Characterization of the Radioactive Material Inventory in the Building 9204-3 Actinide Facility

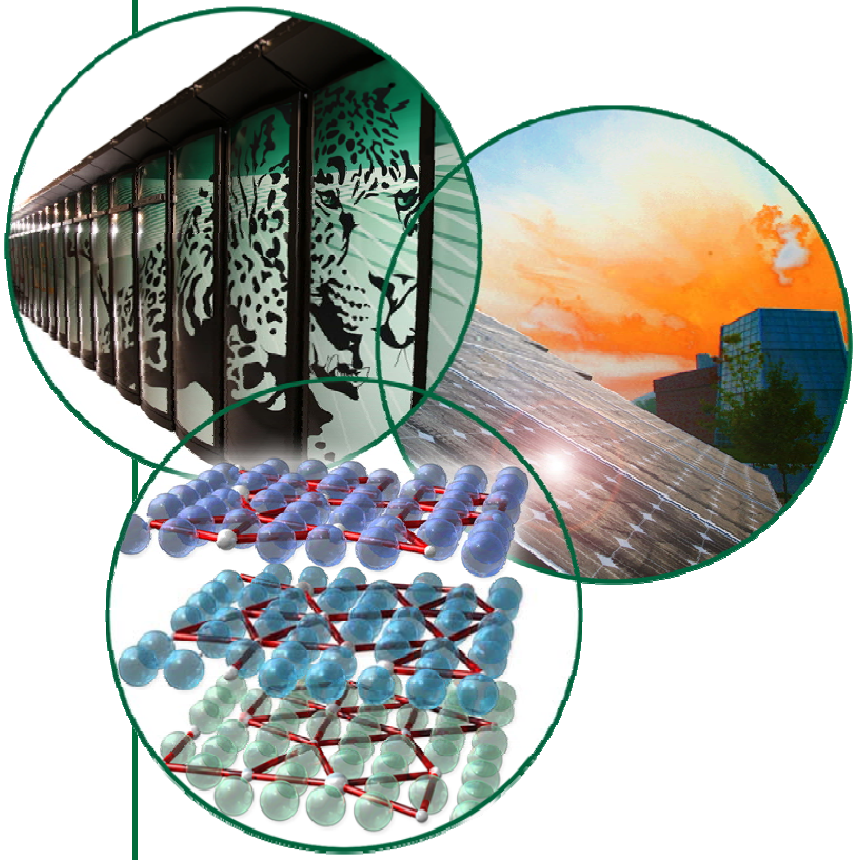
Bill Walker

UT-Battelle / Oak Ridge National Laboratory

DATE: *May 8th, 2012*

A Presentation to the

EFCOG Safety Analysis Working Group



Brief History of Building 9204-3

- Located at Y-12, managed by ORNL

- 1 of 9 Facilities from Manhattan Project dedicated to the enrichment of ^{235}U
  - Beta Calutron Facility → a.k.a. Beta-3!

- After WWII, Beta-3 calutrons were assigned new missions:
  - Stable Isotope Enrichment Program [1950s – 1990s]
  - Actinide Facility (AF) [1960s – 1970s]
    - AF located within a portion of Beta-3.
    - Specialized in isotope enrichments of thorium, uranium, and transuranium elemental series.
    - Also conducted isotopic separation of non-Actinide elements
      - Be, Ca, Pb, Pm, Sm

Identifying Radiological Inventory Issues

- Initial inventory estimates limited to legacy feedstock materials, sealed sources.
  - Info lacking on inventory assoc. w/ contamination & probable holdup.

- In 2008, a Characterization Planning Team was formed to address the inventory issue @ B3.
  - ORNL Representatives & BJC Representatives (now UCOR).
  - Reviewed historical info (log books, procedures, drawings, old SB docs., calutron operation data logs), interviewed former B3 workers, reviewed existing RCT survey data sheets.

Characterization Planning Report

- Provided recommendations for 4 issues specific to inventory characterization:
  1. Defined the Actinide Facility Footprint.
     - Processes, Equipment, Labs, Storage Areas, etc.
  2. Identified & Prioritized items / areas that require characterization to ascertain radioactive material content.
     - *High priority:* Items that were directly in contact with transuranium separation activities & items with significant dose rates.
  3. Identified appropriate characterization methods to be used.
     - (i) Intrusive Sampling, (ii) In-situ Gamma Spectrometry, (iii) RCT Survey Data Sheets, and (iv) Historical Data
  4. Scoped the significant projects tasks, materials, procedures, and personnel necessary to conduct a characterization sampling effort.
     - Glove Box maintenance issues
     - Waste & Disposal issues
     - Identification of expected support personnel
     - Characterization project Man-hour estimates

Executing the Characterization Plan

- Addressed the highest priority items first (deemed to have significant potential for inventory) – ca. 2009.
  - Included processes, equipment & areas that had direct involvement with the processing of transuranium actinides.
  - Characterization techniques included:
    - *Intrusive sampling of various vacuum systems*
      - Historical data (log books) indicated past practice to change out vacuum system oil when heavy metal content too high.
      - Scavenging of volatilized materials indicated a high potential for holdup in the vacuum systems.
      - Also, significant dose rates observed on several vacuum system components.
      - Sampling Result: Inventory in the vacuum system oil *well below bounding estimates.*
    - *In-situ gamma spectrometer assessments of all other Phase 1 items & areas.*

