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Title:	Pit Surveillance (Rev -1)
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Intended for:	Use for overview presentations to new and prospective PT-5 staff members and for recruiting college graduates and for others interested in Pit Surveillance basics.
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Los Alamos NATIONAL LABORATORY EST. 1943

PIT SURVEILLANCE

(REV-1)

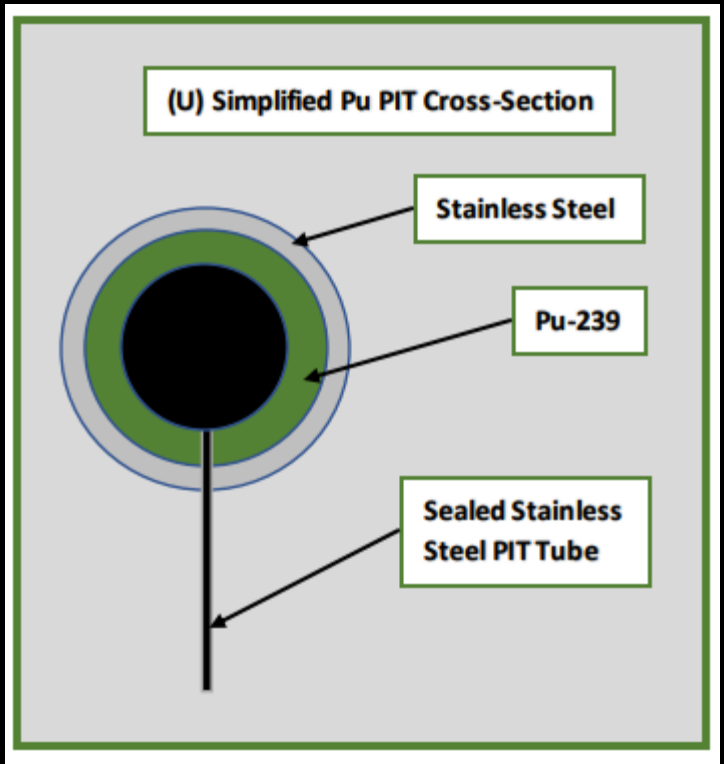
Overview

Assuring a Safe, Secure, Reliable and Effective US Nuclear Weapons Stockpile

May 2022

PIT SURVEILLANCE

- **PITs 101 – Background** (U)



- Nuclear Weapon Plutonium (Pu) "PIT" Basics

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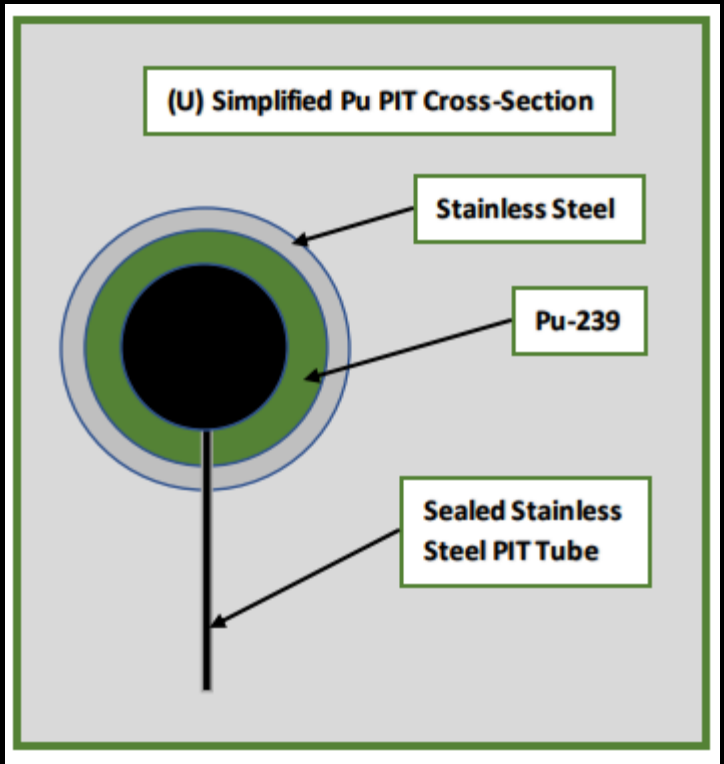
- **PITs 101 – Background** (U)



