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The Application of a Graded Approach in the Regulation of Research and Test Reactors at the U.S. Nuclear Regulatory Commission

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The concept of a graded approach is a basic aspect of the International Atomic Energy Agency (IAEA) for maintaining safety at research reactors. A graded approach is also a fundamental aspect of the regulation of research and test reactors (also called non-power reactors) by the U.S. Nuclear Regulatory Commission (NRC). The purpose in applying a graded approach is to match the degree of scrutiny exercised in the regulatory process to the safety significance of the features or characteristics of the design that is being evaluated.

Research and test reactors regulated by NRC encompass a multitude of designs and power levels. Thermal power levels and designs range from 5 watt Aerojet-General Nucleonics (AGN) solid homogeneous reactors to a 20 megawatt (MW) heavy water cooled and moderated tank reactor. This paper explains the ways reactors are classified by NRC to make application of a graded approach possible in regulating these facilities. Illustrative examples are presented in each area of regulation discussed.

NRC applies a graded approach in all aspects of reactor regulation. The Atomic Energy Act (the Act) is the law passed by the U.S. Congress for the regulation of civilian use of nuclear technology. For research and test reactors useful in the conduct of research and development activities, the Act requires the NRC to impose only the minimum amount of regulation as the Commission finds will permit the Commission to fulfill its obligations under the Act to promote the common defense and security and to protect the health and safety of the public and will permit the conduct of widespread and diverse research and development.

This requirement for minimum regulation is applied in all aspects of the regulation of research and test reactors, including licensing processes, regulatory technical requirements and inspections.

NRC differentiates non-power reactors by considering two types: research reactors and test reactors (both referred to as research reactors by IAEA). The most common attribute that distinguishes between these two reactor types is thermal power level. A test reactor (also called a testing facility in the regulations) has a thermal power level greater than 10 MW. A research reactor has a thermal power level of 10 MW or less. A reactor is also designated a test reactor if it has a thermal power level greater than 1 MW and contains liquid fuel, a in-core circulating fuel test loop or a large experimental facility in the core.

In general, as the risk associated with a reactor increases, the regulatory process becomes more complex with additional review required for approval of licensing actions. For example, an application for a construction permit for a testing facility is required by regulation to be referred to the Advisory Committee on Reactor Safeguards (ACRS) for a review and report. The ACRS is a statutory independent advisory committee to the Commission. A construction permit application for a research reactor is not required by regulation to be referred to the ACRS.

Moreover, as the risk associated with a reactor increases, so do regulatory technical requirements. Nuclear power plants have minimum requirements for the principal design criteria which are described in the regulations. Research and test reactors are not subject to such minimum regulatory design requirements. This allows the flexibility for a wide variety of designs, experimental facilities and programs. The primary regulatory requirements for the design of research and test reactors are maintaining radiation doses to reactor staff and members of the public within acceptable limits during both normal operation and accident conditions. The NRC staff has issued documents which provide guidance on the design of research and test reactors, such as NUREG-1537, Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, which present a way an applicant can meet the regulations but alternatives are also acceptable provided they achieve the same outcomes.

The research and test reactor inspection program also follows a graded approach with three classes of reactors. Class 1 reactors have a thermal power level at or above 2 MW, Class 2 reactors have a thermal power level below 2 MW and Class 3 are reactors that are permanently shut down. The 2 MW demarcation is generally based on reactor core decay heat generation and the ability to dissipate this decay heat without an active emergency core cooling system. The period of time to carry out the inspection program and the scope of inspection varies with reactor class. For example, normally the Class 1 inspection program is carried out over

one year and the Class 2 inspection program over two years. Inspectors normally examine a greater number of records for a particular inspection area at a Class 1 reactor than at a Class 2 reactor.

The full paper will contain greater detail on the application of the graded approach.

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