnetic effects. The NRC staff issued a report titled, “Report on the Sources and Effects of Electrical Transients on the Electrical Systems of Commercial Nuclear Power Plants,” in 1992 in response to PRM 50-56. The staff report was structured accordingly, with EMP, geomagnetic currents, ferromagnetic effects, switching surges, and lightning being addressed in individual chapters. EMI was not addressed in this report because it was being studied under a separate program that eventually led to the issuance of Regulatory Guide (RG) 1.180, “Guidelines for Evaluating Electromagnetic and Radio-Frequency Interference In Safety-Related Instrumentation And Control Systems.”

This brings us to the current work by ORNL on NUREG/CR-6866, titled “Technical Basis for Regulatory Guidance on Lightning Protection in Nuclear Power Plants,” and the staff’s Draft Final Regulatory Guide DG-1137, titled “Guidelines for Lightning Protection of Nuclear Power Plants.”

DISCUSSION

A. NUREG/CR-6866

This report documents the technical basis for guidance on the protection of nuclear power structures and systems from direct lightning strikes and the resulting secondary effects. The scope of the technical basis for guidance includes protection of (1) the power plant and relevant ancillary facilities, with the boundary beginning at the service entrance of buildings; (2) the plant switchyard, (3) the electrical distribution system, safety-related instrumentation and control (I&C) systems, communications, and personnel within the power plant; and (4) other important equipment in remote ancillary facilities that could impact safety.

This report recommends that four primary standards be endorsed for the lightning protection of NPPs, their equipment, and personnel:

- **Institute of Electrical and Electronics Engineers (IEEE) Std 665-1995 (R2001)***:* This report recommends that IEEE Std 665 be endorsed for guidance on lightning protection for NPPs. This standard draws heavily from NFPA 780, which is widely accepted for lightning protection of most types of structures but which specifically excludes power generation plants.
- **IEEE Std 666-1991 (R1996)**: This report recommends that IEEE Std 666 be endorsed for its coverage of grounding and surge protection for medium-voltage equipment in NPPs.
- **IEEE Std 1050-1996***:* In addition to IEEE Std 665 and IEEE Std 666, which focuses on the direct effects of lightning strokes, this report recommends the endorsement of IEEE Std 1050, which covers the specific components necessary to prevent damage to I&C equipment from the secondary effects of lightning.
- **IEEE Std C62.23-1995 (R2001)**: This report recommends the endorsement of IEEE Std C62.23 as general guidance on surge protection. This standard consolidates many electric utility power industry practices, accepted theories, existing standards/guides, definitions, and technical references as they specifically pertain to surge protection of electric power generating plants.

This report further recommends that the applicable portions of IEEE Std 80, IEEE Std 81, IEEE Std 81.2, IEEE Std 142, IEEE Std 367, IEEE 487, IEEE Std 1100, IEEE Std C37.101, IEEE Std C57.13.3, IEEE Std C62.92.1, IEEE Std C62.92.2, IEEE Std C62.92.3, IEEE Std C62.41.1, IEEE Std C62.41.2, and IEEE Std C62.45 be endorsed (with qualifications) by the endorsement of the four primary standards.

B. DG-1137

It should be noted that **this Draft Final Regulatory Guide only applies to new plants.**

This Draft Final Regulatory Guide offers guidance to NRC licensees and applicants for their use in developing and implementing practices that the staff finds acceptable for complying with the agency's regulatory requirements in Criterion 2, "Design Bases for Protection Against Natural Phenomena," as it appears in Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10, Part 50, of the Code of Federal Regulations (10 CFR Part 50). Specifically, Criterion 2 requires, in part, that NPP structures, systems, and components (SSCs) that are important to safety must be designed to withstand the effects of natural phenomena without losing their capability to perform their respective safety functions. While the regulations address lightning protection for safety-related electrical equipment, they do not explicitly provide guidance concerning the design and installation of LPSs to ensure that electrical transients resulting from lightning phenomena do not cause spurious operations in safety-related systems or render them inoperable.

As proposed, DG-1137 will augment the regulations by establishing explicit guidance that is consistent with LPS design and installation practices that are currently applied throughout the commercial power industry. Toward that end, the NRC staff has selected for endorsement a total of four standards issued by IEEE, which taken together, provide comprehensive lightning protection guidance for nuclear power plants. Specifically, the four standards are:

(1) **IEEE Std. 665-1995 (2001 revision)**, *IEEE Guide for Generating Station Grounding*
(2) **IEEE Std. 666-1991**, *IEEE Design Guide for Electrical Power Service Systems for Generating Stations*
(3) **IEEE Std. 1050-1996**, *IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations*
(4) **IEEE Std.C62.23-1995 (2001 revision)**, *IEEE Application Guide for Surge Protection of Electric Generating Plants*.

The Draft Final Regulatory Guide was made available as DG-1137 for public comment. The comment period ended April 20, 2005. The staff received comments from two utilities (Progress Energy and Tennessee Valley Authority). The staff reviewed those comments and incorporated them, as appropriate.

EXPECTED COMMITTEE ACTION

Provide a letter endorsing the draft final regulatory guide.