United States Nuclear Regulatory Commission

Regulatory Approach to Decommissioning of Nuclear Facilities

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Acronyms

- **ALARA – As Low As Is Reasonably Achievable**
- **CFR – Code of Federal Regulations**
- **DECON – Active cleanup reactor decommissioning option**
- **DP – Decommissioning Plan**
- **EIS – Environmental Impact Statement**
- **FSSR – Final Status Survey Report**
- **ISFSI – Independent Spent Fuel Storage Installation**
- **LTP – License Termination Plan**
- **LTR – License Termination Rule**

Acronyms (Continued)

- **NEPA – National Environmental Policy Act**
- **NMSS – Nuclear Materials Safety and Safeguards**
- **NRC – U.S. Nuclear Regulatory Commission**
- **NUREG – Nuclear Regulation (guidance)**
- **SAFSTOR – Storage/on-hold reactor decommissioning option**
- **SRP – Standard Review Plan**
- **TEDE – Total Effective Dose Equivalent**

Decommission

"To remove (as a facility) safely from service and reduce radioactivity to a level that permits:

1. Release of the property for unrestricted use and termination of the license; or

2. Release of the property under restricted conditions and termination of the license"

NRC's Role

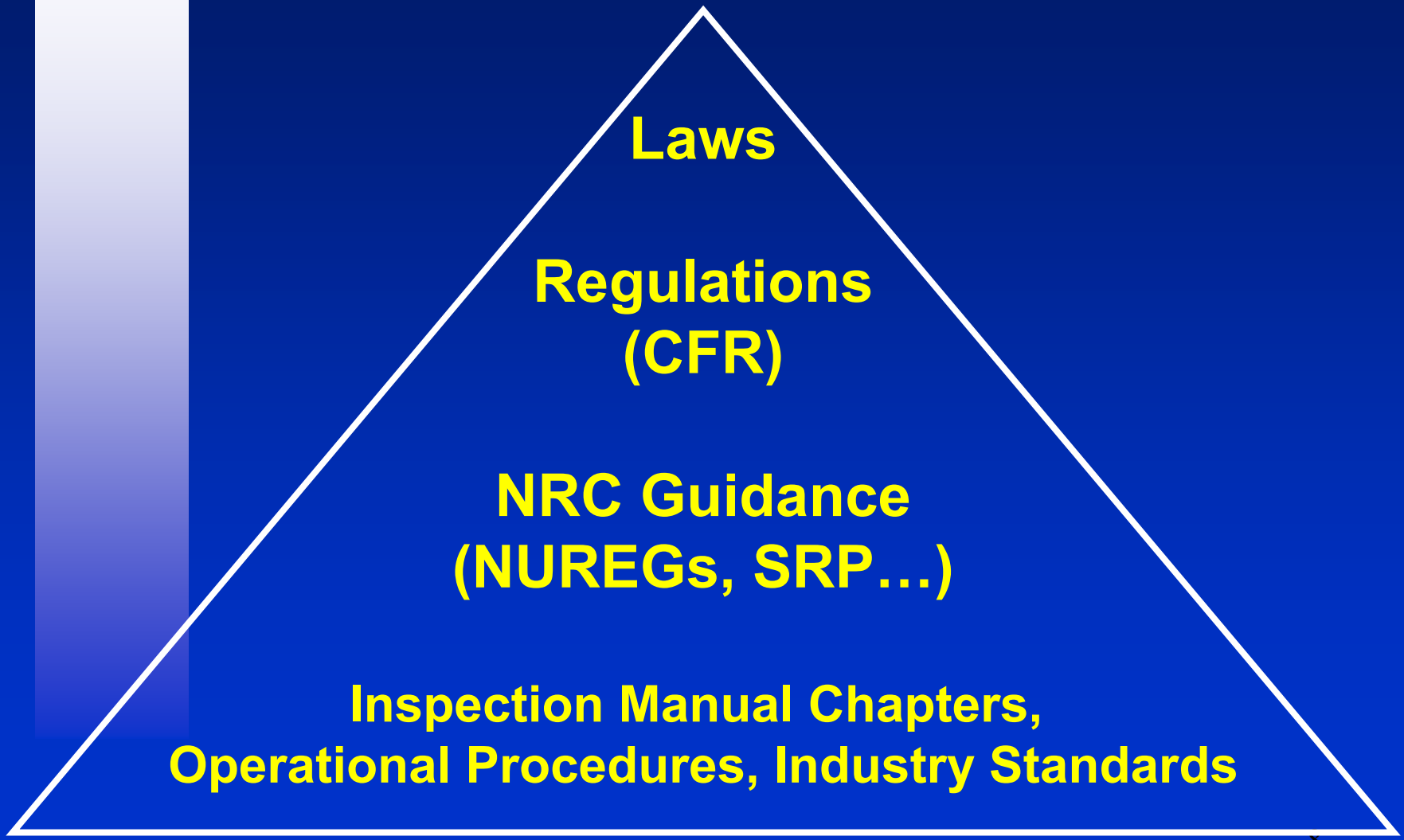
- **Ensure adequate protection of public health and safety, the common defense and security, and the environment in the use of radioactive materials at: nuclear power, research, test and training reactors; fuel cycle facilities; medical, academic and industrial facilities; and the transport, storage, and disposal of nuclear materials and waste**
- **Develop regulations for the safe use and remediation of radioactive materials at NRC licensed sites**

