



MATERIAL CONTROL AND ACCOUNTING



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MC&A Inspection KM Session
November 10, 2022



Topics

- What is MC&A, Special Nuclear Material (SNM), and why is it important?
- Acronyms
- History
- Regulations
- Definitions
- Differences and complements to Physical Security
- Conduct of MC&A Inspections – Fuel Cycle
- Conduct of MC&A Inspections – Reactors
- Inspections Results and Enforcement
- Resources and Questions



Background

Congress enacted Title I of the [Atomic Energy Act of 1954](#), as part of President Eisenhower's Atoms for Peace program, including the clause:

"Source and special nuclear material, production facilities, and utilization facilities are affected with the public interest, and regulation by the United States of the production and utilization of atomic energy and of the facilities used in connection therewith is necessary in the national interest to assure the common defense and security and to protect the health and safety of the public."



What is MC&A?

- Material control and accounting (MC&A) was developed in the 1950s as an element of the global nuclear non-proliferation regime
- The basic objective of MC&A was to enable timely detection and to assure that uranium and plutonium, the two special nuclear materials (SNM), were not stolen or diverted for use in a nuclear weapon
- Post 9/11, MC&A can provide assurance that spent fuel has not been diverted for the purpose of creating a dirty bomb
- All MC&A regulations are in 10 CFR Part 74
- MC&A Inspection Manual Chapter = IMC 2683



What is MC&A? (continued)

- MC&A works in concert with physical protection
 - Physical security protects nuclear facilities and the SNM that they possess from external attack
 - MC&A provides a record of the form and quantity of SNM at a facility acknowledging what is being protected (insider)
 - maintain current knowledge of its SNM and manage its program for securing and protecting SNM. The MC&A program, together with physical protection of facilities and information security requirements, make up the primary elements of the NRC's SNM safeguards program. The MC&A component of the larger safeguards program helps ensure that SNM within a licensed facility is not stolen or otherwise diverted from the facility.



What is SNM?

so “special”