- Nuclear Weapon Plutonium (Pu) "PIT" Basics
- "Primary" fission stage (trigger) of US thermonuclear weapons
- Hollow sphere larger than a bowling ball
- Made of Pu-239, Stainless Steel, Beryllium and/or other materials
- 'Boosted' with Deuterium-Tritium (DT) Gas
- Implosion assembled (IA)
- When the "*primary*" (PIT) is uniformly compressed by conventional explosives inside a warhead, results in a nuclear *fission* detonation which triggers nuclear *fusion* in the "*secondary*"

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- **PITs 101 – Background (Cont.)**
  - Most PITs in the US Nuclear Stockpile were produced between 1978 – 1989
    - Originally designed for ~20-year operational (deployed) life span
  - All PITs in US Weapons Inventory were manufactured at the Rocky Flats Plant
    - During the Cold War, >1,000 PITs per year were manufactured at the Rocky Flats Plant
      - Rocky Flats Plant (Colorado) stopped producing PITs in 1989
  - Only Pu PIT production capability in the United States
    - Los Alamos National Laboratory (LANL) TA-55, Plutonium Facility 4 (PF-4)
      - Past 33 years no new PITs have been manufactured and deployed to the US stockpile*

*PF-4 has produced a limited quantity of "process demonstration" PITs and W-88 'qualification' PITs (2000-present)

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- **Stockpile Stewardship Program**
  - 1994 Defense Authorization Act directed DOE establish Stockpile Stewardship Program
    - Maintain the overall safety and reliability of the U.S. Nuclear Weapons stockpile
    - US maintains a subset of cold-war era nuclear weapons
      - B-61, W-76, W-78, W-80, B-83, W-87 and W-88
  - Stockpile Stewardship Program includes
    - Evaluation
      - PIT Surveillance
    - Maintenance and
    - Improvement initiatives
      - LEP – Life Extension Program (extend weapon lifecycle)
      - Mod – Modification (change operational capability)
      - Alt – Alteration (improve, but do not change operational capability)
        - LEPs, Mods and Alts – all re-*use original PITs*

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Modernization Milestones

The U.S. nuclear warhead lifecycle begins with Phase One: Concept Study and ends with Phase Seven: Retirement, Dismantlement, and Disposition. All of NNSA's LEPs are in Phase Six: Quantity Production and Stockpile Maintenance and Evaluation.

PHASE 6.1 Concept Assessment	PHASE 6.2 Feasibility Study & Down Select	PHASE 6.2A Design Definition & Cost Study	PHASE 6.3 Development Engineering	PHASE 6.4 Production Engineering	PHASE 6.5 First Production	PHASE 6.6 Full-Scale Production

- Completed Warhead Production of W76-1 in 2018
- Completed B61-12 Final Design Review in 2018
- Completed W88 Alt 370 Final Design Review in 2018
- Completed W80-4 Weapon Design & Cost Report in 2019
- Resumed W87-1 Feasibility Study in 2019

Annual Assessment and Surveillance

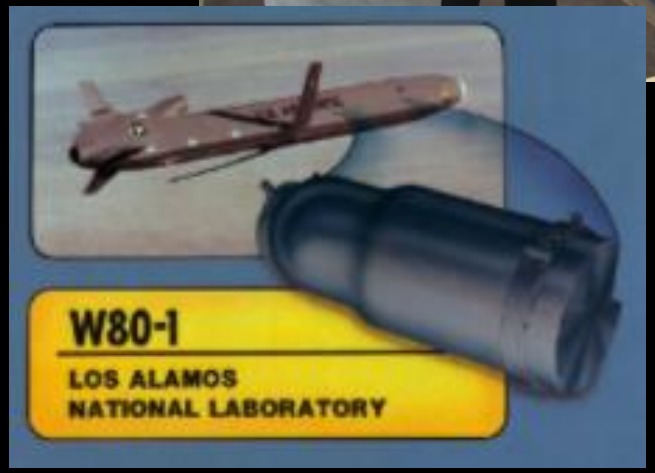
NNSA conducts extensive stockpile evaluations through surveillance of deployed weapons returned from Department of Defense delivery systems to identify any potential defects or aging concerns. These data are a key component in an annual report to the President on the current state of the stockpile. For the last 23 years, the three NNSA Laboratory Directors have certified that the stockpile remains safe, secure, and effective, and that additional underground nuclear explosive testing is not required at this time.