NRC's Decommissioning Program Activities

- Develop regulations and guidance
- Conduct research
- Review/approve DPs & LTPs, license amendment requests and FSSRs
- Inspections
- NEPA compliance
- Confirmatory surveys

Licensee's Role

- Safe decommissioning of the facility
- Responsibility for actions of their staff and contractors
- Ensure adequate protection of workers, public, and environment
- Establish and maintain records to support decommissioning
- Compliance with all requirements


Laws
Regulations
(CFR)
NRC Guidance
(NUREGs, SRP…)
Inspection Manual Chapters,
Operational Procedures, Industry Standards

Decommissioning Infrastructure - Laws

- Atomic Energy Act of 1954, as amended
  - Establishment of program of government control of atomic energy and nuclear materials
- Energy Reorganization Act of 1974
  - Creation of NRC as regulatory agency
- National Environmental Policy Act
  - Establishment of policies for protection of the environment
- Other specific laws
  - West Valley Demonstration Project Act of 1980 (for WVDP)
  - Uranium Mill Tailings Radiation Control Act of 1978

Decommissioning Infrastructure Regulations

- **10 CFR Part 2 – Rules of Practice**
  Licensing, Hearings, Petitions, Rulemaking
- **10 CFR Part 20 – Radiation Protection Standards**
  Public dose limits, License termination criteria
- **10 CFR Part 30 – Byproduct Material Licensing**
  License termination requirements
- **10 CFR Part 40 – Source Material Licensing**
  License termination requirements

Decommissioning Infrastructure Regulations

- 10 CFR Part 50 – Reactor Licensing
  License termination requirements
- 10 CFR Part 51 - Environmental Protection
  NEPA compliance
- 10 CFR Part 70 – Source Material Licensing
  License termination requirements
- 10 CFR Part 72 – ISFSI Licensing

License Termination Standards for Unrestricted Use (10 CFR 20.1402)

- **Total Effective Dose Equivalent (TEDE) ≤ 0.25 mSv/a and As Low As is Reasonably Achievable (ALARA)**
- **Average member of the critical group**
- **All pathways**
- **Period of performance - 1000 years**

License Termination Standards for Restricted Use (10 CFR 20.1403)

- ≤ 0.25 mSv/a TEDE and ALARA, with institutional controls in effect
- Legally enforceable institutional controls
- If institutional controls fail, doses do not exceed 1 mSv/a, or 5 mSv/a, under specific circumstances
- Financial assurance - independent third party
- Licensee and NRC public input/outreach requirements

Alternate Criteria for License Termination (10 CFR 20.1404)

- > 0.25 mSv/a, but < 1 mSv/a TEDE, with institutional controls in effect
- Similar requirements for license termination under restricted conditions
- Licensee must demonstrate doses to public from all man-made sources other than medical will be < 1 mSv/a and ALARA
- Unusual, site-specific circumstances

Principle Guidance Documents

- **NUREG-1700 – Standard Review Plan for Evaluating Nuclear Power Reactor License Termination Plans**
- **NUREG-1757 – Consolidated Decommissioning Guidance**
- **NUREG-1575 – Multi-Agency Radiation Survey and Site Investigation Manual**
- **NUREG-1748 – Environmental Review Guidance for Licensing Actions Associated with NMSS Programs**
- **NUREG-1537 – Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors**

General Decommissioning Process

Materials/Fuel Cycle Facilities

Before Cleanup

--Licensee ceases operations and notifies NRC
--Licensee submits decommissioning plan to NRC for review
--NRC reviews and approves plan, if it is acceptable

During Cleanup

--Licensee conducts cleanup work
NRC conducts inspections

Power Reactor Facilities

Before Cleanup

--Licensee ceases operations and notifies NRC
--Licensee submits post-shutdown decommissioning activities report to NRC for information
--Licensee waits 90 days before starting any major decommissioning activities

During Cleanup

--Licensee conducts cleanup activities
--Licensee submits license termination plan to NRC 2 years before termination
--NRC approves LTP if acceptable
--NRC conducts inspections

After Cleanup

--Licensee conducts final status survey
--NRC conducts confirmatory surveys
--NRC approves final status survey report and terminates license

Reactor Decommissioning Options

- **DECON: Equipment, structures, etc. removed or decontaminated to a level that permits license termination**

- **SAFSTOR: Plant placed in a safe stable condition and maintained in that state until it is subsequently decontaminated to levels that permits license termination**

Entombment (ENTOMB)

In entombment, radioactive materials are encased in a structurally long-lived material, such as concrete. The entombed structure is appropriately maintained and surveillance is continued until the radioactivity decays to a level permitting release of the property by NRC.

