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United States Nuclear Regulatory Commission
Protecting People and the Environment

Development of Regulations for Spent Nuclear Fuel Reprocessing Facilities

Safety and Risk Assessment Issues

One of NRC's key responsibilities is to ensure that the operation of NRC-licensed facilities, including any future reprocessing facility, will present no undue risk to public health and safety. To achieve this goal, the NRC requires safety and risk analyses as part of the licensing of new facilities. Safety and risk analyses require a detailed understanding of the processes and operations of the facility, and an evaluation of how these are affected by off-normal or accident conditions. One of the tools that is used to understand facility operations and evaluate the risk of these activities is called a risk assessment. Selecting the proper risk assessment approaches for reprocessing facilities is an important criterion for ensuring adequate assurances of safety and protection of public health and safety.

REGULATORY GAPS DISCUSSED IN THIS SECTION:

- ✓ Gap 5 – Risk Considerations for a Production Facility Licensed Under 10 CFR Part 70

PRESCRIPTIVE VS. RISK INFORMED REGULATION

The NRC initially developed many of its regulations without considering numerical estimates of risk. Rather, prescriptive, deterministic regulatory requirements were based primarily on basic operational experience, test results, and expert judgment. To develop these requirements, the NRC considered factors such as accepted practice, engineering margins and the principle of defense-in-depth. In this approach, the NRC assumed that certain off-normal events and accidents could occur and required plant designers to use redundant safety systems capable of preventing and/or mitigating the consequences of these design basis accidents (DBA).

Since the early 1980's, however, NRC and its licensees have expanded their knowledge and use of risk assessment to provide insights on the effectiveness of safety systems. A risk assessment is a systematic method for evaluating risk to a person, as it relates to the performance of a particular system (which may include a human component) to understand likely outcomes, sensitivities, areas of importance, system interactions and areas of uncertainty. Today, the NRC uses the insights gained from risk assessment to complement traditional engineering methods when making regulatory decisions about nuclear facilities. This concept is called risk-informed regulation.

NRC POLICY STATEMENTS

The NRC has issued two policy statements on safety and risk assessments. The first policy statement sets safety goals for the operation of nuclear power plants. It states that there should be no significant additional risk from nuclear power plant operations, which translates to an increased risk to a person of approximately 1E-6 per year. A related document discussed risk informed decision making for fuel cycle facilities and makes recommendations for safety goals. The second policy statement increases the use of probabilistic safety assessment (PRA) to the extent supported by the state of the art. The statement is focused on nuclear power plants. There is a related White Paper on risk-informed, performance based regulation.

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RISK ASSESSMENT METHODS

The types of risk assessment methods can be broadly classified as follows:

- **Quantitative** – an approach that quantifies event probabilities and consequences, and provides estimates of uncertainty (e.g., PRA)
- **Semi-quantitative** – an approach that includes some level of quantification of event probability and consequences (e.g., risk index method typically used for Integrated Safety Analyses [ISA])
- **Qualitative** – an approach that uses little or no quantification of event probabilities or consequences (e.g., a qualitative ISA)

Currently, fuel cycle facilities licensed under 10 CFR Part 70 are required to conduct and maintain an integrated safety analysis (ISA). An ISA identifies potential accident sequences in the facility's operations, and designates items relied on for safety (IROFS) to prevent or mitigate the accidents. Various ISA methods are used at the different types of fuel cycle facilities. Some ISAs employ a semi-quantitative risk index method for categorizing accident sequences in terms of their likelihood of occurrence and their consequences.

Reactors licensed under Part 50 initially used a design-basis accident (DBA) approach. Many reactor licensees are using PRA techniques to improve DBA analyses. Applicants for new reactor licenses under 10 CFR Part 52 are required to complete a probabilistic risk assessment.

RISK ASSESSMENT CONSIDERATIONS FOR A REPROCESSING FACILITY

The NRC is evaluating alternatives for establishing risk assessment requirements for reprocessing facilities.

The current risk assessment methods used to demonstrate compliance with 10 CFR Part 70 do not fully address the hazards associated with a reprocessing facility. A reprocessing facility will likely handle large amounts of highly radioactive spent nuclear fuel, which contain fission products and transuranic isotopes. In addition, these materials generate significant amounts of heat. High radiation levels will be encountered in the spent fuel processing and separation areas of a reprocessing facility. The presence of these high radiation materials and processes requires the use of automated, remotely-operated, and remotely-maintained equipment, in addition to complex monitoring and control systems. These operational characteristics differ significantly from those encountered in other types of fuel cycle facilities, where high radiation hazards are not encountered. Although ISA analyses provide adequate safety assurance for these fuel cycle facilities, the hazards and consequences considered in these analyses are not as extensive as those pertaining to certain areas or processes of a reprocessing facility. Accordingly, the NRC needs reasonable assurance that public health and safety is protected through a comprehensive evaluation of the hazards and risks of reprocessing facilities.

Appropriately used quantitative risk assessment methods, such as PRA, may be needed to provide NRC the level of information about reprocessing risks and hazards necessary to make a finding of adequate public health and safety. However, the use of PRA in existing international reprocessing facilities is limited. A PRA analysis is most useful when there is meaningful and representative data to input into the risk analysis models. The NRC will need to assess the benefits and costs of a quantitative risk assessment requirement for reprocessing facilities.