BACKGROUNDER
Office of Public Affairs
301.415.8200
www.nrc.gov ■ opa.resource@nrc.gov

Nuclear Reactor Risk

Background

Potential nuclear power plant accidents have a very small risk of releasing enough radioactivity to affect the public. The NRC further minimizes that risk in several ways. The agency requires U.S. nuclear power plants to have multiple, redundant barriers to contain radioactive material, as well as numerous safety systems, properly trained staff and ongoing testing and maintenance activities. NRC inspectors check on all these areas.

Nuclear power plants are designed to operate safely and protect public health and safety and the environment. Any industrial activity, however, involves some risk. Nuclear reactors keep radioactive material isolated from the environment with several barriers. The first barrier is sealed metal tubes that encase the ceramic uranium fuel pellets. The second barrier is the heavy steel reactor vessel (nine inches to a foot thick) and the piping that carries cooling water to and from the reactor. The third barrier is the heavily reinforced concrete and steel containment building (up to several feet thick) that surrounds the reactor and would hold in radioactivity in the unlikely event a serious accident challenges the first two barriers.

A nuclear power plant uses water to cool its fuel and prevent damage. Diverse and multiple systems at each plant, mostly running on electricity, provide this cooling water. Plants therefore use emergency diesel generators to provide backup electricity if their main power source is lost. In addition, plant operators must keep the plant within safe operating limits and under safe conditions as part of their license. These limits and conditions cover such things as operability of plant equipment, plant operating procedures, periodic equipment testing and maintenance.

Policy, Regulations, and Regulatory Framework

The Commission set nuclear power plant safety goals in a 1986 NRC policy statement, specifying expectations for an acceptably low level of risk to public health and safety. This includes how the risk of cancer fatalities to people near a normally operating nuclear power plant should not exceed 0.1% of the total cancer fatality risks from all other causes.

When the NRC issues a nuclear power plant license, the agency includes criteria and requirements that ensure risks to public health and safety are kept acceptably low. The agency bases its regulations on sound engineering concepts found acceptable for safe plant design and operation. The NRC supports its license application and review processes with detailed regulatory guides and a standard review plan, clarifying license requirements and describing practices that satisfy these requirements. In addition, the NRC issues various generic communications to all appropriate nuclear power plants to address potential safety concerns.

Risk is currently examined using probabilistic risk assessment, a structured look at the likelihood and consequences of system failures, fires and other serious events. A 1995 Commission policy statement covers PRA use in nuclear regulatory activities.

The policy consists of four basic elements:

1. All regulatory processes should increase PRA use in a manner that complements the NRC's traditional defense-in-depth philosophy.

2. PRA and associated analyses should reduce unnecessary conservatism associated with current regulatory requirements and guides, license commitments, and staff practices. Where appropriate, PRA should support the process for imposing additional regulatory requirements, called the backfit rule, 10 CFR 50.109. Appropriate procedures for including PRA in the process for changing regulatory requirements should be developed and followed. The existing rules and regulations shall be complied with unless subsequently revised.

3. PRA evaluations supporting regulatory decisions should be as realistic as practicable, with a publicly available base of information available for review, as appropriate.

4. PRA applications will account for uncertainties when using the Commission's safety goals and related objectives to propose and backfit new generic requirements on nuclear power plant licensees. The Commission's policy is intended to allow consistent and predictable implementation of PRA applications. This promotes regulatory stability, efficiency, and predictability of regulatory decisions, making the regulatory process risk-informed (focusing resources on those items most important to protecting public health and safety).

These safety goals and policies set the basis for the NRC's regulatory framework for making risk-informed decisions.

Risk-Informed Decision-making

The NRC has used PRA to address complex safety issues and make risk-informed decisions, such as those involved in rules on events where a reactor fails to automatically stop the chain reaction, and events where the reactor vessel is suddenly cooled. PRA also contributed to formulating the backfit rule; prioritizing generic safety issues; and preparing generic letters and evaluating industry responses to them.

The NRC has updated its standard review plan and associated regulatory guides to address risk-informed decision making, including:

	SRP Section	RG
• Determining technical adequacy	19.1	1.200
• Plant-specific changes to the licensing basis	19.2	1.174
• inservice testing	3.9.7	1.175
• inservice piping inspection	3.9.8	1.178
• technical specifications	16.1	1.177

Risk-informed decision-making also plays a role in the reactor oversight process, which includes inspection, enforcement, and assessment. Risk insights have been incorporated in many aspects of the inspection program and inspection tools. This better focuses inspection resources on the most safety-significant aspects of plant design and operations. It also ensures the NRC is making its regulatory decisions objectively, relying on sound data and operating experience.

Risk-informed decision-making can also be used to support changes to regulatory requirements and regulations. When risk-informed decision-making approaches help modify basic reactor regulations, they focus on ensuring the regulatory burden of individual regulations matches the importance of that regulation to protecting public health and safety.

One example allows licensees to risk-inform various requirements, focusing attention on more important equipment while still ensuring the plant meets its overall safety requirements. The process ensures plant systems can perform their functions with high quality and reliability consistent with their importance.

October 2024