U.S. DEPARTMENT OF ENERGY

U-233 Disposition Program Update

Presented to
Oak Ridge Site Specific Advisory Board

Presented by
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U-233 Disposition Program

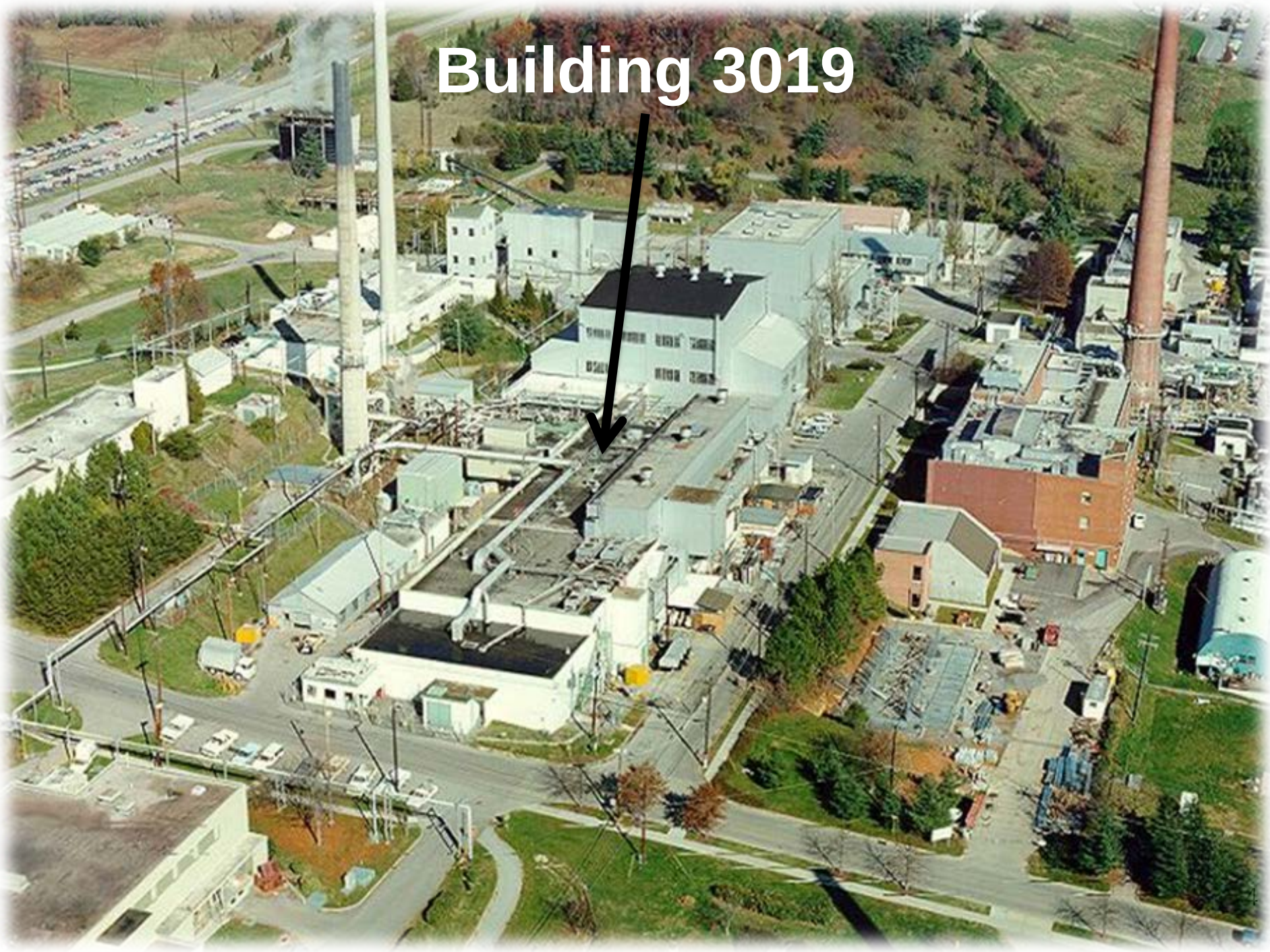
April 11, 2012

About Uranium-233…

- U-233 is created by irradiating Thorium-232
- Used in nuclear energy research on the thorium fuel cycle
  - Th-232 is “stable” and ubiquitous
- Also a fissile material requiring protection from theft or diversion
- U-233 is an alpha emitter
  - Decay chain includes Th-229, used for medical isotope production
- U-232 is always present as a contaminant
  - Tl-208 daughter is a high energy gamma emitter, requires shielding
  - Radon-220 (thoron), a gas at STP, is another challenging daughter
    - Half-life of just 56s, it can still drive certain engineering controls

