U.S. DEPARTMENT OF ENERGY

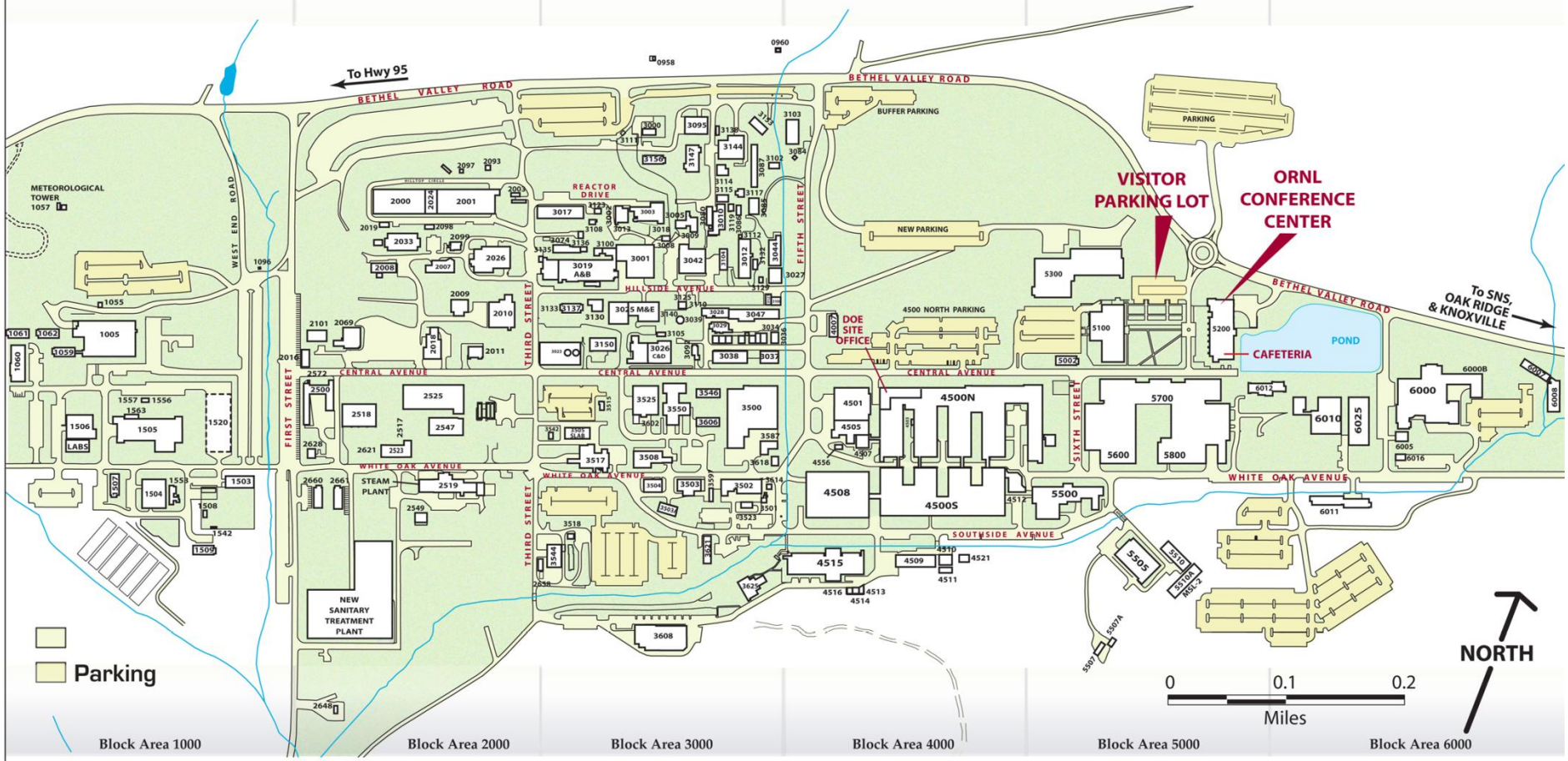
U-233 Disposition Project Update

Presented to
Oak Ridge Site-Specific Advisory Board

by
John W. Krueger, Federal Project Director

March 9, 2011

Oak Ridge National Laboratory Main Campus



1005 Laboratory for Comparative and Functional Genomics
1503 Emergency Operations Center
1505 Environmental Sciences
1520 Joint Institute for Biological Sciences (under construction)
2518 Fire Station
3001 Graphite Reactor
4500N/4500S Chemical and Material Sciences Facility
4508 Metals and Ceramics Facility
4512 Laboratory Shift Superintendent Office
4515 High Temperature Materials Laboratory
5100 National Institute for Computational Sciences/Oak Ridge Center for Advanced Studies
5200 Research Support Center - Visitor Center/Conference Center/Cafeteria
5300 Multipurpose Research Facility (under construction)
5600 Computational Sciences
5700 Research Office Building
5800 Engineering Technology Facility
6000 Holifield Radioactive Ion Beam Facility
6008 Joint Institute for Heavy Ion Research

