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Title: (U) Introduction to Weapon Systems and Pits

Author(s): O'Neil, Brian Erick
Gubernatis, David C.

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(U) Introduction to Weapon Systems and Pits

Unclassified Briefing

David Gubernatis
Group Leader PT-3

Based from:
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Classified by: Adam Farrow, Manufacturing Manager
(Name and Title)

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(Guide, Date, Originating Agency)

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- Dwight Jaeger pulled the weapons and NWC slides together for a tutorial for previous students and they are an excellent overview of these subjects
- Doug Kautz and Adam Farrow did a tutorial for PSM and SMS Student Programs

Section 1

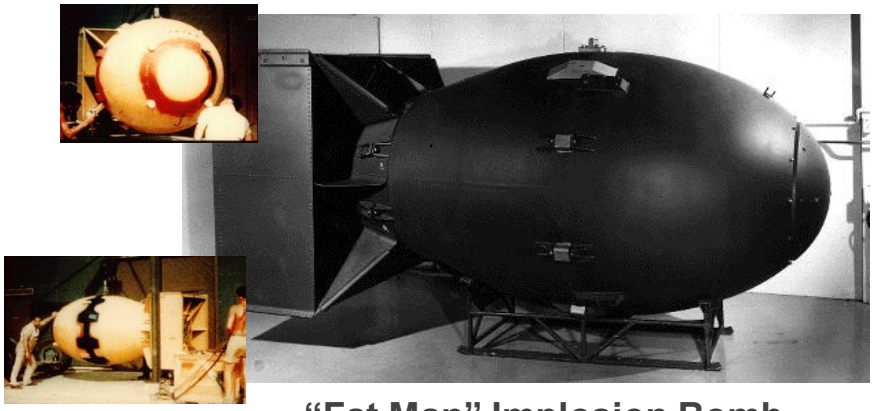
Production Complex

Nuclear Testing

Delivery Systems

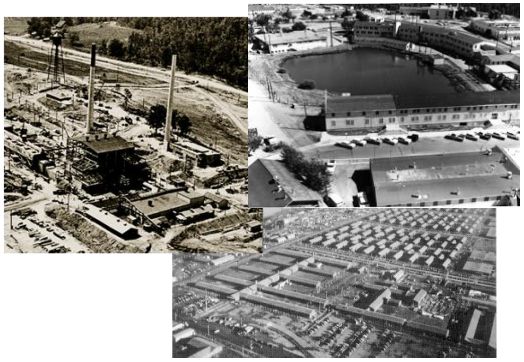
Requirements

Nuclear Weapons and The Weapons Complex have Undergone a Great Evolution Since 1945



"Fat Man" Implosion Bomb
~10,300 lbs

B83 Modern Strategic Bomb
Megaton-Class

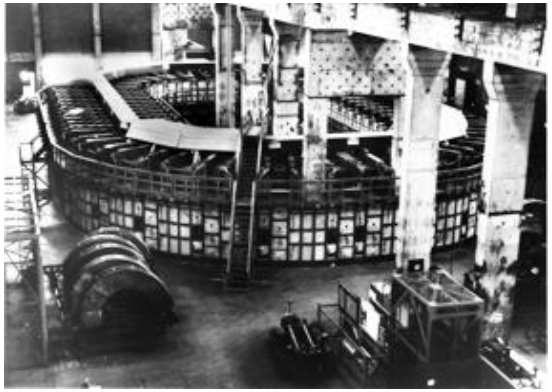


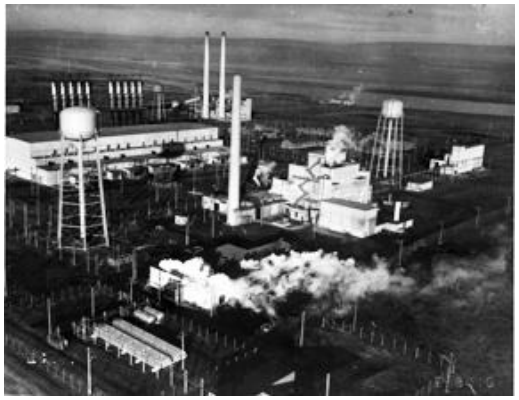
1945
Los Alamos + 2 plants

Peak Complex
~50 sites

Today
8 sites

Nuclear Weapons Complex (NWC) in 1942





September 1942

Oak Ridge*
(Enriched Uranium)