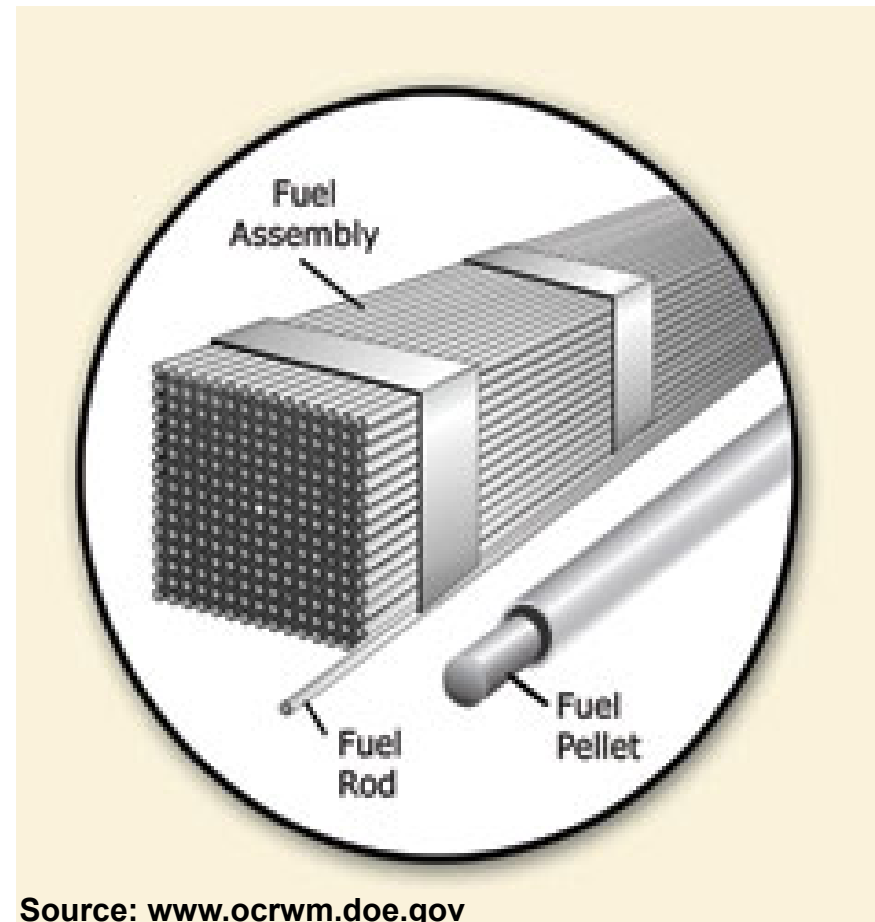
Focus on material

Official Use Only - Security-Related Information



Forms of SNM Typically at NRC Facilities

- 30B cylinders
- Powder
- Pellets
- Pellet chips, fines, sludge
- Plates
- Solutions
- Rods
- Fragments or pieces of rods
- Fuel assemblies (or bundles)
- Fuel Components
- Non-Fuel SNM
 - Detectors (IRMs, SRMs, TIPs, LPRMs)
 - Sources