NRC Entombment History

- **1996 – Commission requests the NRC Staff to analyze entombment as a viable decommissioning option**

- **1999 – Staff recommends ENTOMB as a safe alternative to DECON. Staff recommends research on concrete performance to 100 years vs 60 years in the License Termination Rule 10 CFR 20, Subpart E**

NRC ENTOMB History

- 1999 – NRC holds Public Workshop on ENTOMB
  - Licensees agree ENTOMB is needed as a decommissioning option
  - NRC Staff decides to amend regulations to include ENTOMB
- 2002 - NRC Staff recommends not to continue amending regulations for ENTOMB due to lack of requests and higher priority work

NRC ENTOMB History

- **2005 – Commission directs NRC Staff to cancel work on ENTOMB**
- **2006 – NRC Staff issues Research Information Letter, RIL-0602, "Assessing the Performance of Cement Based Materials as Engineered Barriers for Isolating Radioactive Waste"**

Research Information Letter-0602
Cement Materials for
Radioactive Waste Isolation

- **Low Level Waste and Assured Isolation Facilities**
- **Cement-grout encapsulated waste for Waste Incidental to Reprocessing (WIR)**
- **Cement based grout curtains/ impermeable underground walls to prevent groundwater flow from contacting waste**

NRC Sponsored Entombment Research

- **"Viability of the Entombment Option as an Alternative for Decommissioning Commercial Nuclear Power Reactors," Pacific Northwest National Laboratory, May 1999**

- **"Condition Assessment of Concrete Nuclear Structures considered for Entombment," National Institute of Science and Technology, February 2003**

Entombment Isolation Assessment for Long Term Stewardship

- Radioactive Source Term
- Mechanical or Structural Failures
- Chemical Degradation
- Physical and Chemical Forms and Solubility Rates of the Contaminants
- Isolation from Groundwater
- Dispersal of the Dissolved Contaminants in the Environment outside the Entombment Structure

U.S. Reactor Entombment Experience
Department of Energy Legacy Management Sites

- Piqua –1969 Decommissioned Power Reactor
  - 45 Mw-thermal Pressurized Water Reactor
  - Fuel and Reactor Coolant System Removed
  - Components Entombed in Concrete
  - Concrete and Floor Sealants
  - Sumps for Groundwater Intrusion Monitoring
  - Environmental or Groundwater Monitoring is not required

U.S. Reactor Entombment Experience

Department of Energy Legacy Management Sites

- **Hallam – 1969 – Decommissioned Power Reactor**
  - **240 Mw-Thermal Sodium Cooled Reactor**
  - **Reactor and Sodium Components Removed**
  - **Reactor Heat Exchanger Surfaces Sealed with Polyvinyl and Concrete Coverings**
  - **Belowground portions of the reactor building covered with polyvinyl membrane and soil**
  - **Groundwater monitoring – no radioactivity detected through 2005**

U.S. Reactor Entombment Experience

Department of Energy Legacy Management Sites

- **BONUS – 1970 -Decommissioned Power Reactor**
  - **50 Mw thermal and full temperature 482° C - Boiling Nuclear Superheater Reactor**
  - **Fuel and control rods removed**
  - **Reactor components flushed**
  - **Reactor vessel and components entombed**
  - **Radioactive components stored in main circulation pump room and entombed**

U.S. Reactor Entombment Experience

Department of Energy Legacy Management Sites

BONUS – Current Status

- **Dose Rates in Pump Room: 0.05-0.15 uSv/h (5-15 uR/h)**
- **Nuclear Museum planned for Main Floor**
- **Former Reactor Chief will be the Nuclear Museum Curator**

Useful Websites

www.nrc.gov
www.epa.gov
www.doe.gov
www.epa.gov/radiation/marssim
www.orau.gov/essap/marssim.htm
www.orau.gov/essap/COMPASS.htm
http://ciks.cbt.nist.gov/monograph
www.ead.anl.gov/resrad
http://books.nap.edu/catalog/10835.html
www-rasanet.iaea.org/conventions/waste-jointconvention.htm

More Information

- **Decommissioning Web Page - http://www.nrc.gov/what-we-do/regulatory/decommissioning.html**
  - **Sites; regulations and guidance; process; public involvement; key program documents; International aspects; FAQs; Lessons Learned**
- **NRC's Regulations - http://www.nrc.gov/reading-rm/doc-collections/cfr/**