About Building 3019…

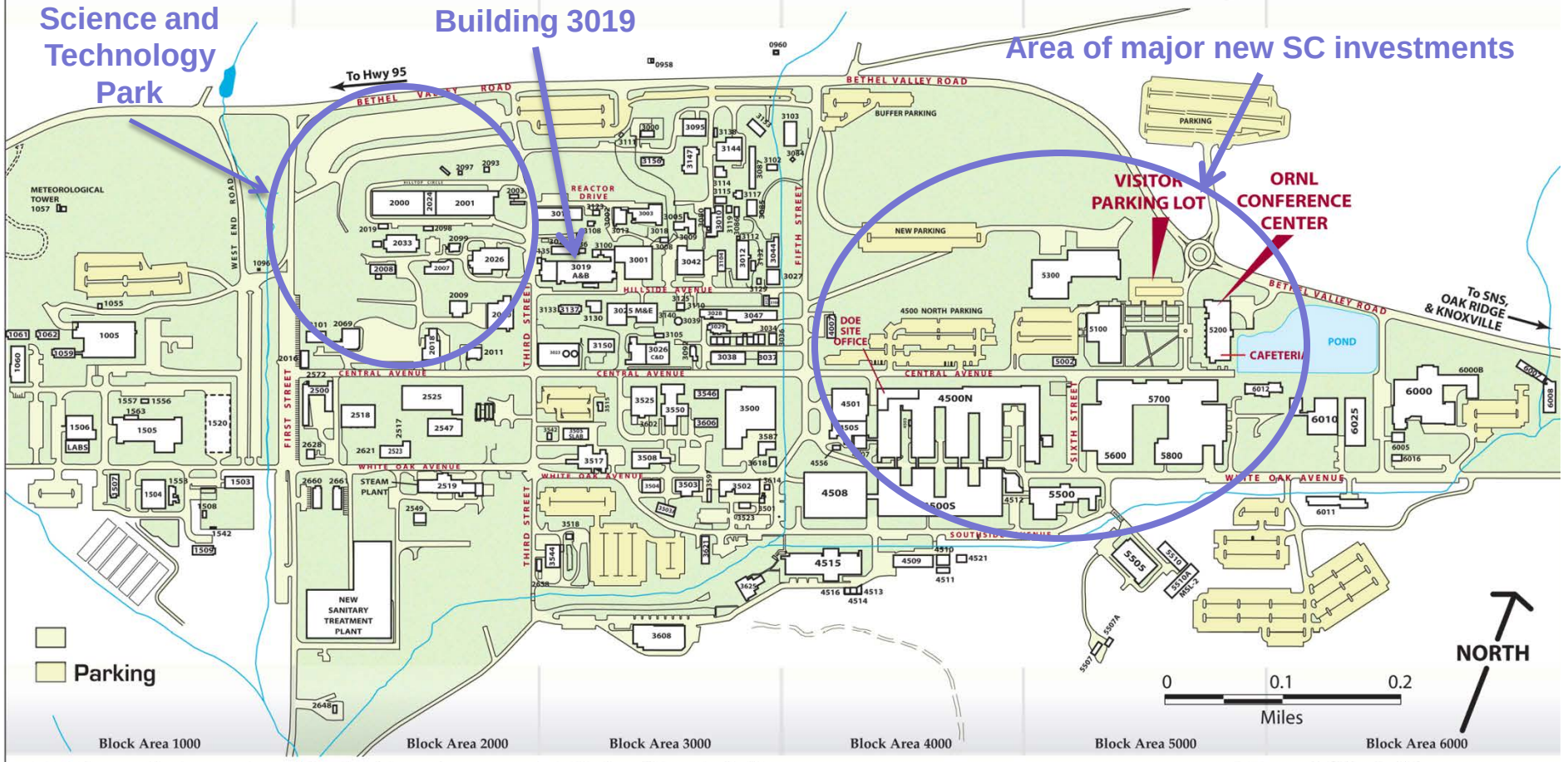
- Constructed in 1943 adjacent to the historic graphite reactor
  - Consists of seven hot cells surrounded by control rooms, laboratory space, and offices
- Utilized as a pilot plant for demonstration of extraction processes
- World's first gram quantities of plutonium isolated in Bldg 3019
- The Atomic Energy Commission consolidated U-233 into Building 3019 and created a "national repository" beginning in 1962
- Building 3019 is now the oldest operating nuclear facility in the world (currently used only for U-233 storage)