Non-Fuel SNM: Radioactive Sources

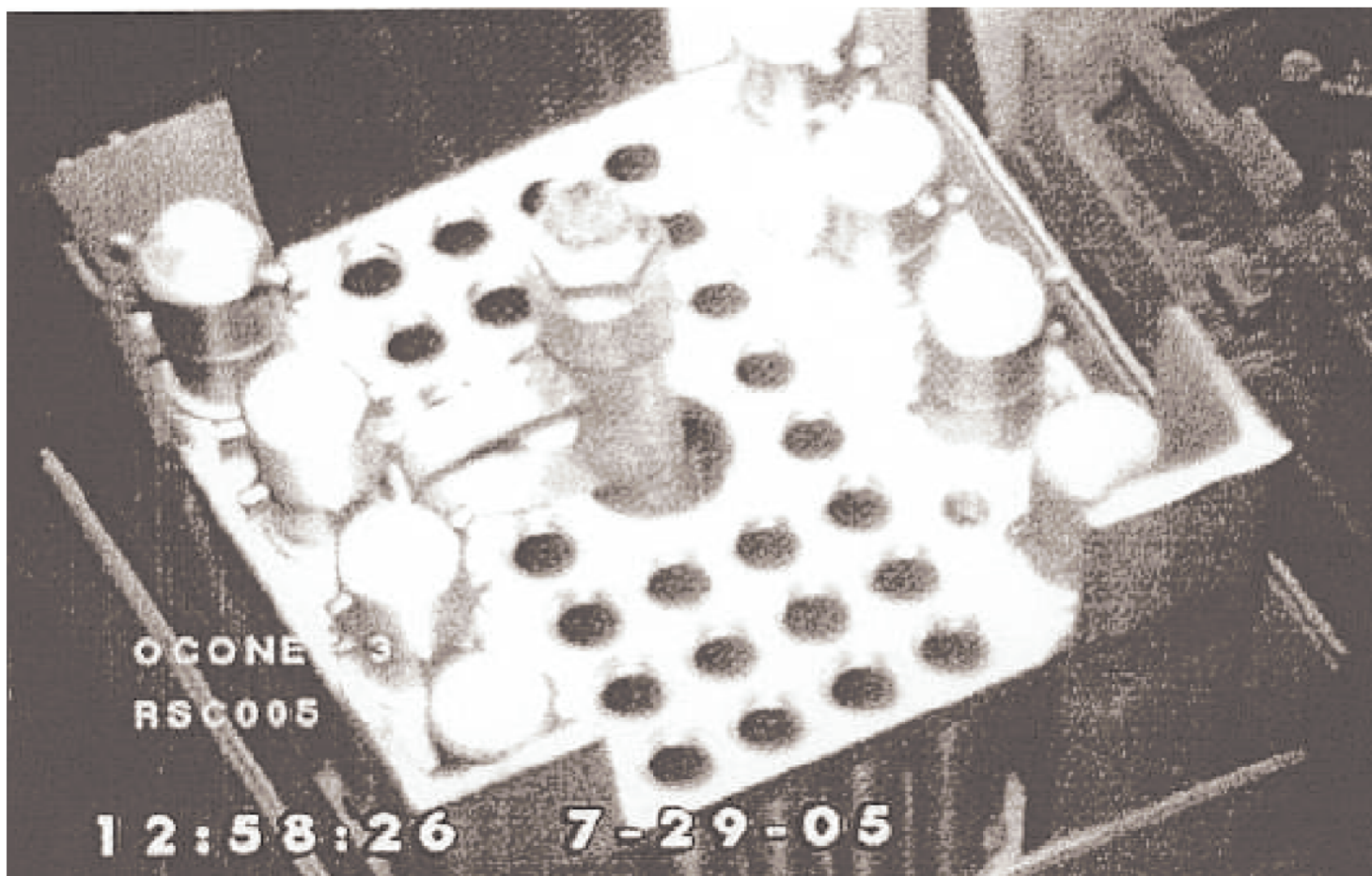


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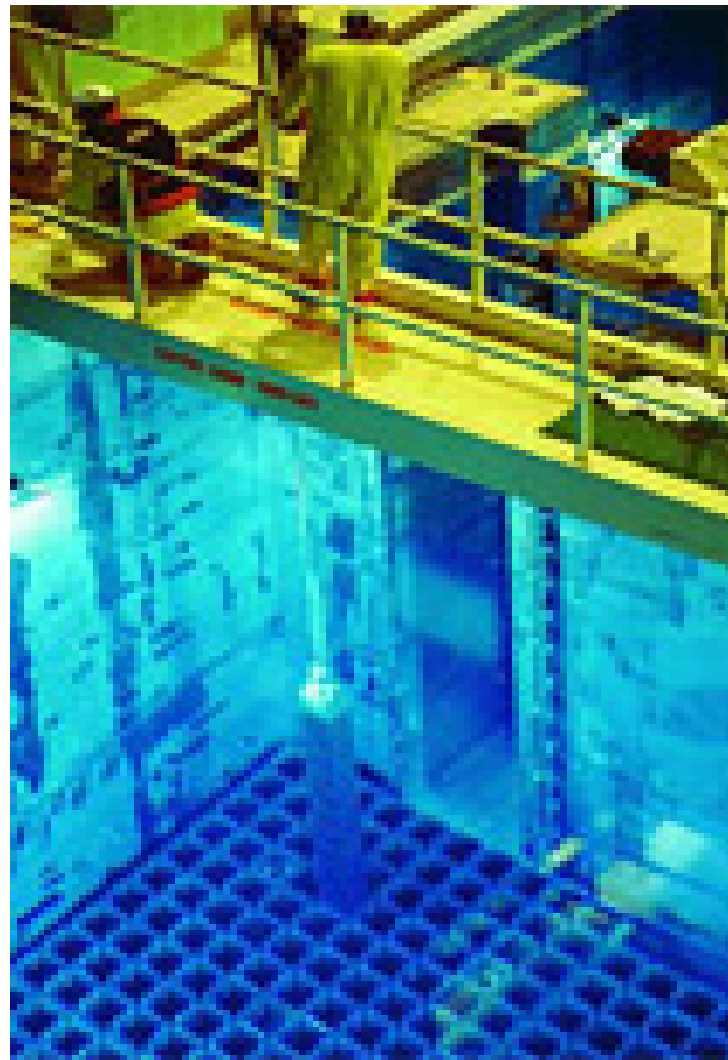