B61-12 flight test

energy.gov/nnsa

NNSA is a semi-autonomous agency within the U.S. Department of Energy responsible for enhancing national security through the military application of nuclear science.

February 2019



W-80 Warhead

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- **PIT Aging Concerns**
  - Plutonium (Pu) is a human-made, unstable element
    - Pu PITs subject to radioactive decay (alpha, beta, gamma & neutron decay)
      - Impurities could be building up in the nation's stockpile of PITs
        - Total mass of Pu decreases over time due to radioactive decay
          - Radioactive decay products Uranium, Americium, other
        - Helium in-growth can change the properties of Pu

  - LANL experiments in the early 2000s provided scientific evidence
    - Material properties of Pu PITs change over time
    - Could affect the performance of nuclear weapons

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- **PIT Aging Concerns (Cont.)**
  - 2019 JASON "*PIT Aging*" Report - Independent scientific advisory group
  - Assessed Plutonium PIT Aging
    - 2019 JASON Report conclusions differed *significantly* from 2006 JASON Report
    - **Unclassified 2019 JASON** Report "*PIT Aging*" summary: "*Finally, we urge that **pit manufacturing** be reestablished **as expeditiously as possible** in parallel with the focused program to **understand Pu** [plutonium] **aging**, to **mitigate against potential risks posed by Pu aging** on the stockpile.*"
      - **Unclassified 2006 JASON** Report "*PIT Lifetime*" summary: "*As a result of the Los Alamos/Livermore efforts, JASON concludes there is no evidence from the UGT [underground nuclear-explosive testing] analysis for plutonium aging mechanisms affecting primary performance on a **timescale of a century** or less in ways that would be detrimental to the enduring stockpile.*"
  - The 2019 JASON Report - Paradigm Shift
    - Elevated NNSA Urgency, Focus and Funding
      - PIT Surveillance (understanding aging Pu in PITs & reducing PIT Surveillance backlog)
      - Reestablishing PIT Manufacturing at TA-55, PF-4

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- **PIT Surveillance Overview**

  - Pit Surveillance is a critical part of Stockpile Stewardship Program
    - Process of technically evaluating the "primary" of weapons
      - Identify potential performance issues resulting from aging

    - LANL PIT Surveillance activities broadly include
      - Enhanced non-destructive evaluations,
      - Destructive evaluations,
      - Inspections,
      - Tests and
      - Computational modeling and simulations

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- **PIT Surveillance Program Drivers**
  - 50 U.S. Code § 2525 - Annual Assessment Report to US President and Congress
    - Certify the condition of US nuclear weapons stockpile
      - Annual assessment of safety, security, reliability and performance
      - Determination if necessary to conduct an underground nuclear test to resolve issues
    - Certified by Directors of the three DOE/NNSA nuclear weapons laboratories
      - Los Alamos National Laboratory (LANL),
      - Lawrence Livermore National Laboratory (LLNL), and
      - Sandia National Laboratories (SNL)
    - USSTRATCOM Commander
      - Operational reliability and effectiveness assessment

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- **PIT Surveillance Program Drivers (Cont.)**
  - In 2007, NNSA modified guidance for PIT Surveillance Program
    - Stockpile Surveillance Transformation Project
    - Requirements-based
    - Focused on filling knowledge gaps for PIT aging
      - National Labs tasked to analyze new and historical surveillance data
        - Evaluate pit components and materials
        - Establish baseline for each weapon type
        - Compare 'as-deployed' to' site-return' characteristics of the cold-war era PITs
      - Comparison data informs understanding of changes due to aging
        - How are safety, reliability, effectiveness characteristics changing over time?