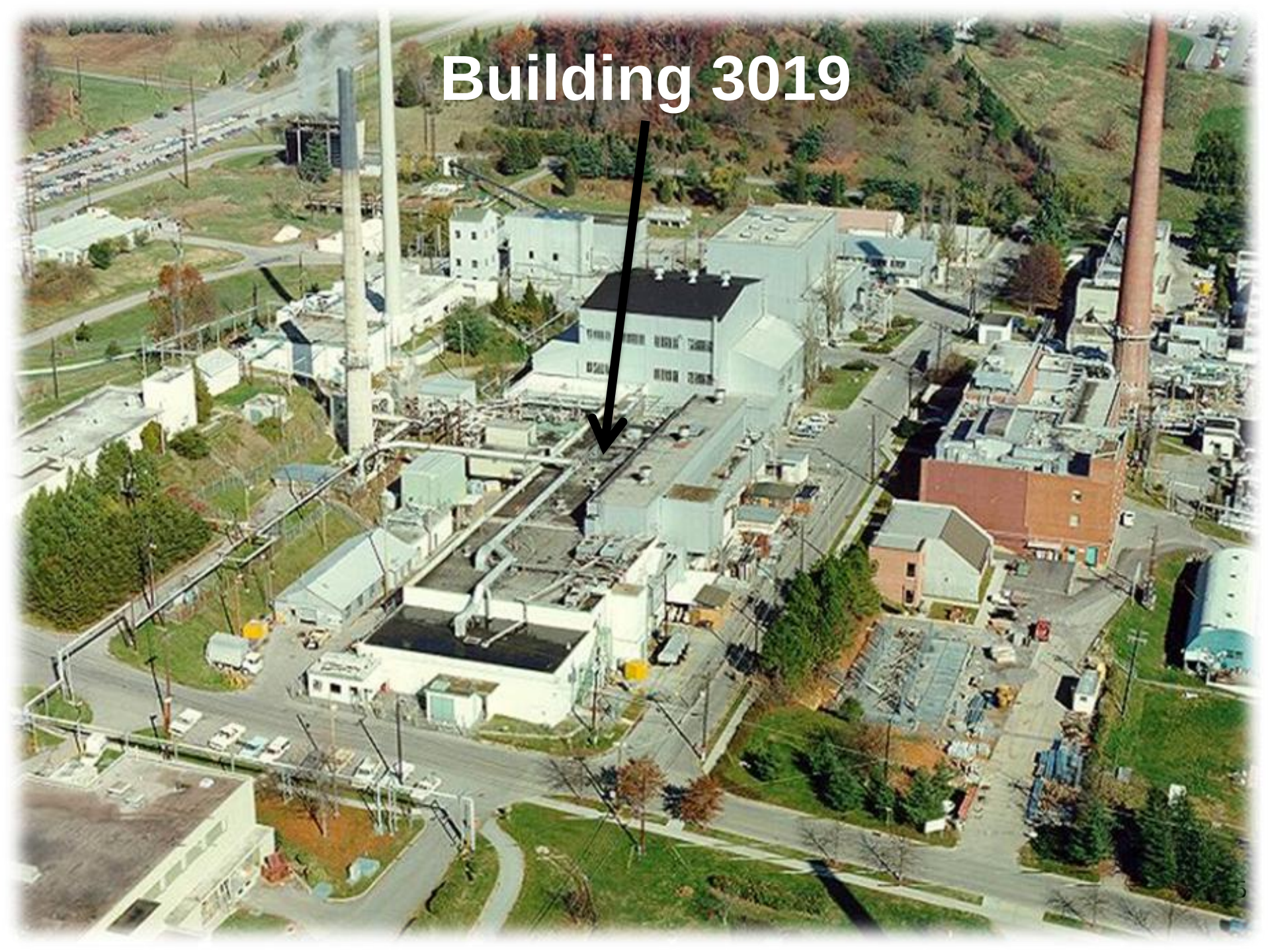
ORNL 2007-G00360A/asg

U-233 Disposition - A Complex Challenge

- U-233 Properties
  - U-233 is man-made in nuclear reactors by irradiating natural thorium (Th-232)
  - U-233 is always contaminated to varying degrees with U-232, which includes two “bad actors” in its decay chain: Tl-208 and Rn-220
    - Tl-208 decay includes a high-energy gamma (2.6 MeV) which causes most of the U-233 inventory to require remote handling
    - Rn-220 (thoron) is an alpha-emitting gas with a short half-life
  - U-233 has nuclear properties similar to weapons-grade plutonium, but the chemistry of uranium
    - High specific alpha activity (inhalation hazard)
    - Weapons-usable fissile nuclear material requiring strict safeguards, tight security, and criticality control

