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

February 17, 2011

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: COMPARISON OF INTEGRATED SAFETY ANALYSIS (ISA) AND PROBABILISTIC RISK ASSESSMENT (PRA) FOR FUEL CYCLE FACILITIES

Dear Chairman Jaczko:

During the 580th meeting of the Advisory Committee on Reactor Safeguards (ACRS), February 10-12, 2011, we reviewed the staff's white paper, "A Comparison of Integrated Safety Analysis and Probabilistic Risk Assessment." Our Radiation Protection and Nuclear Materials Subcommittee also reviewed this matter during a meeting on January 11, 2011. During these meetings we met with representatives of the NRC staff and the Nuclear Energy Institute. We also had the benefit of the documents referenced.

CONCLUSIONS AND RECOMMENDATION

1. The staff's report, "A Comparison of Integrated Safety Analysis and Probabilistic Risk Assessment," provides an exposition of the advantages and disadvantages of the use of ISA and PRA methodologies in the regulation of fuel cycle facilities (FCFs).
2. ISAs, in combination with practices required by current regulations, are adequate for the protection of the health and safety of workers and the public, and for licensing FCFs under 10 CFR Part 70.
3. For more complex facilities, especially those with the potential for large radiological exposure or releases, the use of a PRA approach is advantageous because it provides a basis for prioritization of safety systems and maintenance activities.
4. The staff should continue to develop and test the use of focused PRA-like analyses to help assess the risk significance of inspection findings for FCFs.

BACKGROUND

In a letter to the Commission dated January 14, 2002, the Advisory Committee on Nuclear Waste recommended that the NRC move the ISA process in the direction of quantitative risk assessment to enhance the overall understanding of total system risk and to become more risk-informed. In our letter of February 22, 2010, we recommended that the staff continue to move in the direction of risk-informed regulations using analytic techniques and terminology consistent with other Agency applications. In a Staff Requirements Memorandum (SRM) dated May 12, 2010, the Commission directed the staff to prepare a paper that compares ISAs for FCFs to PRA methods used for power reactors, including "a critical evaluation of how ISAs differ from PRAs." This SRM also directed that the ACRS be given a copy for their review. In a subsequent SRM dated August 4, 2010, the Commission disapproved the staff's proposal to revise the Fuel Cycle Oversight Process (FCOP). The Commission noted that they were looking towards the staff's ISA-PRA comparison paper and associated ACRS letter report to better inform proposed enhancements to the FCOP. In addition, they directed that staff undertake a pilot project to develop a set of cornerstones analogous to those developed for the Reactor Oversight Process (ROP) that could be applied to the FCOP. On December 15, 2010, the staff transmitted their comparison paper to the ACRS for review. The transmittal memo concluded that ISAs were acceptable for assuring safety under 10 CFR Part 70, but that PRA methods may be needed to supplement ISAs to determine the risk significance of a specific finding or violation.

DISCUSSION

Use of PRAs in the regulatory process for reactors is well established. Applicants for certification of standard plant designs under 10 CFR Part 52 are required to perform and submit a description of their design-specific PRA, which supports the NRC's expectations that accidents leading to significant releases of radioactive material have extremely low probability. In addition, all operating reactor licensees have developed and are using PRAs to assess safety performance or enhance plant operation. The staff has also developed and is currently using PRA models to support safety evaluations of operating reactors through the ROP.

Analogous to the role PRA plays for power reactors, an ISA is used to support the licensing process for FCFs licensed under 10 CFR Part 70. An ISA identifies accident sequences and Items Relied on for Safety (IROFS) so that appropriate management measures can be applied to assure that performance requirements in 10 CFR 70.61(b) and (c) are met. These requirements define high and intermediate consequence events and require that the risk from such events be limited by IROFS that reduce event frequency or consequences. The frequency of high consequence events must be highly unlikely and the frequency of intermediate events must be unlikely[1] or the consequences must be reduced such that the event is no longer a high or intermediate consequence event.

We agree that ISAs, in combination with practices required by current regulations, are adequate for the protection of the health and safety of workers and the public, and for licensing fuel cycle facilities under 10 CFR Part 70. However, there are differences between an ISA and PRA, and we continue to see advantages in moving the ISA process systematically in the direction of PRA. It has already started to evolve in that direction.

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[1] While 10 CFR Part 70 defines the consequences in terms of specific measureable parameters, unlikely and highly unlikely are defined by the licensee or applicant, although NUREG-1520 provides numerical ranges that the staff uses to guides its reviews.

An ISA is generally intended to be a conservative assessment, whereas a PRA is intended to be a realistic assessment of the likelihood and consequences of accident sequences, and includes an explicit consideration of uncertainties. A PRA is by definition quantitative, whereas an ISA may be qualitative or quantitative. A PRA provides an overall risk assessment allowing calculation of the relative risk importance of the contributors to the accident sequences. An ISA does not provide a quantitative assessment of the overall risk, but does provide a structured framework for capturing sequences as does a PRA.

