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Review Facility Design Drawings
M3FT-16LA040105011

DOE-Nuclear Energy Office:

Material Protection, Accounting and Control Technologies

Safeguards and Security by Design for Used Fuel Extended Storage
1.02.04.01.05 FT – 16LA04010501

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Work Package Objective:

This work package focuses on developing Best Practices for the design of security for, and domestic safeguarding (e.g. MC&A) of, a pilot scale independent spent/used fuel storage facility consistent with conceptual design efforts in Nuclear Fuels Storage and Transportation (NFST) and Used Fuel Disposal (UFD) campaigns.

Description:

Review basic design of the facility to determine a candidate list of accounting and control requirements that could be considered for safeguards and security purposes.

Overview:

The LANL team reviewed the facility design drawings for the 5000 MTU Pilot ISF – Consolidated Storage Facility Design Concepts, overall site plan, and "Generic Design Alternatives for Dry Storage of Spent Nuclear Fuel"[1]. There are considerations in the design for both horizontal and upright storage of spent fuel cask s. See Figure 1 shows a horizontal configuration for used fuel dry cask storage system, and Figure 2 shows a vertical storage system.[2]

[1] Task Order 16, "Generic Design Alternatives for Dry Storage of Spent Nuclear Fuel," Prepared for United States Department of Energy, Final Report, Holtec International, CB&I, Longenecker & Associates, May 15, 2015.
[2] "Backgrounder on Dry Cask Storage of Spent Nuclear Fuel," U.S. Nuclear Regulatory Commission, updated October 5, 2015, available at: http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/dry-cask-storage.html.

Figure 1. ***A photo of a horizontal dry cask storage system.***[2]

Figure 2. ***A photo of a vertical dry cask storage system.***[2]

Resources for determining nuclear material accounting and control (NMA&C) came from several documents:

Nuclear Regulatory Commission (NRC), Code of Federal Regulation (CFR), Title 10, Part 74, "Material Control and Accounting of Special Nuclear Materials".

Nuclear Regulatory Commission (NRC), Code of Federal Regulation (CFR), Title 10, Part 75, "Safeguards on Nuclear Material - Implementation of the US/IAEA Agreement".

Security of Dry Storage of Spent Nuclear Fuel, WINS International Best Practice Guide, 4.12, June 2015.

Use of Nuclear Material Accounting and Control for Nuclear Security Purposes at Faculties, IAEA Nuclear Security Series No. 25-G, Implementing Guide, Vienna, 2015.

"Application of Framework for Integrating Safety, Security and Safeguards (3Ss) into Design of Used Nuclear Fuel Storage Facility (INFSF), Los Alamos National Laboratory Report #LA-UR-14-27045, Los Alamos, NM, LA-UR-14-26640, January 2015.

FY14 WINS Workshop, "Best Practices for Security of UNF Extended Storage".

"International Safeguards in the Design of Facilities for Long Term Spent Fuel Management," IAEA, June 2014, draft.

Safeguards by Design Guidance for Independent Spent Fuel Storage Installations (ISFSI), INL/LTD-11-22940, Sept 2011.

Candidate List of Accounting and Control Requirements:

The following is a list of requirements that should be considered for the safeguards and security of a used fuel extended storage facility.

- Identify the special nuclear material (SNM) form, enrichment, and quantity at the accounting level, i.e., cask
- Identify accountancy unit, i.e., storage cask (other assemblies, etc.)
- Identify MC&A authority
- Catalogue threats and threat scenarios
- Identify the MC&A system objectives based on the threats and threat scenario (i.e., risk).
- Perform Vulnerability Assessments (VA) based on threats and threat scenario development
- Define Material Access Areas (MAAs)
- Define Material Balance Areas (MBAs)
- Identify (design) the computerized MA&C system
- Identify numbering/tracking system for casks
- Develop programmatic and operating procedures for running MA&C system
    - Storage
    - Shipping/receiving, i.e., cask transfers
    - Cask reloading
- Develop a plan/procedure for loss of continuity of knowledge (CoK)

An integrated organization chart of the nuclear material accounting and control (NMA&C) system elements, are presented in Figure 3. Many of these elements are derived from the list of requirements above.

