Module 3
Target Analysis

Learning Objective

- Understand target identification, including roll-up and protracted theft
- Evaluate target identification in the SNRI
- Recognize the target characteristics and consequence levels
- Understand graded safeguards

Targets of Interest

- Identify targets to be evaluated:
  - Nuclear materials
    - — Theft Targets
      - – Discrete items
      - – Bulk materials
    - — Strategies
      - – Abrupt Theft
      - – Roll-up
      - – Protracted Theft
  - Sabotage Targets
    - — Radiological
    - — Facilities and Equipment

Roll-Up

- What is Roll-Up?
  - *The accumulation of smaller quantities of special nuclear material to a higher category*
- Why is Roll-up calculated and Categorized
  - *lesser materials are usually treated differently than goal quantities and generally there is greater access*
- Why is it a concern?
  - *MPC&A Measures may be less restrictive for smaller quantities*
    - Physical protection
    - Surveillance measures
    - Access controls
    - Inventories (less frequent, <100% sampled)
- Is it always an issue?
  - Credibility of roll up depends on material type, form and likelihood that the Insiders could accumulate a goal quantity before detection

Is Roll-Up Credible?

- Materials outside of process areas
  - Is the total amount of SNM greater than a goal quantity?
  - Can the Insiders gain access to enough areas to accumulate a goal quantity at a point in time (e.g. between inventory periods)?
  - Can the Insiders credibly accumulate a goal quantity before detection (or with a lower probability of detection)?
- Materials within process areas
  - Are less attractive materials treated differently?
  - Can Insiders accumulate a goal quantity before detection (or with a lower probability of detection)?
  - Can Insiders divert, hide and accumulate the material undetected?

Protracted Theft or Diversion

- Protracted theft from Process Area (repeated attempts)
  - Small quantities – easier to remove undetected
  - Requires multiple theft attempts
  - Longer time line than an abrupt theft
  - Chances of being detected increase as the number of attempts needed increases
- Protracted diversion to unauthorized location - abrupt theft from site
  - Small quantities – easier to divert undetected
  - Requires multiple diversion attempts
  - Longer time line than an abrupt theft
  - Chances of being detected during accumulation process increases with each diversion attempt
  - Still requires undetected removal from process area

Substitution Theft Strategies

- Theft or Diversion may involve the substitution of material to reduce the probability of being detected
- Credible Substitution Materials
  - Material that can be successfully used in place of accountable special nuclear material. This substitution is possible because of one or more physical properties shared by the substitution material and the special nuclear material.

Target Characteristics

- For each target specify:
- Chemical form of material
- Element/Isotope (Pu,U-233, U-235, Np-237, Am-241, Am-243)
- Quantities (mass)
- Irradiation Level
- Location
- Residence time (duration)
- Frequency of use or access

Categorization of Nuclear Material – DOE Order 474.2 June 27, 2011

Table C. Graded Safeguards Table

	Attractiveness Level	Pu/U-233 Category (kg)				Contained U-235/Separated Np-237/Separated Am-241 and Am-243 Category (kg)				All E Materials Category IV
		I	II	III	IV[1]	I	II	III	IV[1]	
WEAPONS Assembled weapons and test devices	A	All	N/A	N/A	N/A	All	N/A	N/A	N/A	N/A
PURE PRODUCTS Pits, major components, button ingots, recastable metal, directly convertible materials	B	≥2	≥0.4<2	≥0.2<0.4	<0.2	≥5	≥1<5	≥0.4<1	<0.4	N/A
HIGH-GRADE MATERIALS Carbides, oxides, nitrates, solutions (≥25g/L) etc.; fuel elements and assemblies; alloys and mixtures; UF_4 or UF_6 (≥50% enriched)	C	≥6	≥2<6	≥0.4<2	<0.4	≥20	≥6<20	≥2<6	<2	N/A
LOW-GRADE MATERIALS Solutions (1 to 25 g/L), process residues requiring extensive reprocessing; Pu-238 (except waste); UF_4 or UF_6 (≥ 20% < 50% enriched)	D	N/A	≥16	≥3<16	<3	N/A	≥50	≥8<50	<8	N/A
ALL OTHER MATERIALS Highly irradiated[3] forms, solutions (<1g/L), compounds; uranium containing <20% U-235 or <10% U-233[2](any form, any quantity)	E	N/A	N/A	N/A	Reportable Quantities	N/A	N/A	N/A	Reportable Quantities	Reportable Quantities

[1]The lower limit for Category IV is equal to reportable quantities in this Order.