Building 3019

Mission Drivers

- **Mission:** Safely and efficiently dispose of the U-233 inventory in Building 3019
- Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 97-1
  - Concern about safety of long-term storage in old nuclear facilities
- Security
  - Non-enduring facility status enables temporary exemption from the most recent graded safeguards policy
- Support to the Office of Science (SC) mission at Oak Ridge National Laboratory (ORNL)
  - Threat removal
  - Re-development of the main Lab area into an open campus

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

Inventory Complexities

- Building 3019 U-233 Inventory Properties
  - 1,098 canisters stored within tube vaults in heavily shielded hot cells inside Building 3019 at Oak Ridge National Laboratory
  - Heterogeneous inventory can be grouped into six categories:
    - Consolidated Edison Uranium Solidification Project (CEUSP) Material
    - Molten Salt Reactor Experiment (MSRE) Traps
    - Oxide Powders
    - Metals
    - Zero Power Reactor (ZPR) Plates
    - Miscellaneous
  - Doses of 1-300 R/hr
    - U-232 contribution

Alternatives Analysis

> *"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."*
>
> *- Deputy Secretary Poneman*

- Phase I Alternatives Analysis report favored a combination of direct disposition and co-processing
  - Transfer components desired by other DOE programs
  - Direct dispose of the CEUSP material
  - Co-process remaining inventory with other ORNL wastes
    - Final processing approach requires a Phase II analysis

Phase I Report Summary

- Direct disposition:
  - Eliminates 52% of canister inventory
    - 77% of total Uranium and 85% of U-232 isotope
  - Removal of a significant fraction of the inventory and the U-**232** via CEUSP disposal enables more efficient processing of the remainder
- Co-process remaining inventory (to be updated in Phase II):
  - Dissolve and downblend in Building 3019
  - Utilize TRU Waste Processing Center (TWPC) for co-processing
    - Truck or pipe downblended liquid from 3019 to TWPC
    - Obviates annex construction
- Alternative is safer and more efficient than the existing baseline:
  - Reduces waste volume, processing time, and transportation
  - Reduces worker exposure and accident probability
  - Allows DOE EM to address other important environmental issues sooner

Implementation Status

- Design for original Building 3019 modifications was completed in March 2011, and Annex design was suspended
  - Contractor skill mix adjusted from design to operational emphasis
- Fixed price for Option 2, Direct Disposition (both ZPR and CEUSP), was executed in December, 2011
- ZPR plate shipments initiated 12/19/11
  - 14 of 26 completed safely to date
- A Type B container to facilitate CEUSP shipments has been identified, and acceptability of the waste form for disposal has been "confirmed" (official profile and review still pending)
- Internal review draft Phase II Alternatives Analysis was completed on April 10, and is under review
  - Final draft will be published prior to presentation to DOE-HQ in May/June

The Phase II Alternatives Analysis

- Preliminary Phase II Conclusions
  - Only 22 additional canisters ("thorium return" cans) are eligible for direct disposal, but risk outweighs potential benefit (no additional direct disposal)
  - Isotek will execute an "Interim Transfer Campaign" between ZPR and CEUSP shipments as Stage 2 of programmatic transfers
    - Involves retrieval of 9 high purity canisters for ORNL sampling and potential use as certified reference material (CRM) by NNSA
  - Stage 3 of programmatic transfers will occur during processing
    - Remaining CRM material will be staged for bulk transfer to ORNL for sampling and eventual shipment to a strategic reserve location
    - Test Readiness material will be staged for shipment to the DAF (upon their approval)

Phase II Processing

- Use Building 3019 only for storage and direct shipments
- Building 2026 will be the only processing facility
  - Requires ownership transfer from SC to EM
  - Requires upgrade from Hazard Category III to Cat II, installation of unit operations, and re-start
- Will still co-process the downblended, liquefied inventory at the TRU Waste Processing Center (TWPC) with Melton Valley Storage Tank (MVST) sludges
  - Downblended liquid will be trucked from 2026 to TWPC
- Project plans will include disposal of any unused depleted uranium

Desired Timeline

- **Tentative**: Requires completion and endorsement of the Phase II analysis, plus baseline development
- Will require $35-$45M in annual funding through FY18

- Complete ZPR plate shipments, June 2012
- Complete Interim Transfer Campaign, Aug 2012
- Complete CEUSP shipments, August 2014
- Building 2026 cleanout and process design, FY12-13
- Building 2026 modifications, FY14
- Processing, FY15-17
- Excess dU disposal and facility stabilization, FY18