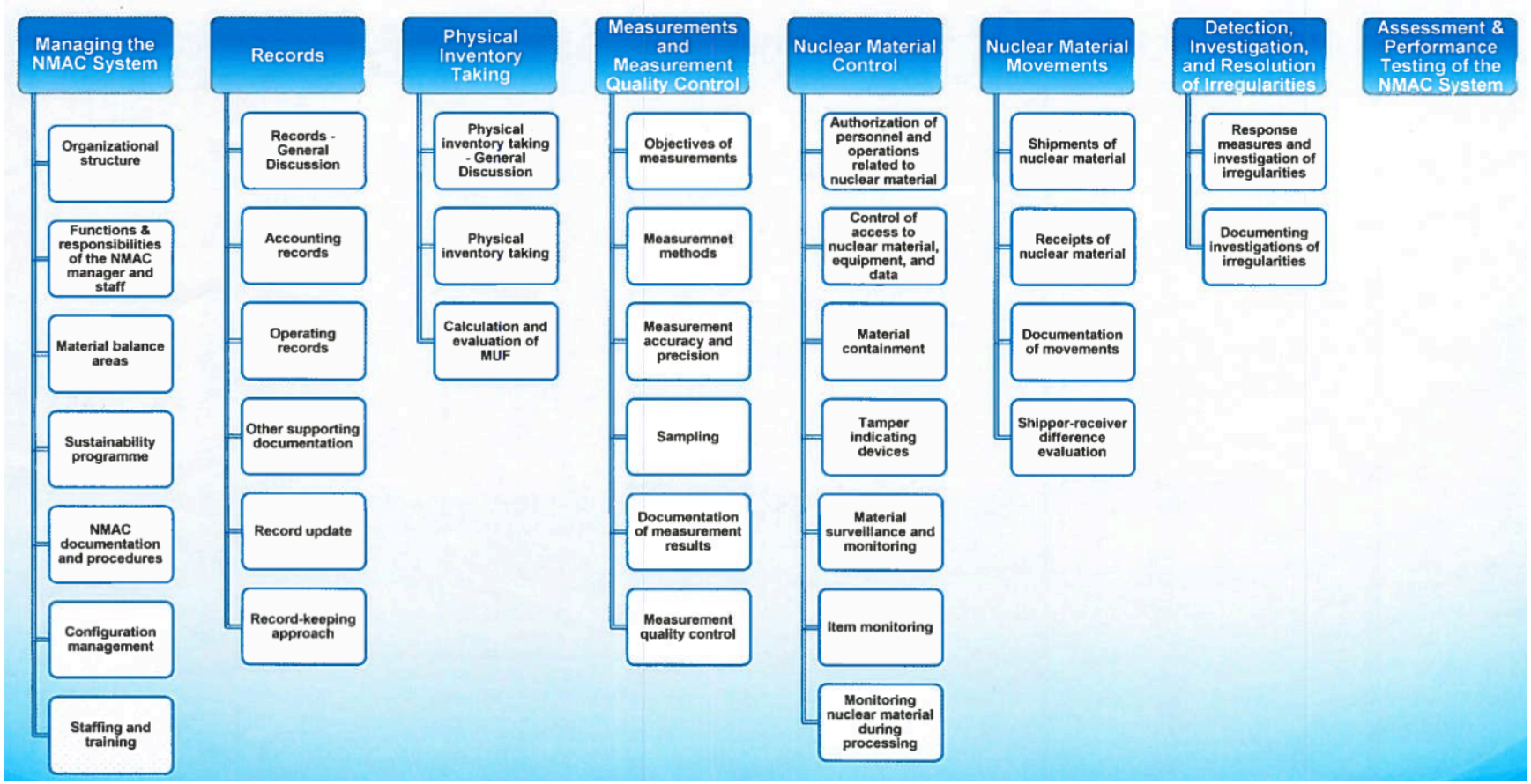

Figure 3. ***Nuclear material accounting and control system elements and measures.***

Categorization of Material

The current NRC categorization of material is found in Regulations 10 CFR, Appendix M to Part 110—Categorization of Nuclear Material[3], and the table is reproduced below.[4]

Table 1
NRC Categorization of Nuclear Material

Material	Form	Category I	Category II	Category III[3]
1. Plutonium[1]	Unirradiated[2]	2 kg or more	Less than 2 kg but more than 500 g.	500 g or less but more than 15 g.
2. Uranium-235 (^{235}U).	Unirradiated:[2]			
	—Uranium enriched to 20 percent ^{235}U or more.	5 kg or more	Less than 5 kg but more than 1 kg.	1 kg or less but more than 15 g.
	—Uranium enriched to 10 percent ^{235}U but less than 20 percent ^{235}U.		10 kg or more	Less than 10 kg but more than 1 kg.
	—Uranium enriched above natural, but less than 10 percent ^{235}U.			10 kg or more.
3. Uranium-233 (^{233}U).	Unirradiated[2]	2 kg or more	Less than 2 kg but more than 500 g.	500 g or less but more than 15 g.
4. Irradiated Fuel (The categorization of irradiated fuel in the tabl is based on international transport considerations. The State may assign a different category for domestic use, storage anc transport taking all relevant factors into account).			Depleted or natural uranium, thorium or low enriched fuel (less than 10 percent fissile content)[4] [5]	

[1] All plutonium except that with isotopic concentration exceeding 80 percent in plutonium-238.

[2] Material not irradiated in a reactor or material irradiated in a reactor but with a radiation level equal to or less than 1 Gy/h (100 rad/h) at 1 m unshielded.

[3] Quantities not falling in Category III and natural uranium, depleted uranium and thorium should be protected at least in accordance with prudent management practice.

[4] Although this level of protection is recommended, it would be open to States, upon evaluation of the specific circumstances, to assign a different category of physical protection.

[5] Other fuel, which by virtue of its original fissile material content is classified as Category I or II before irradiation may be reduced one category level while the radiation level from the fuel exceeds 1 Gy/h (100 rad/h) at one meter unshielded.

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[3] "Appendix M to Part 110—Categorization of Nuclear Material, at U.S. Nuclear Regulatory Commission (NRC), available at: http://www.nrc.gov/reading-rm/doc-collections/cfr/part110/part110-appm.html, updated December 2, 2015."

[4] The nuclear material categorization is similar to that found in IAEA INFCIRC/22/Rev 5.

According to the above table irradiated fuel, (highlighted in blue,) that is <10% fissile content is Category II, which identifies the nuclear security requirements. The categorization is based on international transportation standards. However, according to the Table, "States may assign a different category for domestic use, storage and transport taking all relevant factors into account." This makes defining requirements a little challenging, and it could be more challenging for fuel being shipped between states. Additionally, as the irradiated nuclear fuel ages, the constituent nuclear isotopes in the fuel decay, therefore the categorization of the fuel may change over the lifetime of the facility.

Protracted theft of nuclear material from a storage facility is not a concern. These casks are very difficult to move, open, and extract material. Therefore only abrupt theft of nuclear material is a concern.

If the storage facility is placed on the eligible facility list and selected by the IAEA for inspections, the facility will be expected to conform to any US/IAEA agreements regarding verification of the used nuclear material.