Rod Storage Canister with Individual Rod Storage Containers



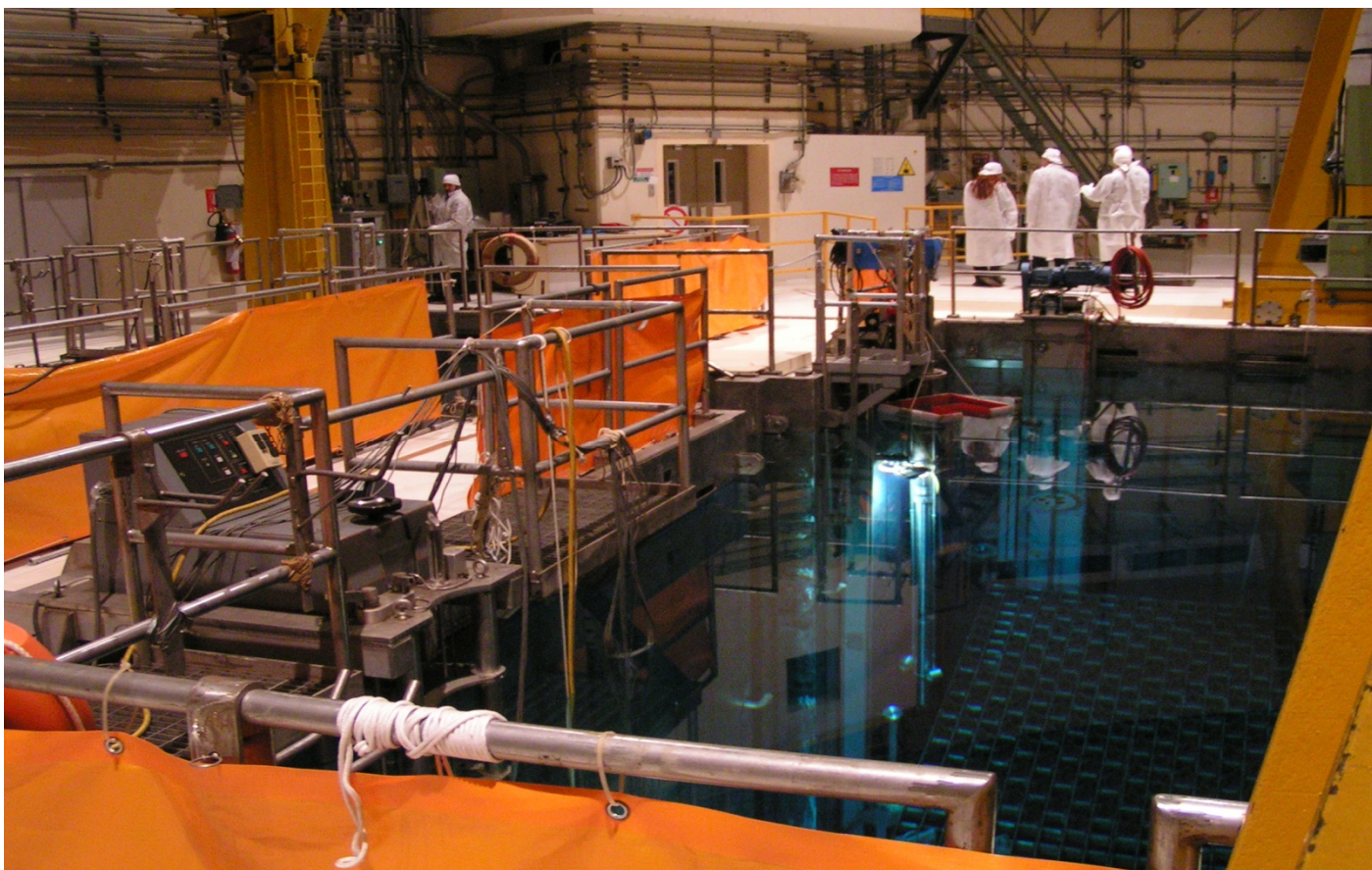


Spent Fuel Racks





Spent Fuel Storage Pool



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Acronyms

MC&A

Material control and accounting

SNM

Special nuclear material

SSNM

Strategic special Nuclear Material

NMMSS

Nuclear Materials Management and Safeguards System (the national nuclear materials database maintained by NRC and DOE)

TID

Tamper-indicating device (seal)

MBA

Material Balance Area

ICA

Item Control Area

IP

Inspection Procedure



“Loss” “Theft” and “Diversion” of SNM

- The term “**loss**” implies that a search has been conducted to confirm the material lost. For fixed sites, this search should be conducted within the one-hour time frame of reportability.
- **Theft:** The term refers to the unauthorized taking of SNM for unauthorized use.
- **Diversion:** This term refers to the unauthorized movement of SNM by individuals authorized access to or control over the material.



Definitions

Book inventory	Total inventory possessed as indicated by accounting records (beginning inventory + material received – shipments)
Physical Inventory	Determination by physical means of the quantity of SNM on hand
SNM	Pu, U-233, U-enriched in isotopes 233 or 235, and any other enriched material which the NRC, pursuant to Section 5.1 of the Act, determines to be SNM, but does not include source material.



Definitions

Safeguards: The use of material control and accounting programs to verify that all special nuclear material is properly controlled and accounted for, as well as the physical protection (or physical security) equipment and security forces.

As used by the International Atomic Energy Agency, this term also means verifying that the peaceful use commitments made in binding nonproliferation agreements, both bilateral and multilateral, are honored.



Definitions

2.390 Information

Correspondence and reports concerning a licensee's MC&A program that are not safeguards. In general, MC&A information is classified and protected as proprietary. It is characterized as "2.390 Information" or "Security-Related Information."