Inventory Complexities

- Building 3019 U-233 Inventory Properties
  - 1,098 canisters stored in 94 tube vaults in heavily shielded hot cells within Building 3019 at Oak Ridge National Laboratory
    - Building 3019 is the oldest operating nuclear facility in the world
  - Heterogeneous inventory can be grouped into six categories:
    - CEUSP monolith
    - MSRE NaF Traps
    - Metals
    - Oxides
    - ZPR Plates
    - Miscellaneous
  - Canister doses range from 1-300 R/hr on contact


Building 3019

Project Scope

- Contract for disposition awarded to Isotek, LLC in 2003
- Scope has evolved to:
  - Design and construction of modifications to Building 3019, a Category 2 Nuclear Facility, Cat 1 Security
  - Dissolution and downblending of the U-233 inventory with depleted uranyl nitrate to reduce the attractiveness level and eliminate the potential for nuclear criticality
  - Design and construction of an annex to Building 3019 for drying and packaging of the final product
  - Conversion of the downblended material to magnesium diuranate and production of a final waste form compliant with the Nevada National Security Site (NNSS) Waste Acceptance Criteria; shipment of waste to NNSS for disposal
  - Placement of Building 3019 in a safe and stable condition in preparation for future decontamination and demolition (D&D)

Project Background

- Design delays and cost growth caused by complicating factors, such as:
  - Transfer of the project from DOE's Office of Nuclear Energy (NE) to the Office of Environmental Management (EM) in 2006
  - Termination of the isotope extraction scope element via the 2006 Energy and Water Development Appropriations Act
  - New information about inventory content, which indicated that the vast majority of the material should be classified as low-level radioactive waste (LLW) rather than transuranic (TRU) waste after processing
    - Affected final waste form and destination
  - Extensive shielding requirements and space limitations required design of a new annex facility to host the back end of the process, rather than utilizing portions of existing Building 3019 as originally planned

Current Project Status

- Design of Building 3019 modifications is >90% complete
  - Will be certified-for-construction (CFC) by the end of this March
- Design of the Annex is 85-90% complete
  - Final review and CFC on hold pending completion of the Alternatives Analysis
- "To Go" cost of the total project may be as high as $400M, depending on the funding profile
  - Includes both capital construction and operations

Alternatives Analysis

- Against a background of increasing national budget deficits and a project history of cost growth and delays, the Deputy Secretary of Energy directed a two-phased "Alternatives Analysis" in the Fall of 2010: Screening and Detailed Analysis

> *"In light of the realized and anticipated cost growth of the current U-233 disposition project, I want to express my full support of another rigorous look at…alternatives, and an evaluation of any new ideas which may emerge…for purposes of determining whether changed circumstances could render a different technical solution more attractive in today's context."*

The Screening Effort (Phase I)

- Examine past alternatives
- Identify relevant changed conditions
- Identify and screen potential alternative disposition pathways
- Final Draft screening report distributed within DOE on Jan. 6, 2011
- DOE executive management endorsed the proposed path forward

Alternatives Screening Core Team

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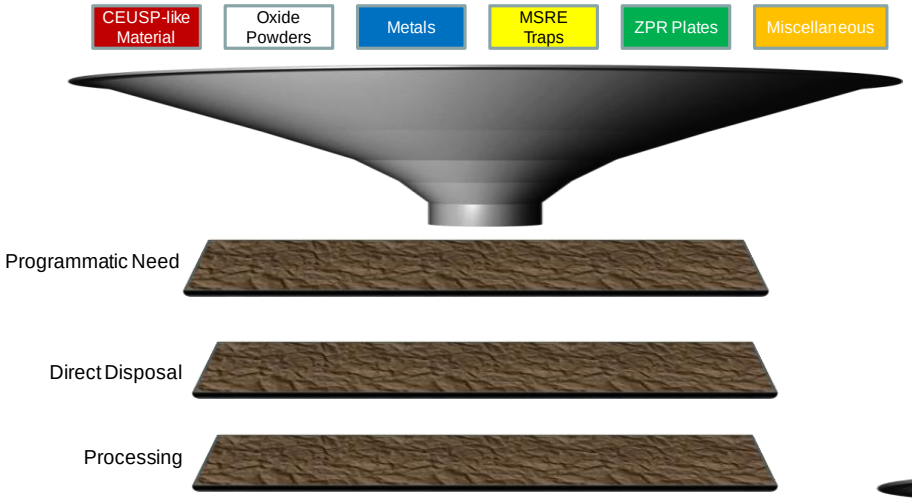
John Krueger, FPD
Johnny Moore, SC-OR
Roger Nelson, WIPP
Brad Patton, ORNL
Tim Powers, ORNL
Doug Toomer, INL

