Nuclear Material Safety and Safeguards

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Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

The U.S. Nuclear Regulatory Commission regulates medical, academic and commercial uses of nuclear materials to protect public health and safety and the environment and to ensure the common defense and security.

The agency issues licenses for nuclear power plants, other types of commercial and research nuclear reactors, the production and use of reactor fuel, and the processing and use of radioactive material produced in reactors. The NRC also certifies packages for the transportation of nuclear materials and regulates the shipment of the materials and the disposal of radioactive wastes.

All non-reactor NRC licensees are regulated by the Office of Nuclear Material Safety and Safeguards (NMSS), one of three major NRC program offices established by law. NMSS's responsibilities fall into six principal areas:

(1) Licensing of fuel cycle facilities
(2) Licensing of nuclear materials for uses other than in reactors
(3) Regulation of the transportation of nuclear materials
(4) Safeguarding of nuclear materials from sabotage and diversion to unauthorized uses
(5) Regulation of radioactive waste disposal facilities and
(6) Regulation of the decommissioning of previously licensed nuclear facilities that are no longer in use.

Some of these functions are carried out by the four NRC Regional Offices,

Fuel Cycle Facilities

The various processing operations required to produce fuel for nuclear reactors are conducted in NRC-licensed fuel cycle facilities. Activities at these facilities include:

- Certain types of uranium mining activities
- Milling and refining uranium ore to produce uranium concentrates

- Production of uranium hexafluoride from uranium concentrates to provide feed material for isotopic enrichment of uranium-235 to levels needed for a nuclear reaction
- Isotopic enrichment processing of uranium hexafluoride to produce fuel with a higher percentage of uranium-235 than in natural uranium, which is mostly (99.8%) uranium-238
- Fabrication of nuclear reactor fuel, including converting enriched uranium hexafluoride to uranium dioxide, forming it into pellets, loading the pellets into zircaloy tubes that are fitted with end caps and welded, and assembling the rods into fuel elements and
- Reprocessing spent fuel for recycle. (This step is not performed in the United Sates.)

Most of the manufacturing operations that make up the nuclear fuel cycle are licensed by the NRC. Exceptions are uranium mining and uranium milling in Agreement States.

At the present time there is no reprocessing of commercial nuclear fuel in the United States; spent fuel is being stored for later disposal in a high-level waste repository. However, the NRC is conducting a safety review of DOE's high-level waste solidification activities at the closed-down West Valley, NY, reprocessing facility.

NMSS's Division of Fuel Cycle Safety and Safeguards reviews operational safety, radiation protection and criticality safety programs as part of the licensing process for fuel cycle facilities.

The office also provides policy guidance and technical support to the NRC regional offices and to Agreement States on their licensing and inspection activities and on incident and emergency responses to ensure protection of the public health and safety. At the present time NRC fuel cycle licenses number about 24.

Nuclear Materials

The NRC regulates approximately 5,000 licenses for the possession and use of radioactive materials for purposes other than the generation of electricity or operation of a research reactor. The 32 Agreement States (which are states that have accepted authority, through agreement with the NRC, over the licensing of radioactive materials within the state) regulate about 16,000 radioactive materials licenses.

Most of the about 5,000 NRC materials licenses are administered by the NRC's four regional offices. NMSS's Division of Industrial and Medical Nuclear Safety at headquarters provides national direction to the regional licensing and inspection activities. It also provides technical guidance and support to the regional offices and, upon request, to the Agreement States.

NMSS also takes appropriate actions to control safety issues involving nuclear materials licensees and directs NRC responses to emergencies in this area.

Uses of nuclear materials under these licenses include medical diagnosis and treatment, food irradiation, sterilization of surgical gloves, smoke detection and industrial measurements.

Transportation of Nuclear Materials

Approximately 3 million packages of radioactive materials are shipped in the United States each year, The transportation of these materials is regulated jointly by the NRC and the Department of Transportation (DOT). The responsibilities of the two agencies are generally divided as follows:

DOT — Regulates packages for small amounts of radioactivity, carriers of radioactive material and the conditions of transport (such as routing, vehicle requirements, handling and storage).

NRC — Regulates users of radioactive material and the design, construction, use and maintenance of shipping containers for large amounts of radioactivity.

Requirements for the shipping containers vary according to the amount of radioactivity in the material being transported.

Type B Packages

Containers used to transport spent fuel, which is highly radioactive, must be "Type B" packages that are designed to withstand a series of impact, puncture, and fire environments, thereby providing reasonable assurance that the packages will withstand severe transportation accidents. NMSS's Spent Fuel Project Office initially reviews the package design to verify its resistance to accidents. An approval certificate must be issued by NMSS before a package, called a "cask," can be used to transport spent fuel.