Form 741

Reports of SNM shipments and receipts transmitted to the NMMSS

Form 742

Reports of nuclear material status (physical inventory) transmitted to the NMMSS



Other Definitions

Tamper-Indicating Device

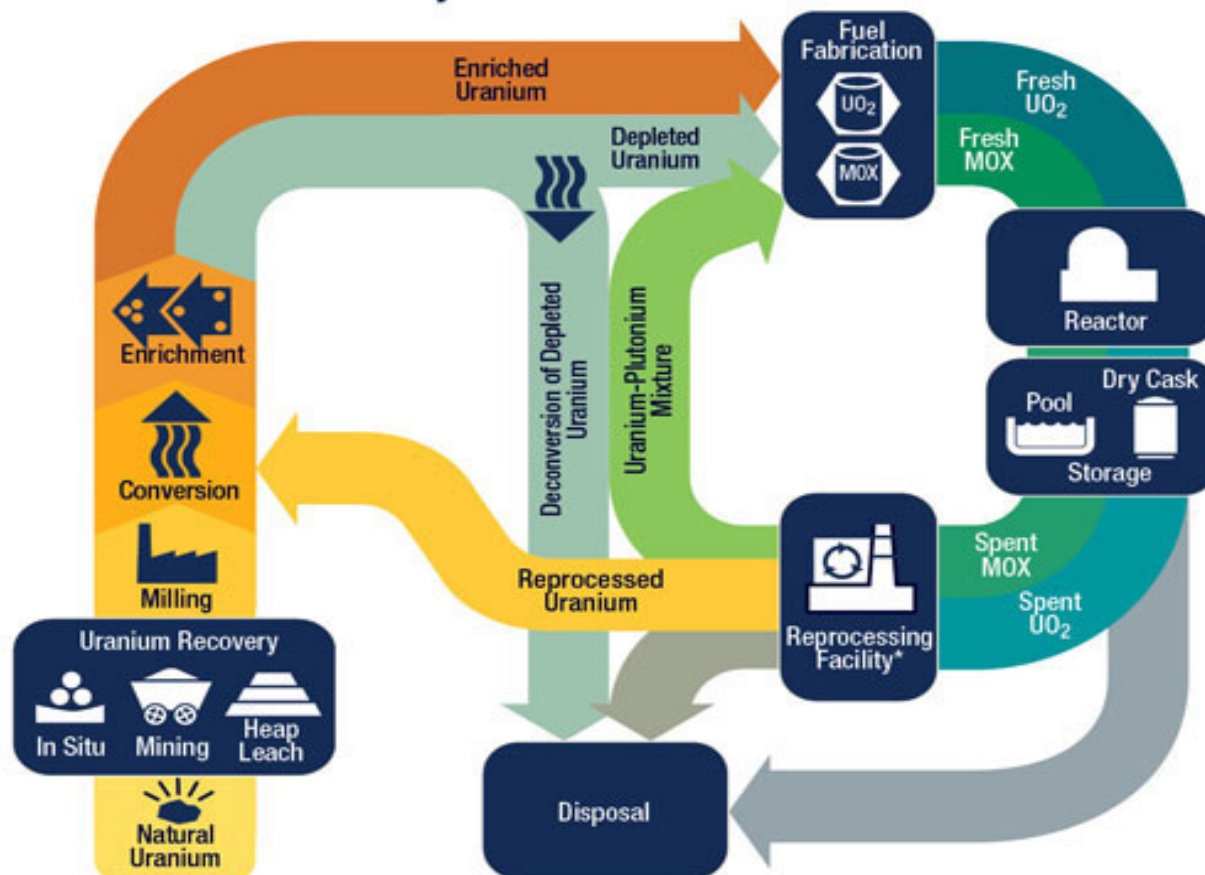
A device used on a container that provides a clear indication of any violation of the integrity of the contents.

Item Control Area

A defined area for which SNM items are maintained in such a way that, at any time, an item count and related quantities of SNM can be obtained from the records for the SNM located within the area; such as, reactor vessels, spent fuel pools, ISFSIs, and non-fuel SNM storage areas.