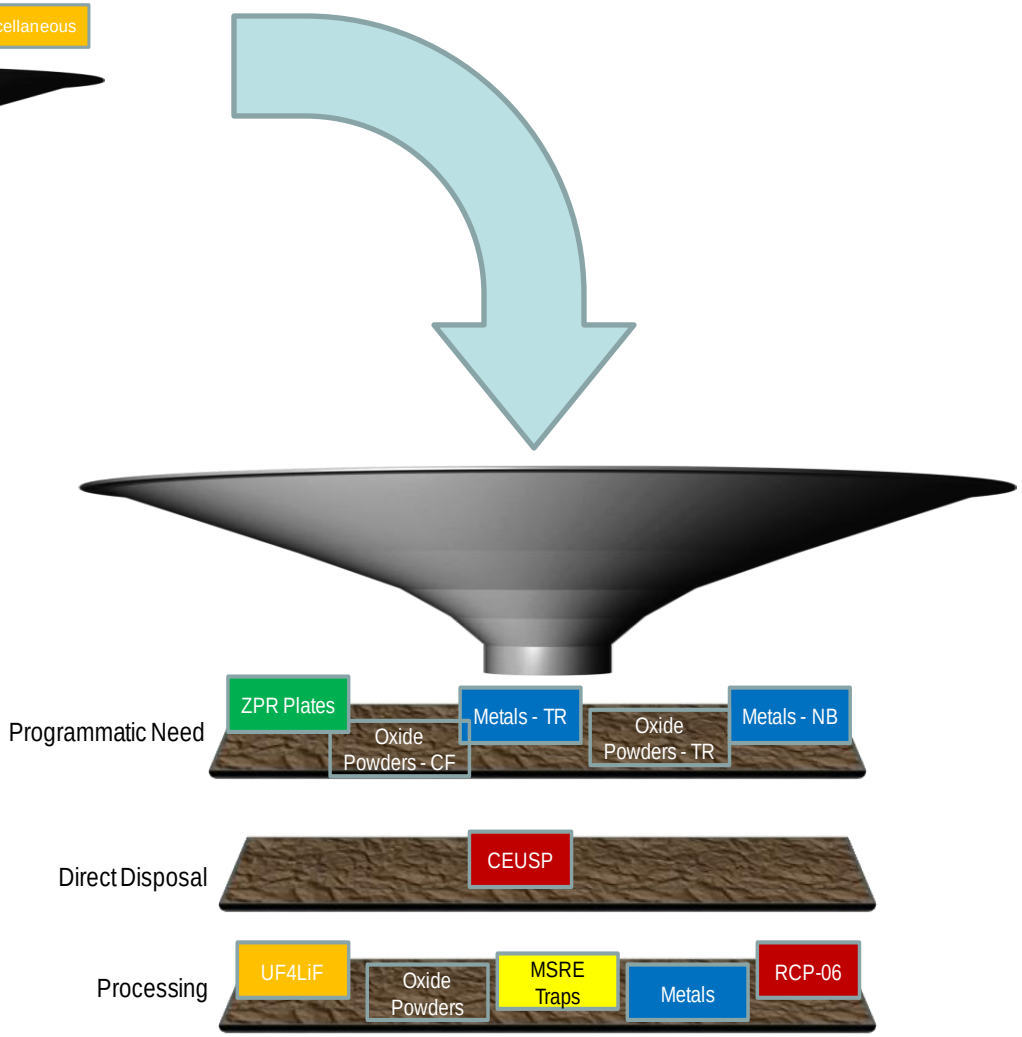
Past Alternatives Analyses

- Changed Conditions
  - Emergence of certain programmatic demands for U-233 subsequent to Decision Memorandum No. 2 (which concluded there were no programmatic demands other than medical isotope production), and the completion of facilities at NNSS capable of accommodating some of these programmatic demands
  - Completion and successful operation of the Transuranic Waste Processing Center (TWPC) in Oak Ridge
  - Successful direct disposal without treatment of a significant quantity of U-233 (LWBR pellets) at NNSS originating from INL
  - Congressional direction to terminate medical isotope extraction from the U-233 inventory in late 2005, recently reinforced by the Office of Science position that a more sustainable form of Ac-225 production, namely accelerator-produced, should be the priority for the Department

