NRO Input to Commissioner Klein's Request for Response to Questions from American Nuclear Society Conference to be Documented in Conference Proceedings

Question #3) Generation 4 Nuclear power plants have different (more extreme) operating conditions compared with current LWRs. As a regulator, what are your expectations with regard to materials qualification for use in these next generation plants?

Response:

The advanced reactor designs are significantly different from LWRs considering the use of high temperature metals and graphite; higher coolant temperatures; a coolant that does not change phase; and different degradation mechanisms such as creep, and behavior of metallic and graphite components in this environment. Based on the significant differences and the lack of experience on the proposed next generation plants, the following is a summary of staff expectations from the applicants:

- The staff would expect a Next Generation reactor applicant to meet the requirements set forth in 10 CFR Part 50 with respect to the design, installation, inspection, operation, and maintenance of materials and components, which are critical to reactor safety.

- Because of the potentially higher temperatures, higher operational stress, and more aggressive environment and the fact that we have essentially no operational history, the threshold for the factor of safety used in design would be subjected to higher levels of scrutiny by the staff.

- Many of the components are subjected to harsh environments which could potentially degrade faster under the influence of higher neutron dose, temperatures, and stresses. The staff would expect the applicant to provide for review and assessment, analytical failure, or performance predictions; which are based on sound science and the application of engineering principles confirmed by experimental data which bounds expected reactor operational environment.

- High temperature gas cooled reactor (HTGR) designs raise the potential for the need of an improved inservice inspection (ISI) program and for continuous monitoring. More components are enclosed in pressure vessels making access for inspection difficult. In addition, HTGR has longer operating cycles between scheduled refueling outages. Thus, there is a need for assessing the requirements of the less frequent ISIs for timely detection of cracking and degradation of components as well as the potential for excessive growth of cracks before the next ISI.

In addition to the above expectations of the next generation nuclear power plant applicants, NRC staff needs to develop independent research capability in the materials area beyond the licensing basis to understand safety margins and failure mechanisms, and reduce uncertainties. In order to conduct independent PRAs of advanced reactors, the staff will need information on the probability of failure of various reactor components. Because of the lack of operating experience, this information will have to be developed analytically using probabilistic fracture mechanics. To do this, potential degradation mechanisms of metallic and graphite components need to be identified, and progression of degradation needs to be quantified under the operating reactor conditions.

Question #4.) How is NRC addressing the issue of counterfeit parts?

Response:

Safety-related equipment in nuclear power plants must meet exacting standards and must be installed, tested, operated, and maintained in accordance with detailed specifications, procedures and federal regulations. Occasionally, concerns arise in the nuclear industry regarding the potential safety vulnerabilities that counterfeit items could pose. This summary describes how the NRC and the nuclear industry provide controls to identify and prevent the use of counterfeit items in domestic NPPs.

- In the 1980s and early 1990s, counterfeit items were discovered at some domestic NPPs. The NRC issued several generic communications that documented these discoveries and the related NRC actions. The NRC provided specific guidance on ways to improve the procurement process in Generic Letter 89-02, "Actions to Improve the Detection of Counterfeit and Fraudulently Marketed Products." A more recent specific example is Information Notice (IN) 2008-04, "Counterfeit Parts Supplied to Nuclear Power Plants." Although none of the counterfeit items described in the recent IN were installed in safety-related applications, the staff wanted to identify that the examples demonstrated the need for licensees to remain vigilant and maintain an effective QA program to reduce the potential for introduction of counterfeit items into their supply chain.

- Currently, the industry, working through the Electric Power Research Institute (EPRI) and the Nuclear Energy Institute (NEI), has formed a group that is engaged in activities to address counterfeit items from entering the nuclear procurement supply chain.

- The NRC has established an internal group whose function is to share information and insights on counterfeit items from a variety of sources (for example, operating experience, construction experience, experiences from other industries, and feedback from other government agencies and international organizations).

- The NRC is working with other government agencies to identify practices and insights for identifying, reporting, and addressing counterfeit items.

- Structures, systems and components (SSCs) used in nuclear safety-related applications are subject to the quality assurance (QA) requirements of Appendix B to Title 10, Part 50 of the *Code of Federal Regulations* (Appendix B) or are dedicated to an equivalent level as part of a commercial-grade dedication program as specified in 10 CFR Part 21 (Part 21).

- Appendix B requires that safety-related SSCs be manufactured under a QA program providing detailed manufacturing and process documentation, procurement, design, handling and shipment, inspection, audits, storage, and test controls. Licensee procurement documents for safety-related SSCs require that the items meet Appendix B and applicable industry codes and standards, such as American Society of Mechanical Engineers (ASME) requirements.

- Part 21 requires that suppliers and licensees report to NRC any defects in safety-related SSCs, including items that have completed the dedication process that could result in a substantial safety hazard.

- Part 21 requires licensees to assure that SSCs procured through commercial-grade suppliers are subject to an acceptance process that provides reasonable assurance these items will perform their intended safety functions.

- Licensees conduct audits and surveys of suppliers to ensure they have implemented regulatory and technical requirements specified in the licensee's procurement documents. The Nuclear Procurement Issues Committee (NUPIC), comprised of representatives from licensee organizations, conducts periodic audits and surveys of suppliers.

- The current NRC vendor inspection program provides oversight of vendors supplying safety-related SSCs through independent inspections and observations of a limited number NUPIC audits and surveys (about 2 per year).