November 1942

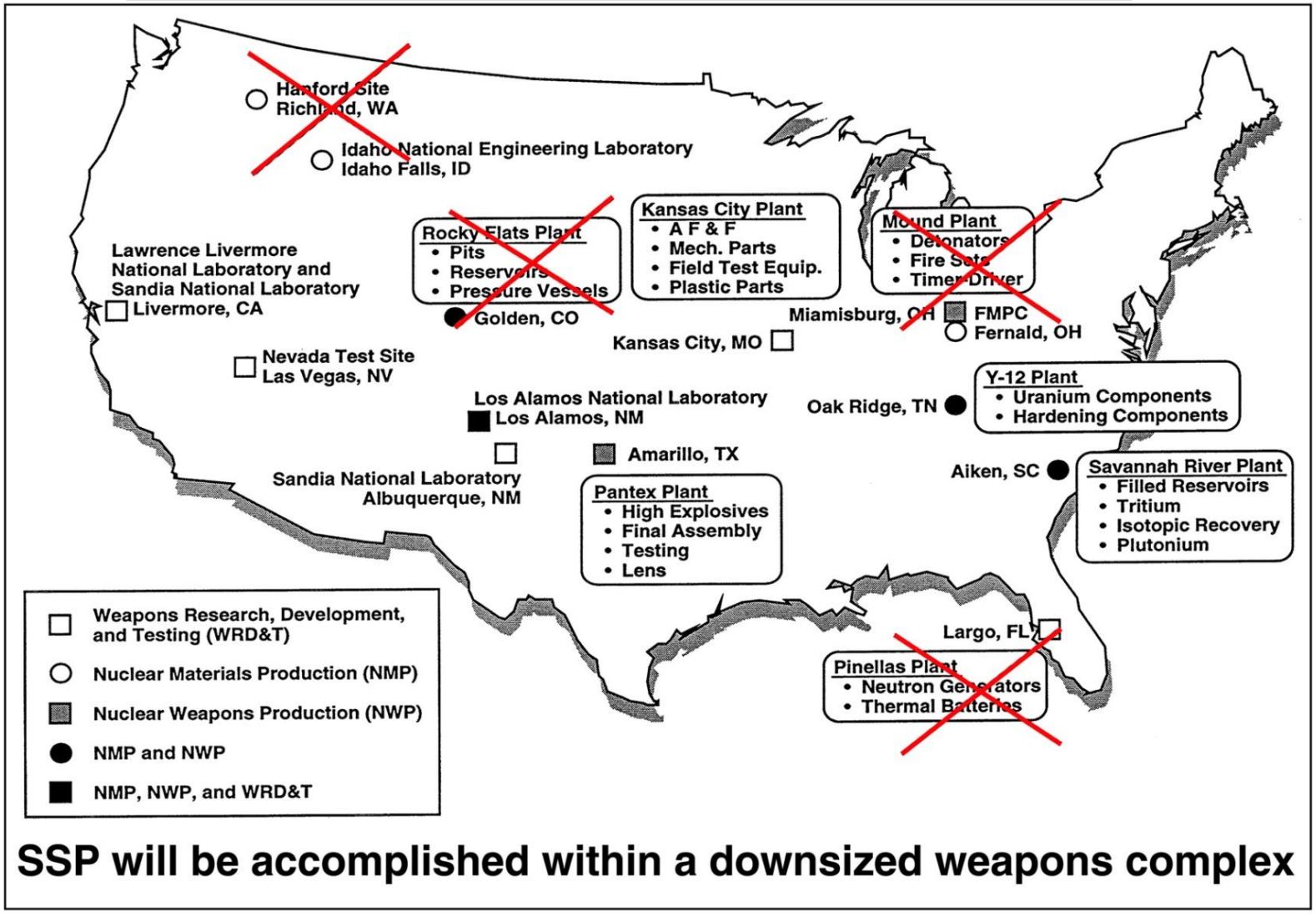
Los Alamos
(Design and Production)

December 1942

Hanford
(Plutonium)