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- Importance of Experience

- "The only source of knowledge is experience."

  - Albert Einstein

- 2014 LANL Annual Assessment Report to the President
  - *"Most personnel with direct knowledge of PIT manufacturing and certification processes have retired leaving a significant knowledge gap."*

- 2021 LANL National Security Science Publication, article: "*PIT Production Explained*"
  - *"Approximately 2,500 people will eventually support the PIT mission at Los Alamos. That number includes a handful of people who used to work at Rocky Flats. But a lot of that expertise is walking out the door as people retire."*

  – Thom Mason, Laboratory Director

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- **PIT Surveillance Details**
  - Pit Surveillance Process
    - Weapons selected from deployed stockpile by the Design Agency
      - Disassembled at PANTEX
      - PITs shipped to LANL for surveillance evaluation
    - Surveillance evaluation activities at LANL include
      - Enhanced non-destructive evaluations
        - Advanced 3D imaging, and other NDE evaluations
          - High Resolution Computed Tomography (HRCT) Analysis
      - Destructive evaluations
        - Chemistry, metallurgy and other material property evaluations
      - Inspections
        - Dimensional, surface science and other inspections
      - Tests
        - Subcritical experiments and other tests
      - Computational modeling and simulations
        - Informed and validated by surveillance data
    - Surveillance data compared to original Rocky Flats Plant certification data
      - Identify and evaluate any potential concerns, defects, changes or anomalies

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- **PIT Surveillance Conclusion**

  - PIT Surveillance Program is Important to National Security
    - Primary input to the Annual Assessment Report to the President
      - Laboratory's confidence in the US nuclear weapon stockpile
        - Certify stockpile safety, security, reliability and effectiveness
  - The 2019 JASON report elevated NNSA concerns about aging pits
    - Additional Emphasis on PIT Surveillance
    - Additional Emphasis on PIT Production at TA-55, PF-4
      - Required by Law* – LANL must produce 30 PITs per year during 2026
        - War Reserve (WR) quality Pu PITs (diamond stamped)
        - *50 U.S. Code § 2538(a)(4) – "*Plutonium pit production capacity*"

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- **Questions?**

- Sources and Additional Information:
  - (U) Los Alamos National Laboratory, National Security Science Publication, Winter 2021, article: *"PIT Production Explained" (Unclassified)*
  - (U) Los Alamos National Laboratory, National Security Science Publication, Winter 2021, article: *"Weapons Surveillance" (Unclassified)*
  - *(U) NNSA Report to Congress, December 2020, "FY2021Stockpile Stewardship and Management Plan– Biennial Plan Summary" (Unclassified)*
  - (U) NNSA Fact Sheet, February 2019, *"Maintaining the Stockpile" (Unclassified)*
  - (U) NNSA Fact Sheet, May 2019, *"Plutonium PIT Production" (Unclassified)*
  - (U) 2019 JASON Defense Advisory Group Letter Report to the NNSA, JSR-19-2A, November 23, 2019, *"PIT Aging"* (Unclassified Summary)
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  - (U) Congressional Research Service Report, R43428 (V4), March 20, 2014, *"U.S. Nuclear Weapon "PIT" Production: Background and Options in Brief" (Unclassified)*
  - (U) DOE Office of Inspector General Audit Report, OAS-L-12-10, September 2012, *"Follow-up Audit of the Stockpile Surveillance Program" (Unclassified)*
  - (U) GAO Report, GAO-12-188, February 2012, *"Nuclear Weapons, NNSA Needs to Improve Guidance on Weapons Limitations and Planning for Its Stockpile Surveillance Program" (Unclassified)*
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  - (U) DOE Office of Inspector General Audit Report, DOE/IG-0661, September 2004, *"National Security Laboratories' Annual Reporting of the Nuclear Weapons Stockpile Assessment"* (Unclassified)
  - (U) TMS Journal of Materials (JOM), September 2003, (Martz & Schwartz- LANL MST-DO), "Plutonium: Aging Mechanisms and Weapon Pit Lifetime Assessment"