Phase II Comparison Table

- Published in the review draft version of the report, these lifecycle numbers are preliminary, and assume $40M level funding:

Cost Category	Original Approach	Phase I Preference	Phase II Approach
Prior Year Costs (<FY12)*	$241.9M	$225.2M	$225.2M
ZPR Plate Transfer Prep (Q1, FY12)	$0M	$8.1M	$8.1M
Direct Disposition Campaign	$0M	$96.5M**	$96.5M**
3019 Modifications	$378.6M	$202.0M	$1.0M
2026 Modifications	$0M	$0M	$9.0M
MVSTA Modifications	$0M	$1.6M	$1.6M
Processing Operations (including S&M)	$380.4M	$273.8M	$123.1M
Excess Depleted U Disposal	$0M	$0.5	$0.5M
Facility Stabilization****	$2.2M	$1.5M	$2.5M
DOE Direct Costs to Support Processing	$31.8M	$19.2M	$4.1M
Management Reserve (to go)	$51.3M	$35.9M	$27.9M
Contingency	$29.0M	$9.1M	$0M***
Total	**$1,115.2M**	**$873.4M**	**$499.4M**

Some Remaining Risks

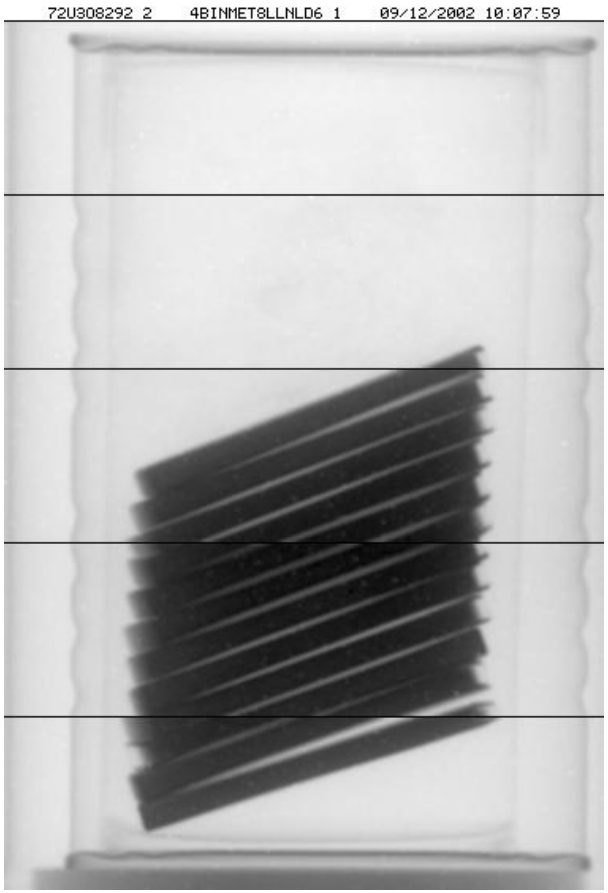
- ZPR shipments: DAF priorities
  - NNSA may experience unplanned national security priorities
- CEUSP disposal:
  - Safeguards and Security (S&S)
    - Security at Building 3019, en route, and at NNSS
  - Waste profile acceptance
- Processing: Need to finalize an optimized approach hand-in-hand with SC, NNSA, and HSS
  - Need to develop security and safety strategies
  - Need MOA on Building 2026 transfer
  - Need to develop baseline cost and schedule
  - Need to start preliminary work now to realize maximum benefit
- Funding