[2]The total quantity of U-233 = (Contained U-233 - Contained U-235). The category is determined by using the Pu/U-233 side of this table.

[3]In this Order "highly irradiated is defined in Attachment 4(Definitions).

Example Consequence Table Based on Material Form and Categories

Form	Category I	Category II	Category III
Weapons	1.0	N/A	N/A
Pure products	0.5	0.25	0.1
High grade	0.25	0.1	0.05
Low grade	0.1	0.05	0.02
Other	0.05	0.02	0.01

Example: Consequence of theft of a 2 kg HEU metal button (Pure Product, Category II) is 0.25.

Actual table would be determined by government policy.

Graded Safeguards to Targets on Site

- Provide the greatest protection to material where loss has the highest potential consequence
- In this context, potential consequence of loss is generally based on quantity of material and the ease with which the material can be used in making a nuclear device

Graded Safeguards Concept Allocates More Security Resources to Higher Value Targets

More attractive

Most Protection

Less attractive

Least Protection

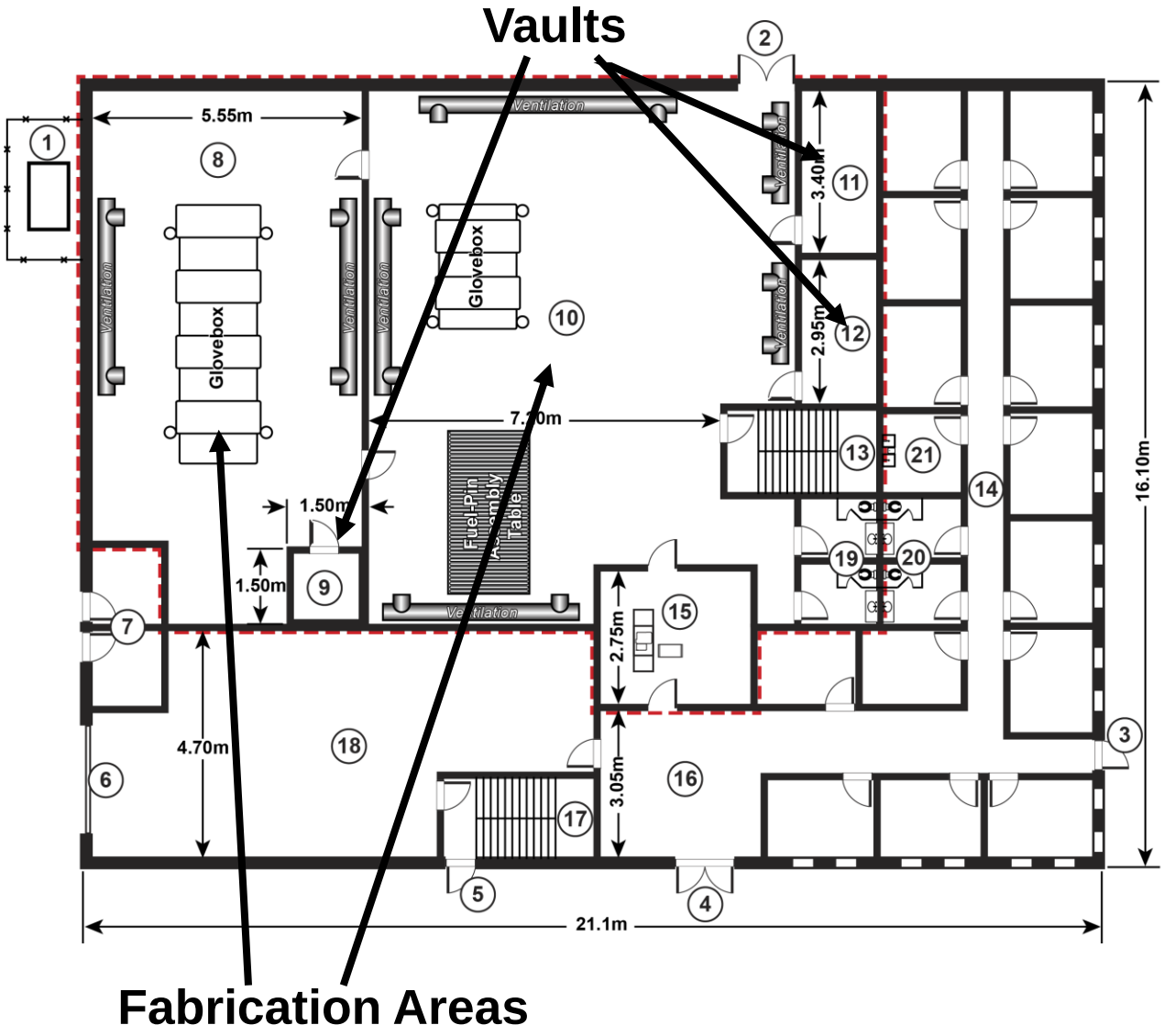
Smallest quantities ⟷ Largest quantities