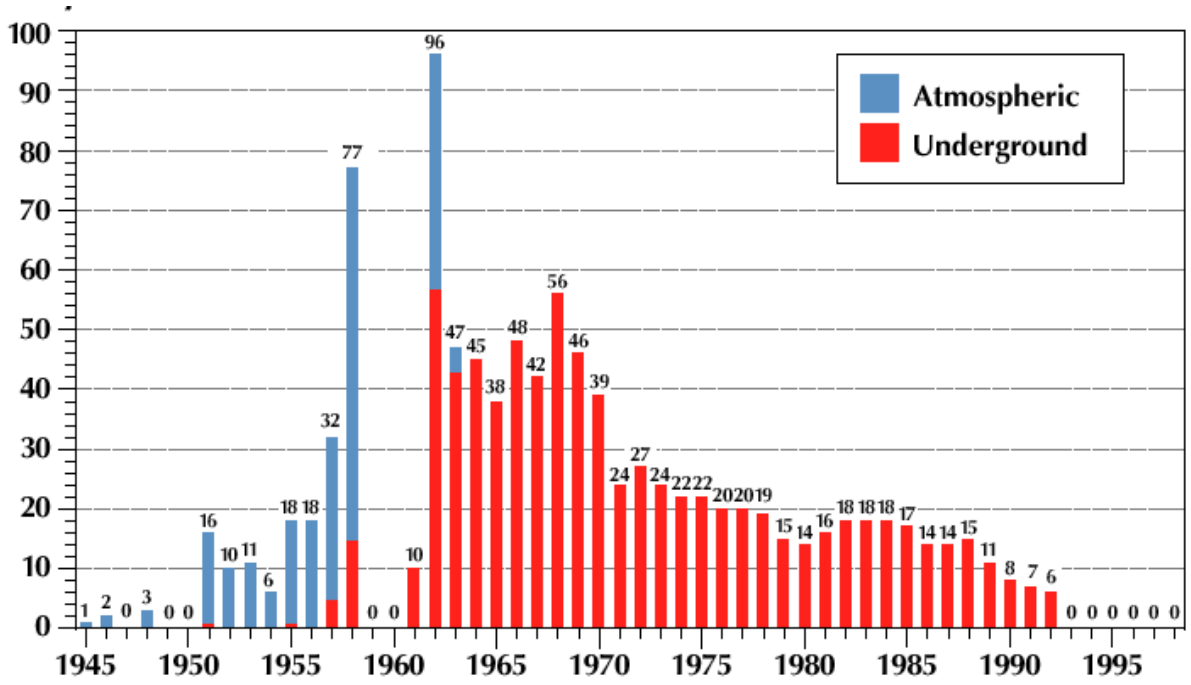
Scientists began arriving in March 1943

The Nuclear Weapons Enterprise Today



SSP will be accomplished within a downsized weapons complex

The U.S. Conducted 1054 Nuclear Tests

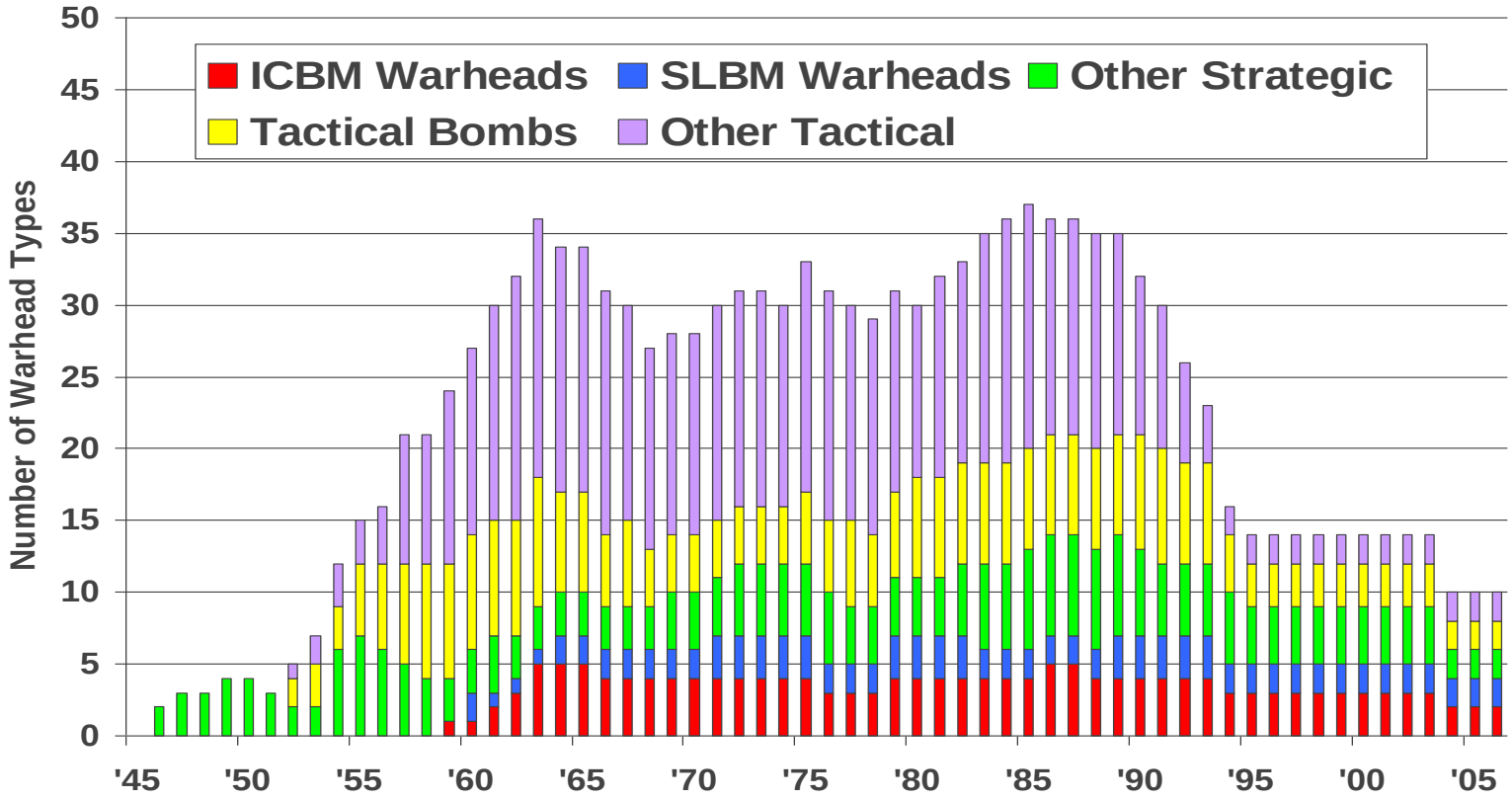


(July 1945 – September 1992)

Nevada Test Site - 62 tests had simultaneous detonations
Rifle, Colorado - 1 test had a simultaneous detonation

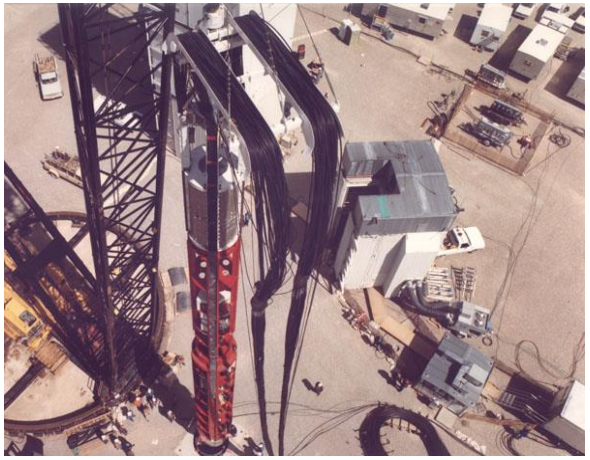
Location	Number of Tests	Number of Detonations
Total South Atlantic	**3**	**3**
Bikini	23	23
Christmas Island	24	24
Enewetak	43	43
Johnston Island	12	12
Pacific	4	4
Total Pacific	**106**	**106**
Alamogordo, New Mexico	1	1
Amchitka, Alaska	3	3
Carlsbad, New Mexico	1	1
Central Nevada	1	1
Fallon, Nevada	1	1
Farmington, New Mexico	1	1
Grand Valley, Colorado	1	1
Hattiesburg, Mississippi	2	2
Nellis Air Force Range	5	5
Rifle, Colorado	1	3
Total Other	**17**	**19**
Atmospheric	100	100
Underground	828	921
Total NTS	**928**	**1,021**
TOTAL	**1,054**	**1,149**