Filtering Material Types



TR – Test Readiness Program
CF – Criticality Safety Program
NB – New Brunswick Laboratory



Programmatic Interest

- The National Nuclear Security Administration (NNSA) Criticality Safety Program has reconfirmed a 2006 request for the ZPR plate inventory
  - 128 canisters can potentially be transferred by Type B container to the NNSS Device Assembly Facility (DAF)
  - POC provided for development of a shipper/receiver agreement

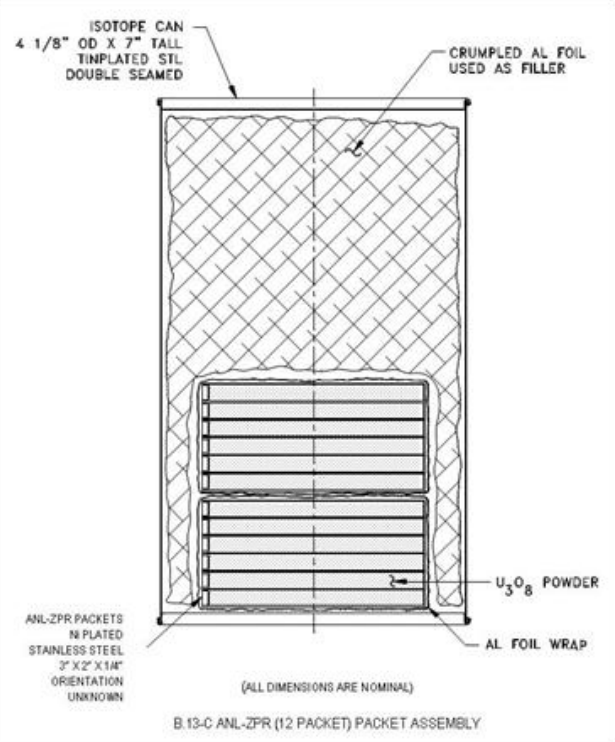


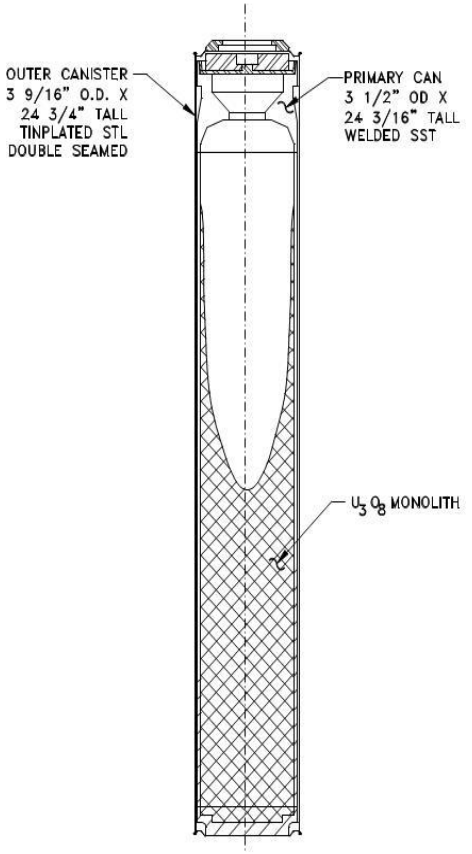
Figure 1: Typical ZPR Plate Package Configuration

Program Interests (cont.)

- A NNSA Test Readiness Program request has been acknowledged by the DAF Steering Group
  - Over 40 additional oxide containers
  - Program support will be confirmed in Phase II of the Alternatives Analysis
- New Brunswick Laboratory has requested approximately 11 canisters (primarily metals) for standards development and calibration needs
  - Very limited ability to store material