Both methods require careful exposition of event sequences and assessment of their consequences and likelihood. Both should account for dependencies that can affect the consequences or likelihood of an event. In practice, however, there is little ISA guidance for evaluating dependencies associated with common cause failure, systems interactions, and human actions.

The ISA-PRA comparison paper acknowledges that supplements or modifications to ISAs may be necessary to support the FCOP. The staff argues that risk significance evaluations for FCFs will often be simple, because many scenarios are simple. Also, events or deficiencies requiring quantitative regulatory assessment are rare (averaging two per year) in FCFs. The example provided in the comparison paper illustrates how an ISA might be used to support FCOP. It also shows a PRA example that, in general, is more straightforward and easier to follow.

There is a wide variety of fuel cycle facilities. Many use straightforward processes and systems, and most have few high consequence scenarios. Most hazards are not expected to pose a significant offsite risk to members of the public. These hazards primarily involve toxic chemicals and fissile materials with the potential for inadvertent criticality. Processes associated with FCFs are generally rendered safe by simply ceasing operation or by the use of passive safety features such as geometry control to prevent inadvertent criticality. Except for plutonium facilities (and, perhaps in the future, reprocessing facilities), radiological sources are expected to be very low in magnitude.

ISA methods are adequate for simple facilities. However, for more complex facilities, especially those with the potential for large radiological exposure or accidents with significant source terms, the use of a PRA approach is more appropriate.

The recent experience with the Mixed Oxide Fuel Fabrication Facility (MOX) has shown that the number of IROFS can become very large in a complex facility. For example, a facility that reprocesses spent nuclear fuel might very well include an extremely large number of IROFS. In an ISA, all IROFS are viewed as being of equal importance. On the other hand, a PRA can be used to rank IROFS in terms of risk importance measures. Without such rankings, licensees and regulatory bodies will find it challenging to apportion their resources for inspecting, monitoring, and maintaining IROFS in complex facilities.

Arguments against using PRA for FCFs include excessive cost, lack of methods for analyzing human error, and lack of existing PRA methods. However, structuring scenarios and identifying possible consequences is essential in either approach. Most scenarios for FCFs would be screened from detailed analysis based on maximum consequences.

The absence of human reliability analysis is a major gap in ISAs, even though most FCF accidents are human-induced. Human reliability analysis is well developed for similar situations. The comparison paper acknowledges that because ISAs do not model human error in detail, there is a potential for dependencies to be overlooked.

The chemical industry has performed a number of PRAs on process facilities. Because these PRAs contain proprietary information, few have been published or cited in the open literature.

In deciding whether to move ISA towards PRA, emphasis should be placed on demonstrating the safety benefits. It is more likely that greater benefits will be achieved for complex facilities with high consequence events. Moving ISA towards PRA can begin with a more rigorous treatment of dependencies and human error. This would be followed by a more structured approach to allow ranking of scenarios and integration of overall risk calculations.

We look forward to additional discussions with the staff on the development and use of cornerstones for the FCOP, as well as the choice of analytic methods for their implementation.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

REFERENCES

1. NRC Memorandum, "Paper Comparing Integrated Safety Analysis for Fuel Cycle Facilities and Probabilistic Risk Assessment for Reactors," dated December 15, 2010 (ML103330474)
2. SECY-10-0031, "Revising the Fuel Cycle Oversight Process," dated March 19, 2010 (ML100570250)
3. Staff Requirements Memorandum (SRM) M100429, "Briefing on the Fuel Cycle Oversight Process Revisions," dated May 12, 2010 (ML101320075)
4. Staff Requirements Memorandum (SRM) SECY-10-0031, "Revising the Fuel Cycle Oversight Process," dated August 4, 2010 (ML102170054)
5. ACNW Letter, " Risk Informed Activities in the Office of Nuclear Material Safety and Safeguards," dated January 14, 2002 (ML020240223)
6. GE Hitachi Nuclear Energy Letter, "Transmittal of Paper Presented at Industry Conference: Applying Nuclear PRA to a Nuclear Fuel Facility Integrated Safety Analysis, dated June 4, 2010 (ML101590377)
7. NEI Letter, "Integrated Safety Analysis: Why It Is Appropriate for Fuel Recycling Facilities," dated September 10, 2010 (ML103270619)

8. NUREG-1513, “Integrated Safety Analysis Guidance Document,” dated May 2001 (ML011440260)
9. NUREG-1520, Rev 1, “Standard Review Plan for License Application for a Fuel Facility,” dated May 2010 (ML101390110)
10. NEI Letter “Industry Statement on Comparison of Integrated Safety Analysis and Probabilistic Risk Assessment at Fuel Cycle Facilities,” dated February 8, 2011 (ML1104702130)

8. NUREG-1513, "Integrated Safety Analysis Guidance Document," dated May 2001 (ML011440260)
9. NUREG-1520, Rev 1, "Standard Review Plan for License Application for a Fuel Facility," dated May 2010 (ML101390110)
10. NEI Letter "Industry Statement on Comparison of Integrated Safety Analysis and Probabilistic Risk Assessment at Fuel Cycle Facilities," dated February 8, 2011 (ML1104702130)

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