# 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**<br>Assembled weapons and test devices | A | All | N/A | N/A | N/A | All | N/A | N/A | N/A | N/A |
| **PURE PRODUCTS**<br>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**<br>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**<br>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**<br>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

Less attractive

Most Protection

Least Protection

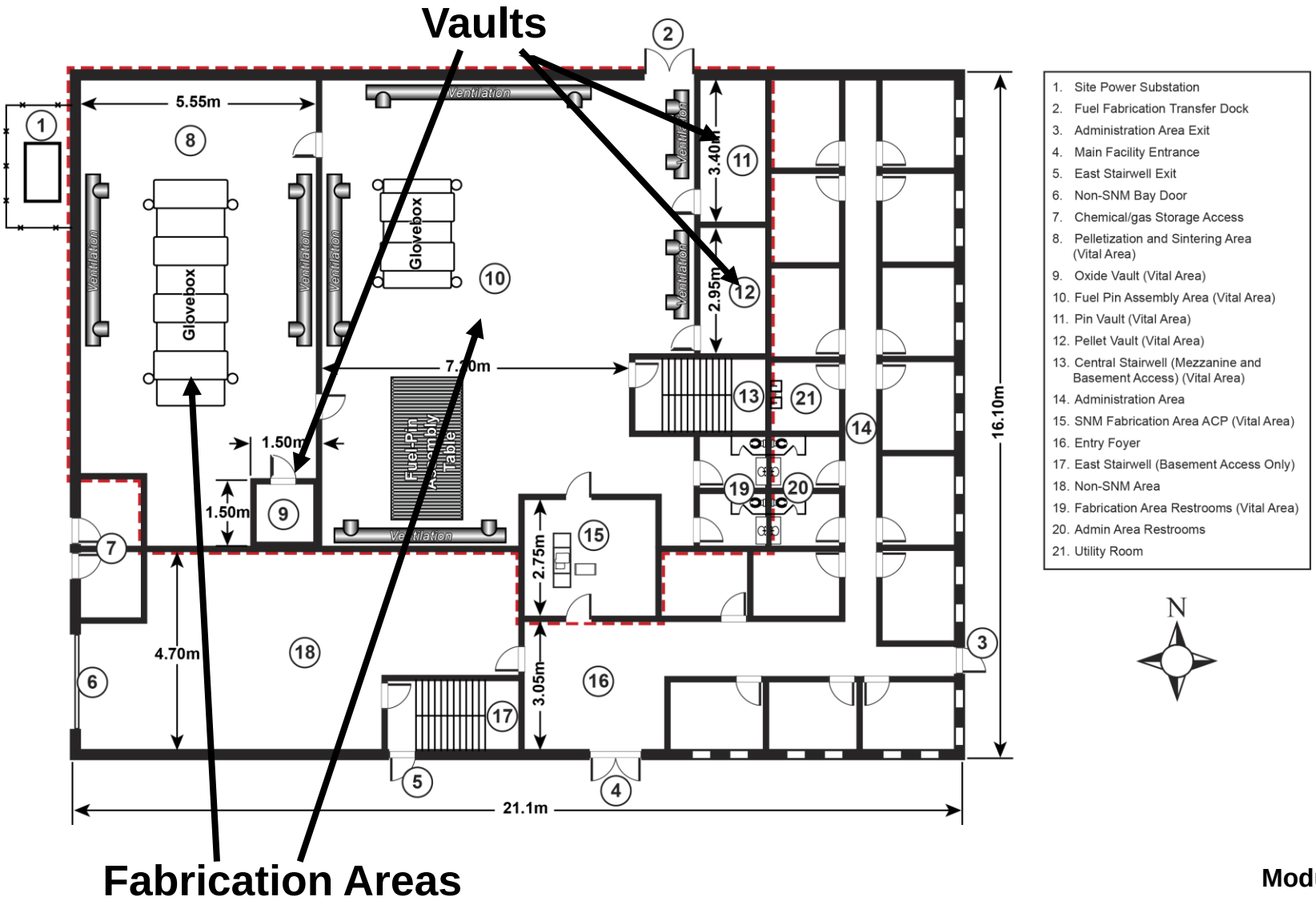
Smallest quantities ⟷ Largest quantities

**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 |
| | R090 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 |
| | R091 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<br>HEU metal | 8.6 kg U (36%)<br>5.2 kg U (95%) | 3.1 kg $^{235}U$<br>5 kg $^{235}U$ | Low<br>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<br>Pin Vault<br>Pellet Vault | $UO_2$<br>$UO_2$<br>$UO_2$ | 94.5 kg U (36%)<br>69.5 kg U (36%)<br>69.5 kg U (36%) | 34 kg $^{235}U$<br>25 kg $^{235}U$<br>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



# 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