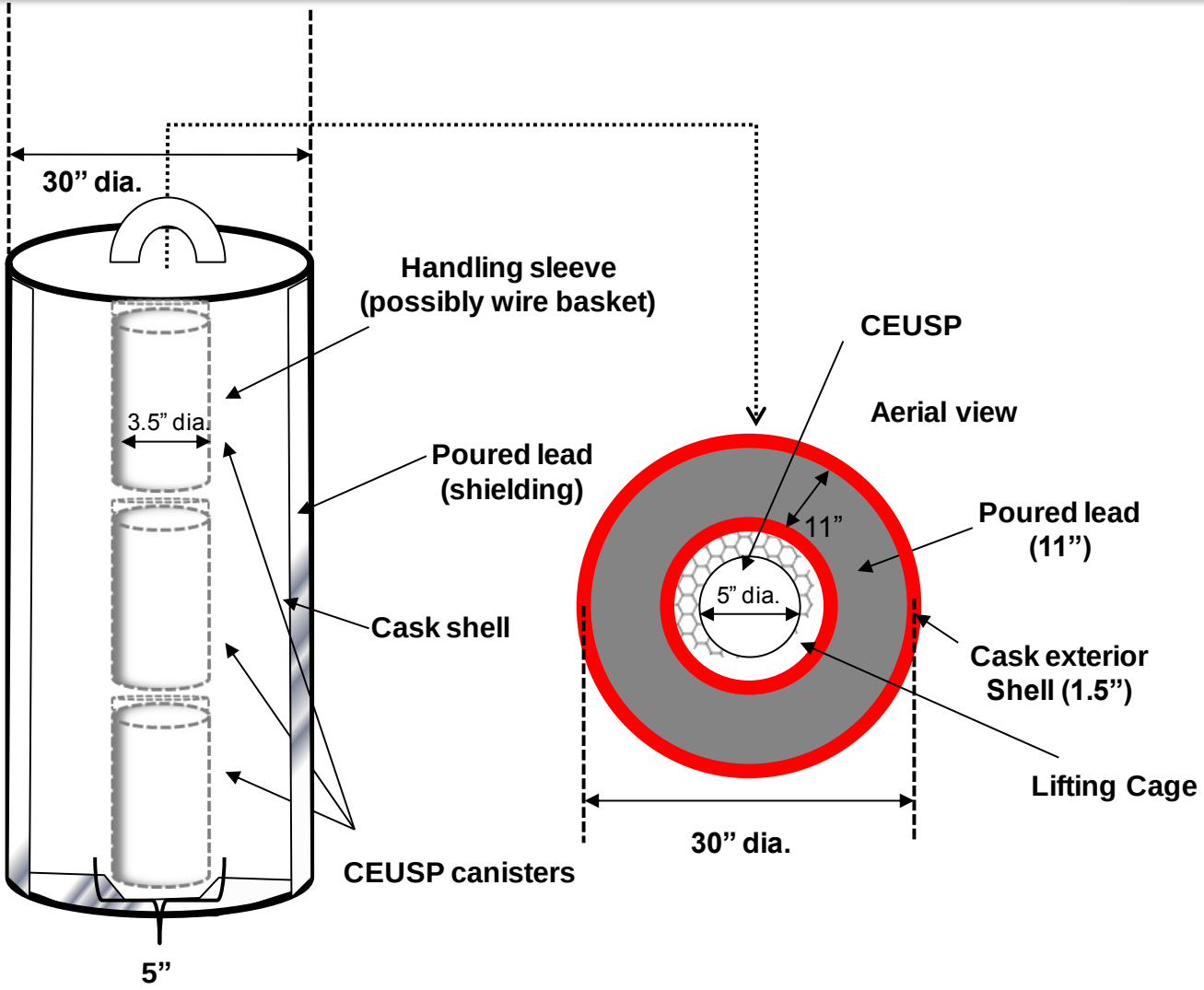
Direct Disposal

- CEUSP material can be direct-disposed without processing
  - 403 canisters
  - Stable U3O8 monolith
  - Meets all NNSS WAC criteria
    - Core team examined all requirements, and produced a compliance matrix
  - Requires development of a new Type B cask (or modification of an existing cask)
  - May be disposed as mixed waste