NRC regulations require that all states located on approved routes be notified by the licensee before a series of spent fuel shipments begins. Under DOT's guidelines, a state may indicate a preferred route through the state other than via an Interstate System highway.

In addition to the protection provided to spent fuel shipments by the Type B shipping container, a physical protection system is applied to minimize the possibilities of radiological sabotage of the shipments, particularly in highly populated areas. Armed escorts must be provided while a shipment travels through urban areas, for example. NMSS also must approve routes proposed by licensees for shipment of spent fuel to ensure that sabotage concerns are considered.

Type A Packages

Small amounts of radioactivity can be shipped in "Type A" packages. Contents are restricted so that failure of packages containing these materials would not present a serious health problem if the contents were released. Type A packages must be designed to withstand normal conditions of transport, but not accidents.

Most medical isotopes are shipped in Type A packages. Lesser amounts of radioactivity, such as that contained in smoke detectors, may be shipped in ordinary boxes.

Low Specific Activity Packages

Another category, the "Low Specific Activity " package, is used where the radioactivity is low concentration, such as uranium ore or yellowcake. LSA material may be shipped in bulk or packages and presents a minimal health hazard in transport.

NMSS develops policy and guidance for inspection and quality assurance programs to ensure that transportation regulations are followed for nuclear materials shipments. Approximately 1,500 individual inspections are performed by the NRC per year — principally by the regional offices.

In case of an accident involving actual or suspected leakage during the transportation of packages of radioactive material regulated by the NRC, the agency's role includes ensuring that affected parties are aware of the event and offering and responding to requests for technical assistance by providing information, advice and evaluations. The Federal Emergency Management Agency is responsible for coordinating federal

and state participation in developing emergency response plans. The state government in the affected area is recognized as being responsible for assuming control of the accident scene to protect the public health and safety.

Safeguarding of Nuclear Materials

"Safeguards" refers to (1) measures taken to deter, prevent or respond to the unauthorized possession or use of significant quantities of special nuclear material through theft or diversion and (2) measures taken to protect against radiological sabotage of nuclear activities.

NMSS, in consultation with other Federal agencies, continually reviews the domestic and foreign threat environments and their relationships to NRC's domestic safeguards regulations. The staff also reviews threat-related information on a continuous basis to monitor any change in adversary characteristics and to assess safeguards-related events associated with NRC-licensed facilities and activities.

NMSS's Division of Fuel Cycle Safety and Safeguards develops and implements safeguards policies and the overall safeguards program for licensed nuclear materials, facilities and activities. It recommends improvements for physical security and nuclear materials control and accountability. Protection provided in the commercial sector for weapons-usable "special nuclear material" is comparable to that provided for similar material under government control. (The term "special nuclear material" refers to plutonium, uranium-233, uranium containing more than the natural abundance of uranium-235 or any material artificially enriched in any of these substances.)

The Division also performs international safeguards and foreign physical protection evaluations of nuclear export license applications, coordinates implementation of the United States/International Atomic Energy Agency Safeguards Agreement at NRC-licensed facilities, and provides technical support to strengthen IAEA safeguards through interagency groups and direct assistance.

Safeguards for nuclear power reactors generally stress protection against radiological sabotage — such as a deliberate tampering or breaching of containment that could result in spread of radioactive materials in an uncontrolled fashion — rather than theft or diversion.

Safeguards for licensed nuclear fuel cycle facilities and non-power reactors (such as university or research reactors) emphasize protection against theft or diversion of special nuclear material.

NMSS's Division of Fuel Cycle Safety and Safeguards is responsible for protecting against radiological sabotage and theft or diversion of special nuclear material at nuclear fuel facilities and during transportation. Another NRC office, the Office of Nuclear Reactor Regulation, performs this function for reactors.

Radioactive Waste Disposal

Radioactive wastes generated from commercial uses of radioactive material include high-level and low-level wastes and mill tailings. High-level radioactive waste consists of irradiated nuclear reactor fuel and certain liquid and solid wastes resulting from the reprocessing of irradiated reactor fuel. All other radioactive waste is low-level. The NRC also regulates mill tailings, which are the residues from processing ore to recover uranium and thorium.

High-Level Radioactive Waste Disposal

No facilities are presently available for the permanent disposal of high level radioactive wastes. In passing the Nuclear Waste Policy Act of 1982 (NWPA), Congress found that a national problem had been created by the accumulation of spent fuel from nuclear reactors, certain materials from the reprocessing of spent fuel, and other highly radioactive materials requiring permanent isolation.

The NWPA provided for the development of repositories for the disposal of high-level radioactive wastes and spent nuclear fuel. In 1987, the NWPA was amended to focus the development of a repository on only one site — Yucca Mountain, Nevada. If the Nevada site does not prove suitable, the Department of Energy (DOE) is mandated to obtain further Congressional guidance.