- Lower Priority Items assessed last - ca. 2010 /2011

Building a Bounding Plutonium Profile

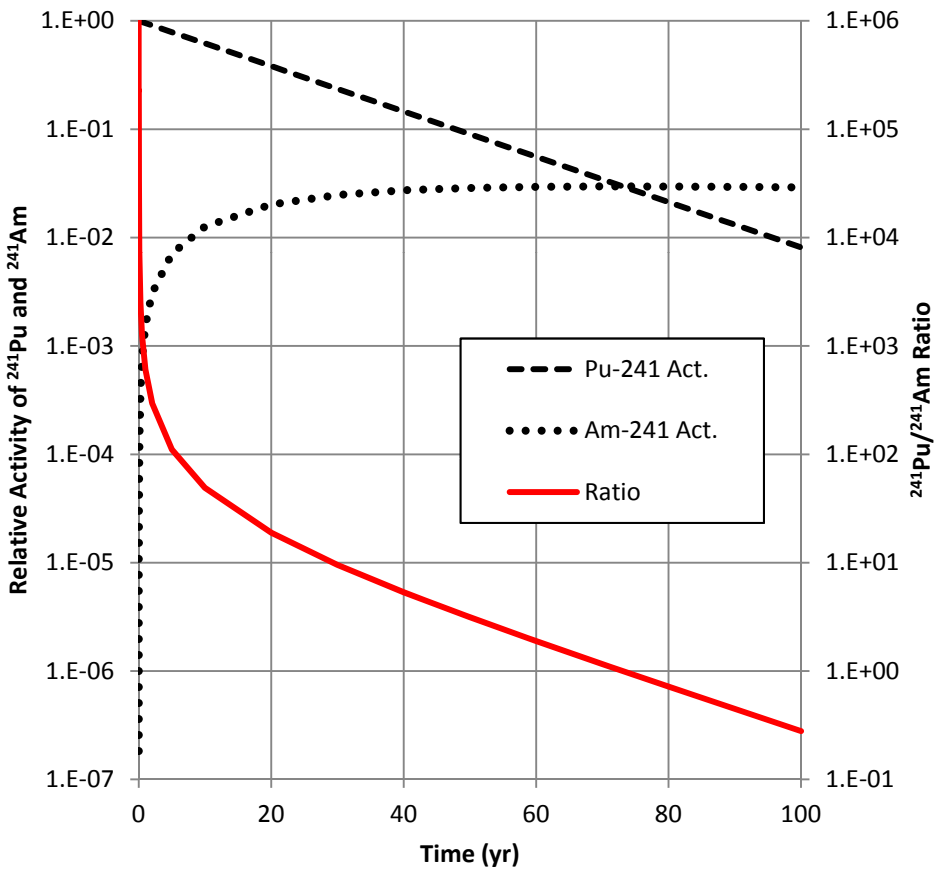
- In-situ Gamma Spec (ISGS) great for detecting significant γ emitters. Not effective at detecting weak β–γ emitters and pure α emitters.

- Needed to construct a bounding Pu (α-emitters) profile that would complement the ISGS assessments.
  - Used isotopic data from vacuum system oil lab analysis for baseline Pu profile.
  - Developed a composite Pu profile based calutron operation / logbook data on recovered recycle material.
    - Composite Case 1: Composite Pu profile based on 30-yr of decay.
    - Composite Case 2: Composite Pu profile based on no decay.
  - Bounding profile determined to be composite Pu profile based on 30-yr of decay.
    - Bounding Pu profile based on greatest impact to facility hazard categorization assessment.
    - Bounded all other cases, including intrusive sampling of vacuum system oil.

Applying the Bounding Pu Profile & Decay Chain Analysis for Others

- ^{241}Am = key indicator of the presence of plutonium.
  - ^{241}Pu → ^{241}Am
  - ^{241}Pu/^{241}Am ratio = 9.54
    - (based on 30 years of in-growth)
  - Balance of Pu isotopes could then be assigned to the item / area inventory once the ^{241}Pu content was defined.

- Some detected gamma emitters not associated with plutonium decay. Examples:
  - ^{214}Bi, ^{214}Pb
    - (in-growth attributed to ^{230}Th decay)
  - ^{212}Bi, ^{208}Tl
    - (in-growth attributed to ^{232}U decay)
  - ^{228}Ac, ^{212}Bi, ^{208}Tl
    - (in-growth attributed to ^{232}Th decay)



Supplemental Inventory Modeling Using Microshield Software App

- Several items too complex to derive inventory estimate with ISGS rudimentary geometry models.
  - Geometry issues
  - Attenuation issues
  - Elevated background dose rate issues

- Used μShield to refine inventory estimate.
  - ^{241}Am primary γ emitter.
  - μShied model rebase lined ^{241}Am content.
  - All other isotopes as detected by ISGS were then normalized based on the updated ^{241}Am content.

Characterization Effort Complete!

- Final characterization assessments completed in 2011.
  - Low Priority Items: Supplemented ISGS with RCT survey data sheets for large areas / obstructed equipment.

- Initiated Safety Basis – (ca. 2011 - 2012) Hazard Categorization update.
  - When contamination & holdup added to inventory, the Initial Haz Cat exceeded HC-3 threshold!
  - Conducted hazard assessment / dispersibility analysis per NSTP-2002-2. Final Haz Cat assessment was documented to be below HC-3.
    - Bounding event: Seismic Event w/ subsequent Fire
  - Updated Safety Basis submitted for approval in April 2012.

Benefits of Characterization Effort

- Inventory now includes contributions due to contamination & holdup.

- Updated Safety Basis documentation.

- Risks were identified and mitigated during the Characterization Project:
  - Glove boxes
    - Old, deteriorated gloves / bag-outs changed with new gloves / bag-outs.
    - Ventilation system instrumentation upgrades (GB pressure gauges).
    - Ventilation Filter upgrades (GB inlet & outlet filters).
    - Clean out of glove boxes & disposal of chemicals / contaminated items.
  - Disposal of equipment/items with significant inventory (where possible).