- Suppliers of safety-related SSCs holding ASME nuclear (N) or quality (QSC) certifications are also subject to ASME oversight.

- In addition to the procurement controls described above, licensees conduct other activities appropriate to the safety and reliability importance of the purchased item. These activities include manufacturing oversight; release-for-shipment authorization activities; receipt inspections and tests; and periodic, in-plant, post-installation inspections and testing.

- Individuals and companies involved in counterfeiting activities are subject to criminal prosecution, as detailed in Part 21.

Licensee procurement programs are required to comply with the Code of Federal Regulations, and applicable industry codes and standards. These regulations and standards help to ensure that the supply chain for each component in the manufacturing process can be trusted. Additionally, NRC generic communications have kept stakeholders apprised of problems encountered. This information has helped minimize the likelihood of installation of counterfeit items in U.S. NPPs.

NRC inspection programs provide oversight to ensure licensees comply with regulatory requirements and adequately control their procurement and plant operational processes to preclude the introduction of counterfeit items into domestic NPPs.

With the significant increase in the services provided by vendors and the fabrication of safety-related components necessary to support new reactor construction, the vendor inspection program has been substantially enhanced to provide assurance that vendors are providing components and services that are consistent with their safety significance. Further, the NRC has worked with the industry and other government Agencies to identify the best practices for assuring that counterfeit items are identified and appropriately addressed before being used in safety-related applications at NPPs.

Question #6.) Since most of the large components are being built overseas now, how are you at the NRC following this offshore manufacturing (to ensure they are meeting NRC expectations)?

Response:

Under the regulatory framework in the U.S., licensees have the principal responsibility for assuring that NRC requirements are being met, including the assurance that vendors, regardless of where located, are complying with NRC requirements. As such, the NRC's approach relies on a combination of oversight of licensees' or applicants' activities to oversee vendors, and direct inspection of vendors. In addition, the NRC has established bi-lateral and multi-lateral relationships with foreign regulators to share insights on vendor performance and to enhance the understanding of the differences in regulatory frameworks and practices used by other regulators.

The NRC has enhanced its oversight of vendors with the creation of two new vendor inspection branches in the Office of New Reactors. To address the increased level of vendor activity anticipated for new reactors, Inspection Manual Chapter (IMC) 2507, "Construction Inspection Program, Vendor Inspections," and supporting inspection procedures, were created to enhance the existing operating reactor vendor inspection program implemented consistent with IMC 2700, "Vendor Inspection Program." Since 2007, about 12 routine vendor inspections per year have been conducted at vendors around the world and many of these inspections have been conducted at vendor facilities overseas. To date, the NRC has inspected a number of the vendors that fabricate large components for nuclear power plants to assure that the NRC's technical and quality requirements are being met. For example, the NRC has conducted inspections at Japan Steel Works in Japan, Doosan Heavy Industry in Korean, and Creusot Forge in France that provide many of the large forgings that are used to fabricate the large components. Also, under bi-lateral arrangements, the NRC has observed inspections conducted by the French regulatory authority, ASN, at Creusot Forge in France. In addition, the NRC has inspected vendors such as Areva in France, Babcock & Wilcox Canada in Canada, and Mitsubishi Heavy Industries in Japan that use the large forgings to fabricate the large components for nuclear reactors. Other vendors located offshore that fabricate large components will be inspected in the future consistent with the scope of supply provided by these vendors and the availability of NRC resources.

In cooperation with regulators from 9 other countries, the NRC participates in the Vendor Inspection Cooperation Working Group (VICWG) under the Multinational Design Evaluation Program (MDEP). Through this working group, the NRC has established stronger communication with its peer regulators in the area of vendor oversight that support enhanced exchange of information on vendor performance. Efforts of the VICWG include observation of host country vendor inspections, developing clearer understandings of the regulatory frameworks in each country regarding vendor oversight and quality assurance requirements, and sharing the results of vendor inspections. These activities provide increased understanding of vendor performance around the world, not just for the NRC, but for the other participating countries. The insights gained from the VICWG, and other MDEP working groups, has been used to inform the NRC's vendor inspection program for new reactors to appropriately focus the resources NRC has devoted to this area.

In addition to the direct inspections of vendors, the NRC also oversees the implementation of the U.S. nuclear industry's auditing of vendors. This is accomplished through the direct observation

of a sample of audits conducted by the Nuclear Procurement Issues Committee (NUPIC) and NRC staff participation in periodic NUPIC meetings each year. NUPIC is made up of all domestic U.S. NRC reactor licensees and was created to improve the efficiency and effectiveness of the industry's oversight of vendors. Observations of NUPIC activities have included vendors located offshore as well as domestic U.S. vendors. Further, during inspection of applicant and licensee implementation of their quality assurance programs, the NRC assures that procurement documentation includes the appropriate technical and quality requirements for safety-related items regardless of whether the vendor is a domestic U.S. supplier or a supplier located offshore.

In summary, vendors supplying parts and services to the nuclear power industry that provide a safety function will be subject to the same oversight regardless of where in the world they are located. The results of our direct inspection of vendors and oversight of NUPIC audits are publicly available in the NRC's electronic records system, ADAMS, and are available on the NRC's public website at http://www.nrc.gov/reactors/new-reactors/oversight.html under the Vendor QA inspections link.