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







Division of Fuel Facility Inspection

- Region II + DFM
- Conversion, Enrichment, Fuel Fabrication (+ Navy)
- Types of Inspections
- MC&A inspection program commensurate with the safeguards risk (quantity and enrichment)
- Categories I, II, III
- SG Condition 1 = Fundamental Nuclear Materials Control Program



Inspection Procedures

Category III Fuel Fabrication Facilities

IP 85401 Management Structure

IP 85402 Measurement Program

IP 85403 Measurement Control Program

IP 85404 Physical Inventory Program for Low Enriched Uranium Fuel Facilities

IP 85405 Item Control

IP 85406 Resolution Program for Low Enriched Uranium Fuel Facilities

IP 85407 Assessment Program

IP 85408 Recordkeeping Program



Inspection Procedures

Category III Enrichment Facilities

IP 85401 Management Structure

IP 85402 Measurement Program

IP 85403 Measurement Control Program

IP 85405 Item Control

IP 85407 Assessment Program

IP 85408 Recordkeeping Program

IP 85501 Physical Inventory Program for Uranium
Enrichment Facilities

IP 85502 Detection Program for Uranium Enrichment
Facilities

IP 85503 Resolution Program for Uranium Enrichment
Facilities



Inspection Procedures

Category I Facilities

IP 85303 Material Control and Accounting Management
Structure and Personnel Training and Qualification

IP 85305 Item Monitoring

IP 85307 Process Monitoring

IP 85309 Measurement Systems and Control

IP 85311 Physical Inventory Program

IP 85313 Alarm Resolution Program

IP 85315 Internal Control

IP 85407 Assessment Program

IP 85408 Recordkeeping Program



Inspection Procedures

Power Reactors

IP 71130.11





MC&A Regulations for Power Reactors

In summary, the inspection goal is to answer the following questions:

- *Does the licensee keep records of receipts, shipments, and internal movements (including location) of all SNM?*
- *Does the licensee have written procedures that enable it to account for its SNM?*
- *Does the licensee conduct a physical inventory of all SNM at a frequency not to exceed every 12 months?*
- *Does the licensee submit the required reports to NMMSS?*



Background Concerning MC&A Inspections at Power Reactors

Dec 2000	Millstone Unit 1 identified loss of 2 spent fuel rods
Mar 2004	Vermont Yankee identified that 2 rod pieces were misplaced (found later in another location in spent fuel pool)
Jul 2004	Humboldt Bay identified loss of rod segments
May 2005	Hatch found unaccounted for pieces in the SFP
Jul 2005	Oconee identified a misplaced rod (later found)



Inspection Results

- Millstone Unit 1 SL II, \$288K civil penalty (CP) for loss of 2 rods
- Vermont Yankee SL III, no CP for misplacing 2 rod segments
- Humboldt Bay SL II, \$96K CP for loss of 3 rod segments
- V. C. Summer SL IV non-cited violation (NCV) for inadequate physical inventories
- Millstone 2&3 SL IV NCV for inadequate physical inventories



Inspection Results

- Palisades SL IV NCV for inadequate physical inventories
- Farley SL IV NCV for inadequate physical inventories
- South Texas SL IV NCV for inadequate physical inventories
- Prairie Island SL IV NCV for inadequate physical inventories



Inspection Results

- Beaver Valley SL IV NCV for inadequate physical inventories
- Hatch SL II, \$104K CP for lost rod pieces and poor record-keeping
- Palo Verde SL IV NCV for inadequate physical inventories and procedures
- Oconee SL III, no CP for 2 misplaced rods



Inspection Results

- LaCrosse SL IV notice of violation (NOV) for inadequate physical inventories and procedures
- Robinson Two SL IV NCVs, one for inadequate physical inventories and one for recordkeeping
- Pilgrim SL IV NOV for loss of 9 detectors



Inspection Results

- BWXT- LTC (laboratory) SL IV NOV for inadequate physical inventories
- Salem SL IV NCV for inadequate physical inventories
- GE-Vallecitos (laboratory) VIO for loss of item containing 14 grams unirradiated U-235



Summary of Inspection Findings

- 2 SL II violations with CP (including Millstone Unit 1)
- 2 SL III violations with no CP
- 3 SL IV NOVs
- 10 SL IV NCVs
- 3 with no findings of significance



Power Reactor MC&A Inspections

- IP 71130.11 implemented in CY2010
 - Security-related inspection
 - Resource estimate 16 +/- 8 per site
 - Performed by resident inspectors (with some exceptions)
 - Triennial inspection cycle



Applicable Regulations



10 CFR Part 74.11 - Reports of loss or theft or attempted theft

- (a) Each licensee who possesses one gram or more of contained uranium-235, uranium-233, or plutonium shall notify the NRC Operations Center within 1 hour of discovery of any loss or theft or other unlawful diversion of special nuclear material which the licensee is licensed to possess, or any incident in which an attempt has been made to commit a theft or unlawful diversion of special nuclear material....