ZPR Plate Shipments

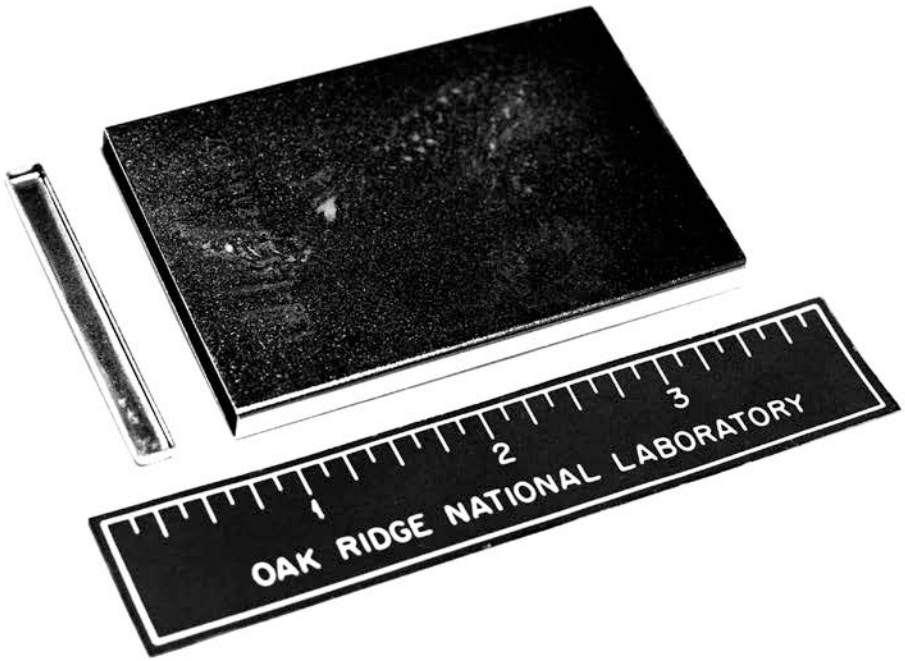
(Photos Tell the Story)

ZPR Plate Description

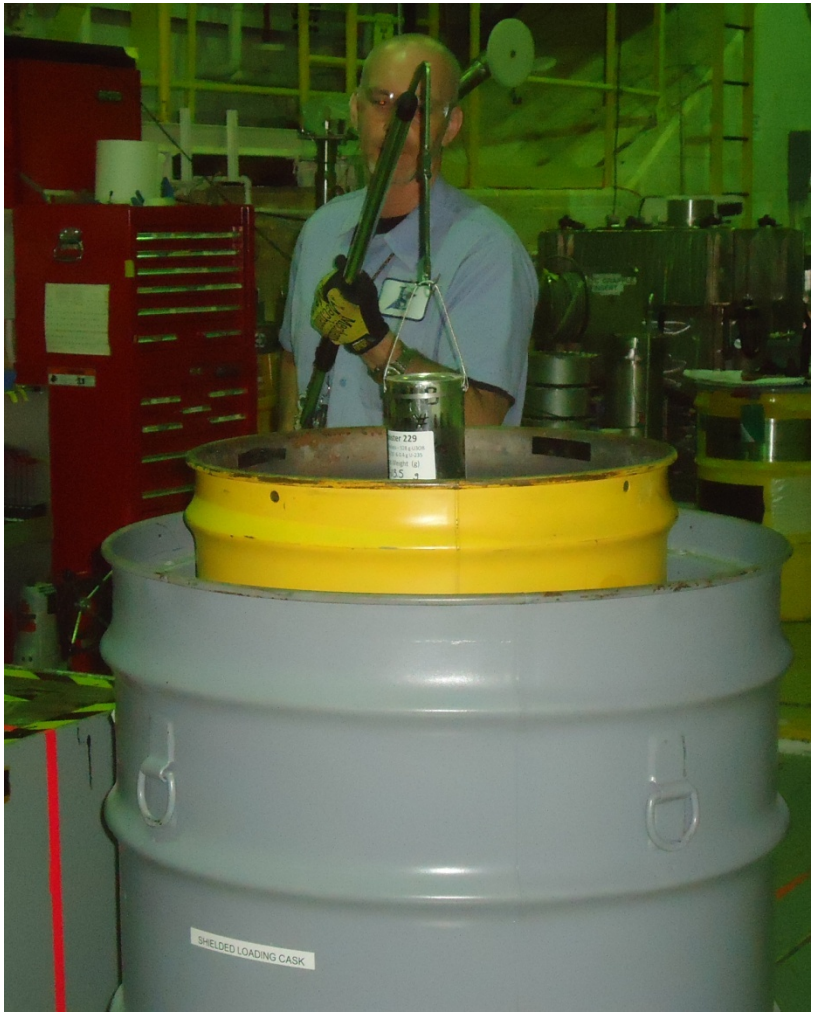
- 1743 packets fabricated in Building 3019 during 1978-1979
- First shipment to ANL in 1979; Packets returned to ORNL in 1985
- Welded, nickel-plated, stainless steel packets (3” x 2” x ¼”), each with 28 grams of ^{233}U
  - 33 grams total U_3O_8 in each
  - 10% of total U; 3% of U-233 in storage
- 128 canisters (11.7% of total)
  - 12 to 16 plates per canister
- 1-3 R/hr at canister contact



Empty ZPR packet



Canister Loading into a 5X22



Closing the 5X22 Inner Container

Labeling the 5X22

ZPR shipments now 57% complete!

Isotek's Accelerated Shipping Team

Questions?