

# **Safeguards and Material Accounting for Advanced Reactors and Associated Fuel Cycles**

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# Agenda

- Background
- Domestic Safeguards
  - HALEU
  - Fuel Facilities
  - Medical Isotope Facilities
  - Advanced Reactors
- International Safeguards
- Conclusions



# Background

- Safeguards applied to domestic nuclear facilities are principally **Physical Security** and **Material Control & Accounting**
- **MC&A** is a program to control and account for certain types of nuclear material used at a licensed facility, including SNM and source material, to deter and detect loss, theft, diversion, misuse, or unauthorized production or enrichment of nuclear material
  - **Material Control** – Control of access and monitoring status
  - **Material Accounting** – Maintain knowledge of location and quantities
- **MC&A** considers insider threats



# MC&A Requirements

- General reporting and recordkeeping requirements apply to each person licensed by NRC who possesses, transfers, or receives 1 gram or more of SNM
  - Reactors, Medical Isotope Production (Part 50)
  - Fuel Cycle Facilities, Greater-Than-Critical-Mass Facilities (Part 70)
  - Independent Spent Fuel Storage Installations (Part 72)
  - Agreement States (Part 150)
- Special reporting requirements
  - Licensees possessing certain source material (Part 40)
  - Licensees subject to IAEA safeguards (Part 75)
- **10 CFR Part 74, Material Control and Accounting of Special Nuclear Material**



# Additional MC&A

- Specific material control & accounting requirements for licensees who:
  - Possess and use SNM of low strategic significance (Cat III)
  - Possess and use SNM of moderate strategic significance (Cat II)
  - Possess and use formula quantities of strategic SNM (Cat I)
  - Possess uranium source material and equipment capable of producing enriched uranium
- **10 CFR Part 74, Subparts C, D, and E**



# Elements of MC&A

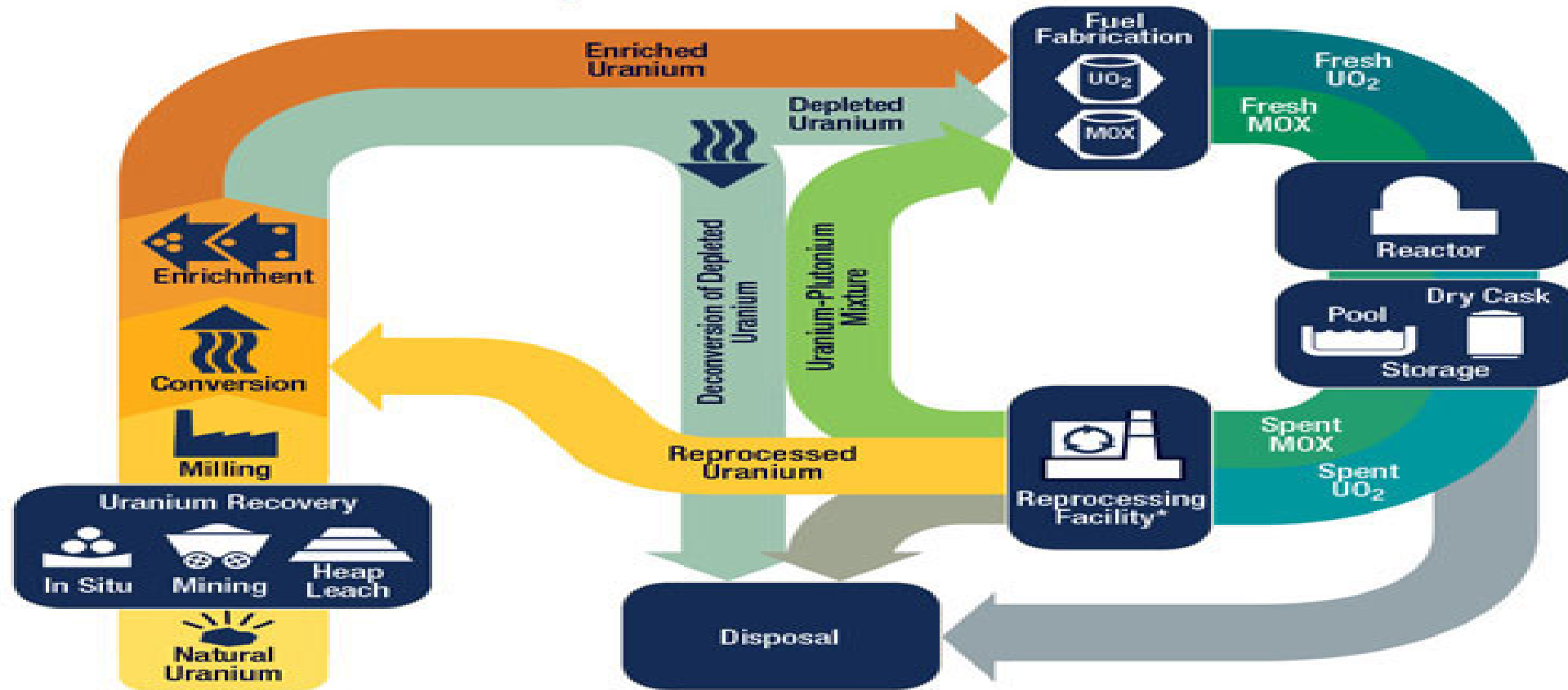
- Management structure
- Measurements
- Measurement control
- Physical inventory
- Item control and monitoring
- Detection and Resolution of indicators
- Process monitoring
- Independent assessment
- Recordkeeping

