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Material Attractiveness and Categorization Activities at the Nuclear Regulatory Commission

Joseph Rivers, Oleg Bukharin
NRC Office of Nuclear Security
and Incident Response

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Background

- NRC is in the process of revising its regulations for physical protection of special nuclear material (SNM).
  - Revise nuclear material categorization table.
  - Put over 50 Orders into regulations – accumulated since 9/11/01.
- NRC has a legislative mandate to make available for public comment its proposed regulatory changes.
- Commission directed NRC staff to conduct “enhanced” stakeholder outreach, including with international partners.
- Revisions to INFCIRC/225 recently issued– want to ensure consistency.

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Current NRC Approach

- Categorization table (I, II, III; Pu, U-235, U-233, irradiated fuel).
  - Nearly identical to Categorization Table in INFCIRC/225/Rev. 5.
  - Cat I = “Formula Quantity of Strategic Special Nuclear Material.”
  - Cat II = “SNM of Moderate Strategic Significance.”
  - Cat III = “SNM of Low strategic significance.”
  - Based on threat of Improvised Nuclear Device (IND).
  - Approximately 50 year old.

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Current Table - App. M to 10 CFR Part 110

Material	Form	Category		
		I	II	III
1. Plutonium	Unirradiated.	2 kg or more	Less than 2 kg but more than 500 g	500 g or less
2. Uranium-235	Unirradiated. Uranium enriched to 20 pct U^{235} or more.	5 kg or more	Less than 5 kg but more than 1 kg	1 kg or less
	Uranium enriched to 10 pct U^{235} but less than 20 pct.		10 kg or more	Less than 10 kg
	Uranium enriched above natural, but less than 10 pct U^{235}.			10 kg or more
3. Uranium-233	Unirradiated.	2 kg or more	Less than 2 kg but more than 500 g	500 g or less

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Current NRC Approach (cont.)

- Two-factor consideration - type and quantity.
  - Ease of use.
  - Insufficient to provide risk-informed, graded approach.
  - Led to lack of consistency and transparency in regulations.
    - 5 kg high enriched uranium (HEU) metal vs. 5 kg of HEU in soil.
- "Right-size" security regulations by adding attractiveness to SNM categorization.
  - Make appropriate to individual forms of SNM.
  - Restore regulatory predictability/clarity.

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INFCIRC/225/Rev. 5 Attractiveness Factors

- "…the basis for a graded approach…depends on the type of nuclear material (e.g. plutonium and uranium), isotopic composition (i.e. content of fissile isotopes), physical and chemical form, degree of dilution, radiation level, and quantity.

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Material Attractiveness Factors Considered

- Factors.
  - Form (metals, compounds, solutions, in a matrix).
  - Weight percent of SNM in compound (dilution factor).
    - Calculations based on total weight of bulk material or item – should not include cladding material that is easily removed.
  - Radiation level–considering changes.

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Initial Attractiveness Levels Considered

Uranium-235	
Nuclear Material	Attractiveness Level
Pure Products Metals, simple compounds (≥20 wt %) (compounds that can be converted to metal in a single step).	A
High-Grade Materials Complex compounds (≥20 wt %) (compounds that cannot be converted to metal in a single step; solutions (≥25 g/l).	B
Low-Grade Materials Metals and compounds (≥1 wt % and <20 wt %); solutions (≥1 g/l and <25 g/l).	C
All Other Materials Uranium (<10% U-235); highly irradiated material (≥1000 R/h @ 1 m); metals and compounds (<1 wt %); solutions (<1 g/l).	D

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Initial Attractiveness Levels Considered

Plutonium and Uranium-233	
Nuclear Material	Attractiveness Level
Pure Products Metals (≥20 wt %), simple compounds (≥20 wt %) (compounds that can be converted to metal in a single step) .	A
High-Grade Materials Complex compounds (≥20 wt %) (compounds that cannot be converted to metal in a single step; solutions (≥25 g/l).	B
Low-Grade Materials Metals and compounds (≥1 wt % and <20 wt %); solutions (≥1 g/l and <25 g/l); Pu (≥80 % Pu-238).	C
All Other Materials Uranium (<6% U-233); highly irradiated material (≥1000 R/h @ 1 m); metals and compounds (<1 wt %); solutions (<1 g/l)	D

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Los Alamos National Laboratory Study

- Logic Model.
  - Acquisition Module.
  - Processing Module.
  - Weapons Module.
  - Degradation Model.