Applicable Regulations



10 CFR Part 74.19 - Recordkeeping

- (a) Each licensee shall **keep records** showing the receipt, inventory (including location and unique identity), acquisition, transfer, and disposal of all special nuclear material in its possession regardless of its origin or method of acquisition....
- (b) ... shall establish, maintain, and follow **written material control and accounting procedures** that are sufficient to enable the licensee to account for the special nuclear material in its possession under license....
- (c) ... shall conduct a **physical inventory of all special nuclear material** in its possession under license at intervals not to exceed 12 months....



Applicable Regulations

10 CFR Part 74.13 - Material status reports (DOE/NRC Form 742)

- (a) Each licensee, including nuclear reactor licensees ... shall complete and submit, in computer-readable format Material Balance Reports concerning special nuclear material that the licensee has received, produced, possessed, transferred, consumed, disposed of, or lost. ... within 60 calendar days of the beginning of the physical inventory required by §§ 74.19(c)....



Applicable Regulations

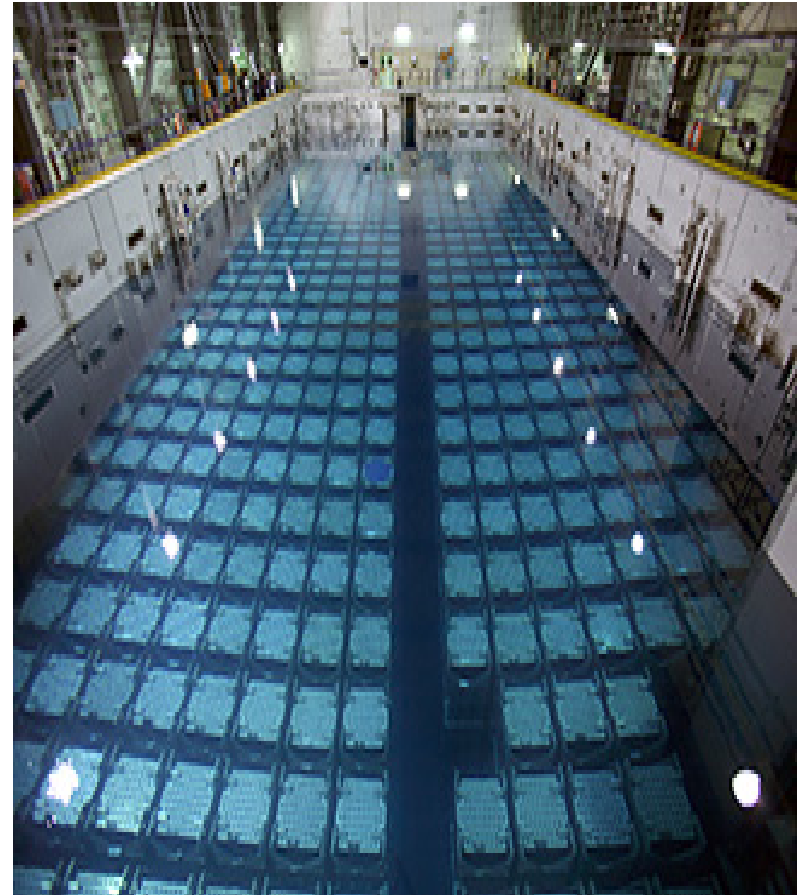
10 CFR Part 74.15 - Nuclear material transfer reports (Form 741)

- (a) Each licensee who transfers and each licensee who receives special nuclear material shall complete in computer-readable format a Nuclear Material Transaction Report... in accordance with instructions whenever the licensee transfers or receives a quantity of special nuclear material of 1 gram or more of contained uranium-235, uranium-233, or plutonium....



Conduct of MC&A Inspections

- Currently, in-depth MC&A inspections at power reactors are conducted under IP 71130.11
- Primary objective is to determine if the licensee has a program in place to account for all spent fuel and that all SNM in the inventory can be located.
- The three basic components of an MC&A program at a power reactor are:
 - Record-keeping, which produces the book inventory
 - Written procedures
 - Physical inventory at a frequency not to exceed every 12 months





Inspection Requirements

15 requirements in 5 areas:

1. SNM records

- Determine if MC&A activities are documented
- Review 10 SNM transfer forms for completeness
- Verify fuel failures and reconstitutions since last inspection documented changes and locations.