Level of protection is consistent with consequence of loss.

Material on Site at the SNRI – All Buildings

Facility/ Material Balance Area	Location	Material Form	Material Amount (wt% enrichment)	Total Isotope Amounts	Radiation Levels
Research Reactor	Reactor	UO_2 HEU Fuel Assemblies (240 in reactor)	686.4 kg U (36%)	247.2 kg ^{235}U	High >1 Sv/h at 1m
	R.090 Fresh Fuel Vault	UO_2 HEU Fresh Fuel Pins (80 assemblies in storage)	228.9 kg U (36%)	82.4 kg ^{235}U	Low
	Irradiated Fuel Pool	UO_2 HEU irradiated fuel Pins (100 in pool)	28.6 kg U (36%)	10.3 kg ^{235}U	High 0.2–0.3 Sv/h at 1m
	R.091 Product Vault	HEU metal	23 kg U (95%)	22 kg ^{235}U	Low
Waste Storage Site	Tanks	Liquid Mixture (2 tanks, 1,000 liters ea)	Trace Amounts of U (3%)	trace	High 0.5–1 Sv/h at 1m
	Small Buildings	Solidified Waste (50 containers)	Trace Amounts of U (4-10%)	trace	High <0.5 Sv/h at 1m
X-ray Facility		Fresh Fuel Pins HEU metal	8.6 kg U (36%) 5.2 kg U (95%)	3.1 kg ^{235}U 5 kg ^{235}U	Low Low
Waste Measurement Facility		Waste Drums	1 kg U	trace	Low
Oxide Storage Bunker		UO_2 HEU	250 kg U (36%)	90 kg ^{235}U	Low
Fuel Fabrication Building	Oxide Vault Pin Vault Pellet Vault	UO_2 UO_2 UO_2	94.5 kg U (36%) 69.5 kg U (36%) 69.5 kg U (36%)	34 kg ^{235}U 25 kg ^{235}U 25 kg ^{235}U	Low
Analytical Laboratory		Samples all forms	1.1 kg U (36%)	400 g ^{235}U	Low
Shipping and Receiving Facility		Oxides and hot waste	See Section 2.10		Low

Fuel Fabrication Building: Target Identification and Location



1. Site Power Substation
2. Fuel Fabrication Transfer Dock
3. Administration Area Exit
4. Main Facility Entrance
5. East Stairwell Exit
6. Non-SNM Bay Door
7. Chemical/gas Storage Access
8. Pelletization and Sintering Area (Vital Area)
9. Oxide Vault (Vital Area)
10. Fuel Pin Assembly Area (Vital Area)
11. Pin Vault (Vital Area)
12. Pellet Vault (Vital Area)
13. Central Stairwell (Mezzanine and Basement Access) (Vital Area)
14. Administration Area
15. SNM Fabrication Area ACP (Vital Area)
16. Entry Foyer
17. East Stairwell (Basement Access Only)
18. Non-SNM Area
19. Fabrication Area Restrooms (Vital Area)
20. Admin Area Restrooms
21. Utility Room

Areas and Operations in the SNRI Fuel Fabrication Building

- Pellet Sintering Area – Glove box where UO_2 powder is pressed into pellets and the pellets sintered.
- Oxide Storage Vault - stores UO_2 powder
- Fuel Pin Assembly Area– Glove box where pellets are assembled into fuel pins
- Pin Vault – Stores finished fuel pins
- Pellet Vault – Stores pellets prior to assembly into fuel pins
- Administration Area (AA) – general offices

Summary

- Target identification must begin with definition of the risks or consequences of what is to be protected against.
- Target identification based on both physical form and quantity.
- The output of the target identification process is referential information (target characteristics and location) tied to consequence levels (target importance).
- Importance of graded safeguards in protecting targets.

Questions From Audience