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Stakeholder Interaction

- Other U.S. Government Agencies.
- Industry.
- Non-Governmental Organizations.
- Foreign Governments.

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Initial Stakeholder Feedback

- Generally Consistent with INFCIRC/225.
- Technically Sound.
- Concern over complexity of the approach.
- Concern over metals and compounds having different treatments.

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Revised Table

	Uranium-235			
Nuclear Material	Attractiveness Level	Cat I	Cat II	Cat III
High-Grade Materials Metals and compounds (≥20 wt %), solutions (≥25 g/l).	A	≥5 kg	≥1 kg <5 kg	≥RQ <1 kg
Low-Grade Materials Metals and compounds (≥1 wt % and <20 wt %); solutions (≥1 g/l and <25 g/l).	B	N/A	≥25 kg?	≥RQ <25 kg?
All Other Materials Uranium (<10% U-235); highly irradiated material (≥1000 R/h @ 1 m); metals and compounds (<1 wt %); solutions (<1 g/l).	C	N/A	N/A	≥RQ

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Revised Table

	Plutonium and Uranium-233			
Nuclear Material	Attractiveness Level	Cat I	Cat II	Cat III
High-Grade Materials Metals and compounds (≥20 wt %); solutions (≥25 g/l)	A	**≥2 kg**	**≥0.4 kg** **<2 kg**	≥RQ <0.4 kg
Low-Grade Materials Metals and compounds (≥1 wt % and <20 wt %); solutions (≥1 g/l and <25 g/l); Pu (≥80 % Pu-238)	B	N/A	**≥10 kg?**	**≥RQ** **<10 kg?**
All Other Materials Uranium (<6% U-233); highly irradiated material (≥1000 R/h @ 1 m); metals and compounds (<1 wt %); solutions (<1 g/l)	C	N/A	N/A	≥RQ

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Continuing Feedback

- Concern about changes from higher to lower categories (Perceived as significant reduction in security).
- Concern about large quantities of HEU or Pu in dilute materials.

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Need to Retain Current Categorization

- Concern about changes from higher to lower categories (Perceived as significant reduction in security).
- Concern about large quantities of HEU or Pu in dilute materials.
- Need to demonstrate "High Assurance of Adequate Protection."
- Potential consequence linked to the Category.
- Protection Strategies must be informed by the risk.

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Current Approach

- Maintain existing categories (allows emphasis on potential consequences).
- Allow for alternative security measures for levels of dilution (dilution identified in INFCIRC/225 and serves as a proxy for processing difficulty).
  - Moderate -- <20 weight percent and >= 1 weight percent.
  - Very -- < 1 weight percent.

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Protection Strategies – non-dilute

- Cat I.
  - Containment.
- Cat II.
  - Immediate Detection with Pursuit and Recovery.
- Cat III.
  - Detection and Recovery.

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Protection Strategies – moderately dilute

- Cat I
  - Immediate Detection with Pursuit and Recovery.
- Cat II.
  - Prompt Detection and Response.
- Cat III.
  - Detection and Recovery.

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Protection Strategies – very dilute

- Cat I, II, III.
  - Detection and Recovery.

Conclusions

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- Approach “right sizes” security requirements.
- Provides incentives for dilution, which makes material less attractive and adds difficulty to the adversary’s acquisition of material and delay to an adversary’s ability to use material, providing more defense in depth.
- Maintains high assurance of adequate protection.