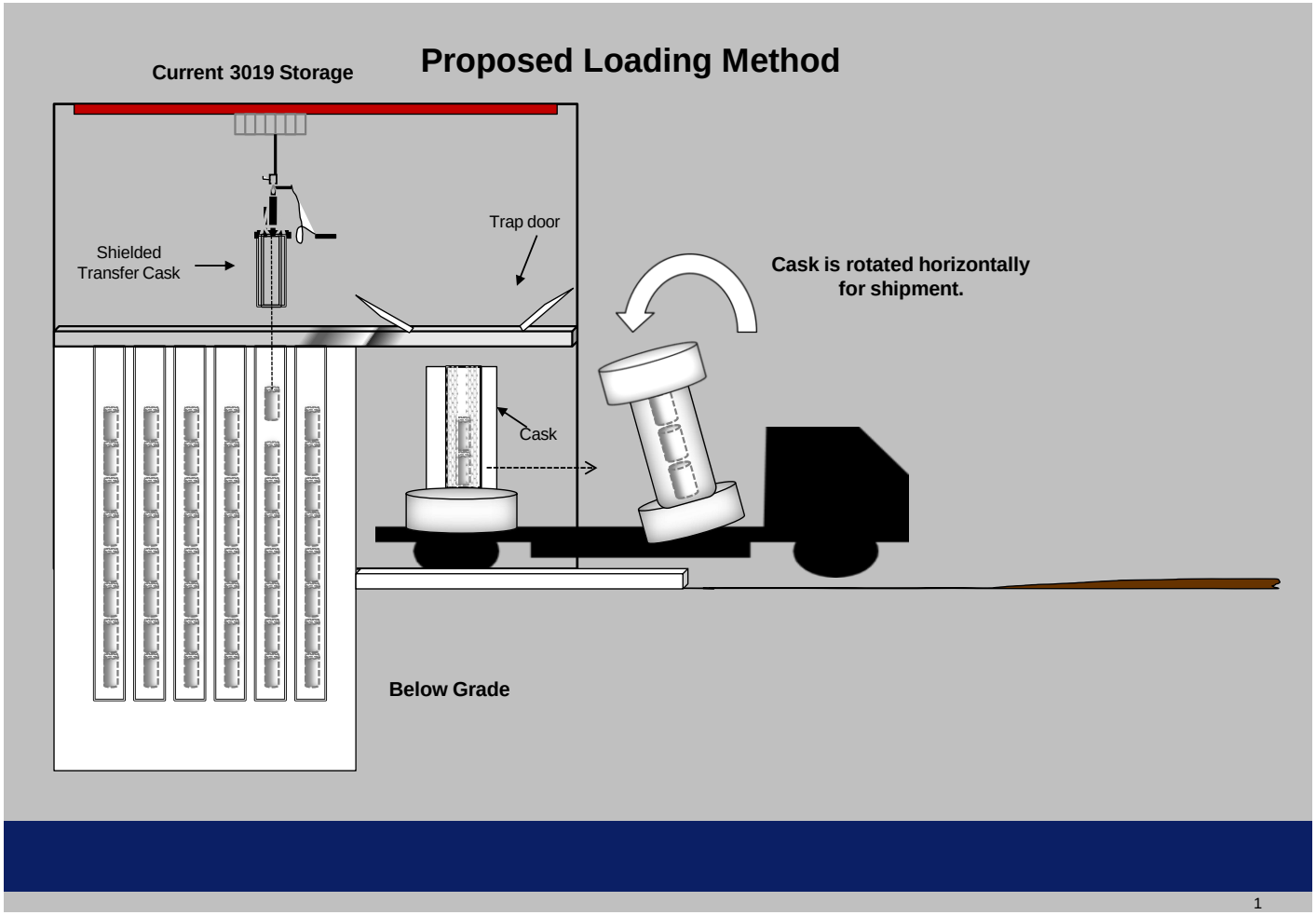


B.8 CEUSP PACKAGE ASSEMBLY

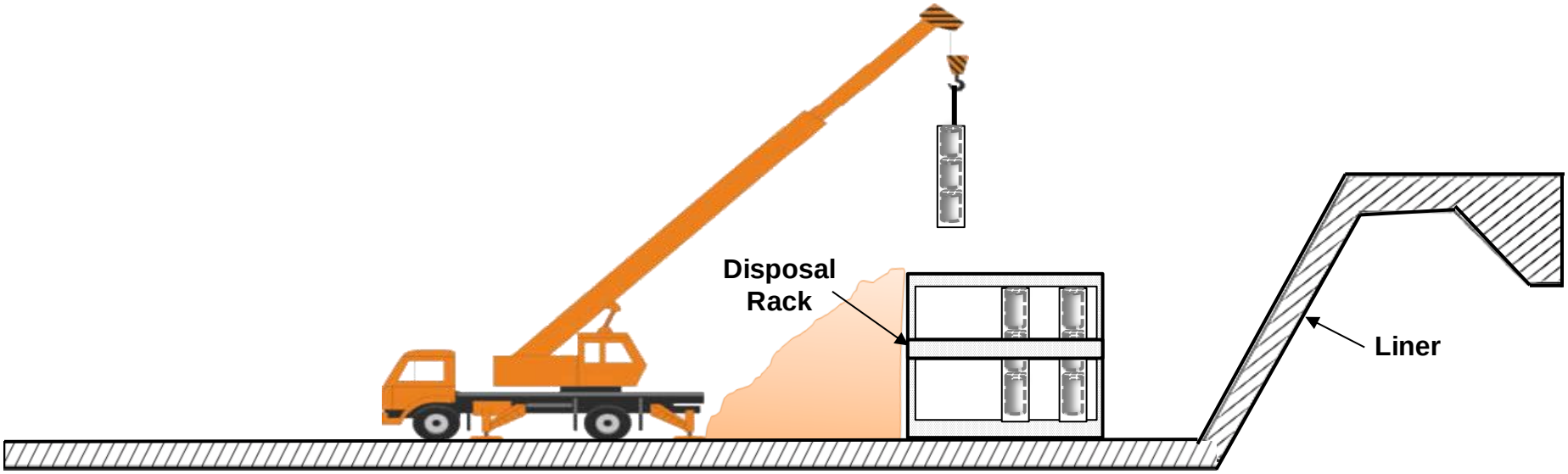
Type B Container Concept



Loading Concept



Disposal Concept



Benefits of Direct Disposition

Direct Disposition = (Program Transfers + Direct Disposal)

- Accelerated disposition (relative to baseline) of 51% of the inventory (canisters), 77% of the total U, and 85% of the troublesome U-232 isotope
- Potential 75% reduction in unit cost for half of the inventory
- Reduction in subsequent processing time and risk, as well as waste shipments
- Helps enable a more efficient processing alternative

Processing

- Off-site alternatives (i.e., Savannah River and Idaho National Laboratory) were screened out
  - On-site repackaging required, and lack of transportation capability
- 17 approaches to processing on-site were screened down to two viable technological alternatives to the baseline approach
  - Dry-blending within existing ORNL hotcells
  - Aqueous downblending followed by co-processing of the downblended solution with Melton Valley Storage Tank Sludges (MVST) sludges at the Oak Ridge TWPC

Dry-Blending Steps

- Blending cans, ideally designed to fit into the new Type B container used for CEUSP transport, would be pre-loaded with grinding balls and a pre-determined blending agent
- U-233 canisters would have to be transported from Building 3019 to the treatment location
- U-233 oxide canisters would have to be cut open and sub-divided into preloaded blending canisters such that the U-233 isotope is sufficiently diluted

Dry-Blending Steps

- Metals canisters have to be oxidized prior to loading into blending cans
- NaF traps and other fluoride bearing canisters have to be vented and oxidized before loading into blending cans
- Blending cans have to be tumbled for a pre-determined amount of time to ensure adequate mixing
- Blended canisters would have to be loaded into a Type B container and shipped for disposal after safeguards have been removed

Aqueous Downblending