The NWPA gave DOE the responsibility for siting, constructing, operating and decommissioning the repository under NRC license and regulation. The NRC is charged with evaluating DOE's application for authority to construct a repository and reaching a licensing decision on construction authorization within three years from the receipt of the application. After the

repository construction is completed, DOE will apply to NRC for a license to receive and possess the wastes.

DOE will also apply to NRC for license amendments if they intend to permanently close the repository, dismantle surface facilities, remove controls to restrict access to the site or undertake any other activities involving an unreviewed safety question.

The Division of Waste Management within the Office of Nuclear Material Safety and Safeguards manages the NRC's program for licensing, inspecting and regulating the repository. This includes developing a program of pre-licensing interface with DOE, Federal and State authorities and any affected Indian tribes. The aim is to achieve an ongoing understanding of DOE's program and identify repository licensing concerns and issues at an early stage.

Until the repository is approved and constructed, spent nuclear fuel is being stored primarily in specially designed, water-filled basins or dry storage casks at individual reactor sites around the country. Alternative methods for additional storage may include:

Independent Spent Fuel Storage Installations — using wet storage in separate pools or dry storage in casks, modules or vaults off the reactor site. A license of this type has been issued for a wet storage pool at an off-reactor site to General Electric Co., Morris, Illinois. The NRC is reviewing an application from Private Fuel Storage for an independent spent fuel storage installation in Utah, using dry casks.

Low-Level Waste

Two disposal sites in the United States are currently accepting low-level radioactive waste from certain areas of the country. The two sites are located in Barnwell, South Carolina, and Hanford, Washington. Under a provision of the Atomic Energy Act enabling states to assume certain regulatory responsibilities from the NRC, both sites are licensed by the "Agreement States" in which they are located.

NMSS's Division of Waste Management provides guidance to Agreement States in low-level waste areas.

The Barnwell low-level waste facility will generally accept waste from all states except North Carolina. The Hanford

facility accepts waste from the states of Alaska, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming. In addition, Envirocare of Utah is licensed by the NRC to operate a facility near Clive, Utah, for disposal of uranium and thorium mill tailings. The facility also accepts certain other radioactive wastes under a State of Utah license.

The Low-level Radioactive Waste Policy Act gave the States — rather than the Federal government — responsibility for providing additional disposal capacity for low-level radioactive waste. Most states have entered into regional compacts to provide adequate disposal capacity in the future without building a new waste facility in every state. Sites located in non-Agreement States will be regulated by the NRC.

NRC regulations and guides contain performance objectives and technical requirements for the land disposal of low-level wastes. Performance objectives include limits on radioactive material released to the environment and provide for protection against inadvertent intruders after active operations cease.

Technical requirements in NRC's regulations and guides include an examination of site suitability to ensure avoidance of sites with, for example, unacceptable earthquake vulnerabilities and erosion or flooding. Environmental monitoring is required before the site is chosen to provide basic data about the site. Similar monitoring is required during operation to provide early warning of releases of radioactive materials before they leave the site boundary. The regulations also require proper packaging and form of the waste and classifying each package of waste to indicate its radiological hazards, based on the concentration of radioactive materials.

Low-level wastes exceeding the limits of NRC's classification system are to be disposed of by the Federal Government. The Department of Energy is responsible for disposal of these wastes, but has not developed a facility for their storage or disposal. Disposal in the high-level waste repository is one option recognized by the NRC.

The NRC licenses and regulates uranium mills, heap leaching facilities, ore-buying stations, commercial in-situ solution mining operations and uranium extraction research and development projects. The licenses are administered by NMSS's Division of Fuel Cycle Safety and Safeguards. NMSS also is reviewing the remedial actions that DOE is taking at two inactive mill tailings sites.

Decommissioning

"Decommissioning" means removing a nuclear facility from service and reducing residual radioactivity to a level that permits termination of the license.

For nuclear power reactors, NMSS's Division of Waste Management is responsible for overseeing reactor licensees during the final stages of decommissioning, after fuel has been removed from the spent fuel pool, and for approving termination of the license when the decommissioning activities are successfully completed.

The NRC group that licenses operating nuclear power plants, the Office of Nuclear Reactor Regulation, has responsibilities during the initial stages of decommissioning and has complete responsibility for regulating the decommissioning of research and test reactors.

NMSS's Division of Waste Management provides national direction, technical guidance on decommissioning reviews and support for all non-reactor licensees.

The above areas of responsibility evolved from the Energy Reorganization Act of 1974, which established NMSS as one of the three major program offices of the NRC. Under this authority granted by Congress, NMSS has a primary role in ensuring that the NRC performs its mission to regulate the safe use of nuclear materials in the public sector.

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