2. Programs and Procedures

- Verify changes to procedures reviewed and approved and did not decrease effectiveness of the program
- If changes made, verify responsibilities identified and training conducted



Inspection Requirements

3. Physical Inventory

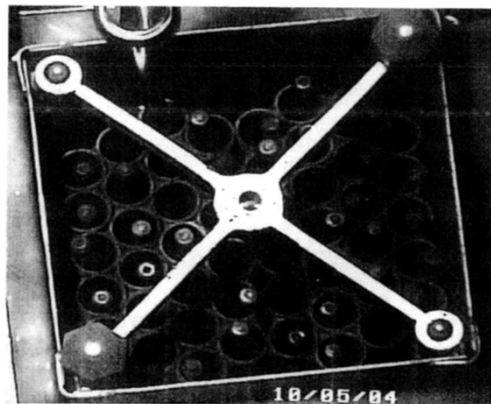
- Verify inventories every 12 months
- Review most recent inventory for completeness
- Verify inventory performed using physical observation and not just records review
- Verify non-fuel SNM included in inventory (IRMs, SRMs, LPRMs, TIPs)
- Determine if last 2 inventories reconciled with book inventory, discrepancies entered into CAP



Inspection Requirements

3. Physical Inventory (continued)

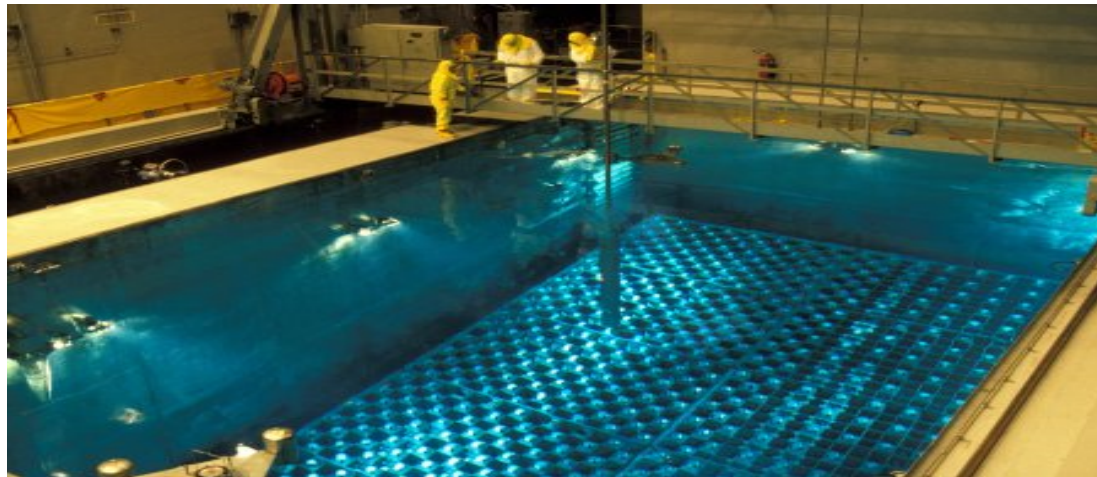
- Verify a random sample of 10 fuel assemblies are in proper location in SFP
- Verify a sample of containers of rods, pellets, fragments are in assigned locations and have not been accessed
- Verify all baskets and other containers of SNM hanging from side of SFP are clearly identified





Inspection Requirements

4. **SNM Reports** - Verify licensee made required reports (NRC Form 741 and 742) to NMMSS
5. **PI&R** - Verify licensee is identifying issues relative to MC&A and entering them into the CAP





Primary Factors that Led to the Violations Identified

- Inadequate physical inventories
- Lacked attention to detail when rods were removed from an assembly and consolidated in a storage container
- Closed the container without performing an adequate physical inventory of the contents. (*Note: This is the danger of allowing physical inventory of a closed container*)
- Poor records for internal movements
- Did not think of physical inventory of SNM as covering anything other than assemblies
- Allowed a contractor to perform work in the spent fuel pool with no oversight
- Inadequate record-keeping, training, and written procedures



Additional Information and Resources

- [10 CFR Part 74](#)
- [IMC 2683](#)
- [IP 71130.11](#)
- [Nuclepedia MC&A Page](#)

Questions?

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