- Front end (dissolution and downblending) is identical to baseline approach and can utilize the newly completed design
- Downblended material is discharged into the ORNL LLLW system instead of the Annex, and is pumped to the TWPC tanks
  - Could be transported to TWPC by shielded tanker truck instead
  - Obviates annex construction and challenging drying operations
- Material is blended with MVST sludge and cemented for transport in a Type A container to NNSS

Comparison

- The Core Team currently favors aqueous downblending in Building 3019 and solidification in the TWPC over both the baseline approach and the other alternatives examined in the screening report (but additional work is needed, i.e., Phase II)
  - Eliminates the need for the 3019 Annex and the associated construction and equipment costs
  - Avoids substantial future D&D liabilities
  - Aqueous downblending is a mature, demonstrated technology
  - Greatly reduces the amount of waste requiring shipment

Comparison (cont.)

- No pre-treatment is necessary for any of the U-233 inventory forms
- No high equity material would be brought to any facility other than Building 3019A
  - Security footprint at ORNL would not have to increase
- The MVST sludge contains excess alkalinity that must be neutralized; The acidic content of the downblended uranyl nitrate will reduce the amount of acid that must be purchased by TWPC, creating a synergistic effect
- This option would allow the project to utilize much of the investment already sunk into the baseline design

Path Forward

- Complete the CFC design package for Building 3019 modifications
- Suspend further spending on the Annex design
  - This design element can be resurrected later, if necessary
- Initiate planning for a direct disposition operations:
  - Programmatic transfers and CEUSP material disposal
- Complete Phase II of the Alternatives Analysis and select the preferred processing approach
- Possible timeline
  - Program transfers in 2013
  - CEUSP disposal: 2015 - 2017
  - Processing of remaining inventory: 2015 - 2017