Enrichment facilities are also required to have controls to prevent unauthorized enrichment



# Nuclear Fuel Cycle

## The Nuclear Fuel Cycle



\* Reprocessing of spent nuclear fuel, including mixed-oxide (MOX) fuel, is not practiced in the United States.  
Note: The NRC has no regulatory role in mining uranium.

As of January 2019



# MC&A for HALEU

- Category II enrichment and quantities
  - 10 CFR 74 Subpart D – SNM of Moderate Strategic Significance
- Additional requirements for Category II beyond Category III
  - More-specific requirements for internal controls, measurements, measurement controls
  - More frequent inventory
  - Lower threshold for excepted items
- Applicable Guidance
  - NUREG-2159, “Acceptable Standard Format and Content for the Fundamental Nuclear Material Control Plan Required for Special Nuclear Material of Moderate Strategic Significance” [DRAFT]



# Fuel Cycle Facilities

- Fuel Fabricators
  - Currently 3 Category III and 2 Category I
  - Application expected for a new TRISO facility
- Enrichment Plants
  - Currently two licensed as Category III (UUSA, Centrus); one is operating
  - Amendment in review from Centrus for limited HALEU production
- Each facility is required to have a Fundamental Nuclear Material Control plan (FNMCP) approved by NRC and incorporated as a license condition



# Medical Isotope Facilities

- The operating license application for SHINE is currently under review
  - Application includes FNMCP for approval as license condition
- Requirements at other proposed facilities will depend on type and quantity of material and the operating processes



# Advanced Reactors

- Some advanced reactor designs involve complex fuel handling and closer integration of the fuel cycle with the reactor
- Different fuel types and advanced reactor designs may need new approaches to meet the MC&A objectives
- Technical studies supported by NRC help inform implementation of MC&A for advanced reactor designs
  - “Model MC&A Plan for Pebble Bed Reactors” (ORNL, 2019)  
[ML20112F355]
- DOE is currently supporting further studies for advanced designs



# Safeguards by Design

- Safeguards by Design (SBD) is a set of principles promoted by the IAEA to facilitate the implementation of nuclear safeguards in facilities
- While SBD is not required for domestic facilities, the Commission has stated that safeguards should be considered in the design of advanced reactors along with security, emergency preparedness, and threat of theft (“Policy Statement on the Regulation of Advanced Reactors,” 73 FR 60612, 2008)



# International Safeguards

- Advanced reactor facilities would be subject to international safeguards in accord with the U.S.-IAEA Safeguards Agreements
- These may include reporting of SNM transactions and inventory, providing design information, and possible design verification visits by IAEA.
- NRC export licensing review includes consultation with Executive Branch agencies to ensure appropriate controls on nuclear equipment, components, and material
- The advanced reactor fuel cycle would have the same controls
- NRC works closely with interagency and international groups to support U.S. nonproliferation objectives



# Conclusions

- The existing regulatory framework for domestic and international safeguards can be applied to advanced reactors and advanced fuel cycles
- NRC has experience with safeguards for a range of material categories through licensing and oversight of existing facilities
- Some advanced reactor designs may need innovative approaches for MC&A, which should be considered while developing designs
- Pre-licensing engagement is strongly encouraged