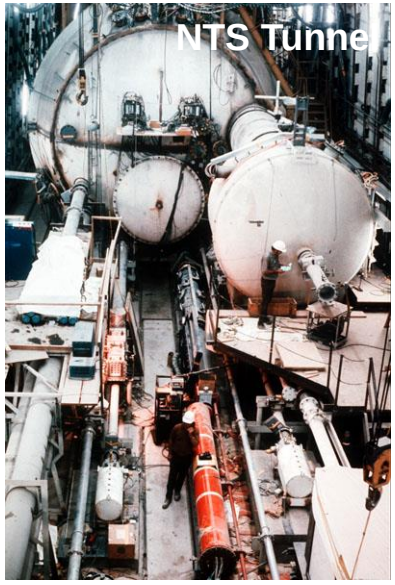
Weapon Types and Numbers have Dramatically Decreased Since 1989



Nuclear Tests Have Been Conducted for Many Purposes

Purpose	Detonations
Joint US-UK	24
Plowshare	35
Safety Experiment	88
Storage-Transportation	4
Vela Uniform	7
Weapons Effects	100
Weapons Related	891
TOTAL DETONATIONS	**1,149**





Nuclear Weapons are Complex Devices, Requiring a Broad Range of Engineering and Scientific Expertise

- Nuclear Explosive Package
- Radars
- Impact Fuzes
- Shock absorbers
- Casing
- Detonators
- Firing sets
- Transverters
- Capacitors
- Switches
- Switch tubes
- Rectifiers
- Programmers
- Neutron generators
- Reservoirs
- Stronglinks
- Batteries
- Timers
- Spin generators
- Parachutes
- Ejector systems
- PAL controllers

B83 Strategic Bomb - Total parts = 6,519

Science and Technology Foundations

MATERIALS AND PROCESSES | COMPUTATIONAL SCIENCES | DYNAMIC MATERIALS – HYDRODYNAMICS | MICROELECTRONICS | ENGINEERING SCIENCES

The NNSA has recaptured the technology to manufacture and certify Pits at LANL

Coater

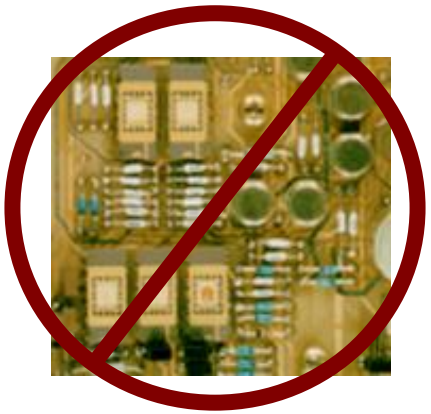
Plutonium Glove Box

The manufacture and certification of the Pits represents a microcosm of the entire Stockpile Stewardship Program

Stockpile Refurbishments Require Modern Technologies and Components

Several factors prevent us from rebuilding the stockpile in exactly the same manner that the original weapons were built.

For example:

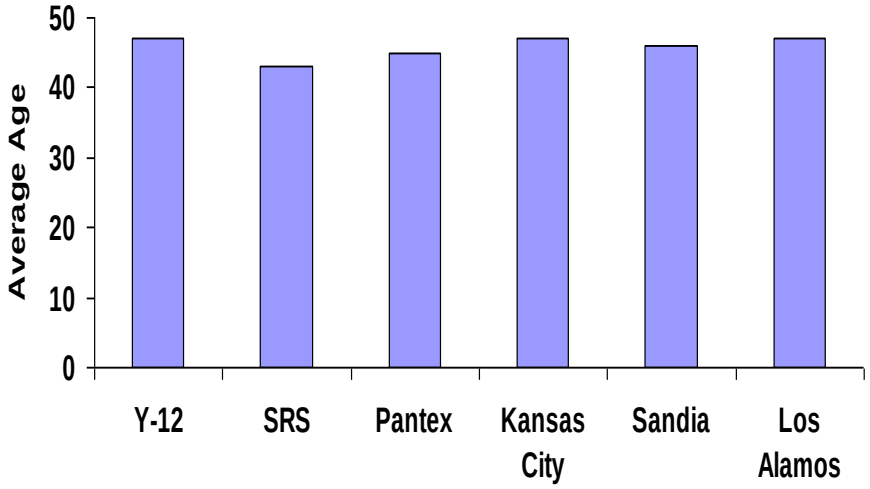


Sunset electronics no longer are available

High-reliability, weapon-specific processes are no longer available

Original materials are no longer acceptable (e.g., carcinogenic epoxies)

The Real Issue is People

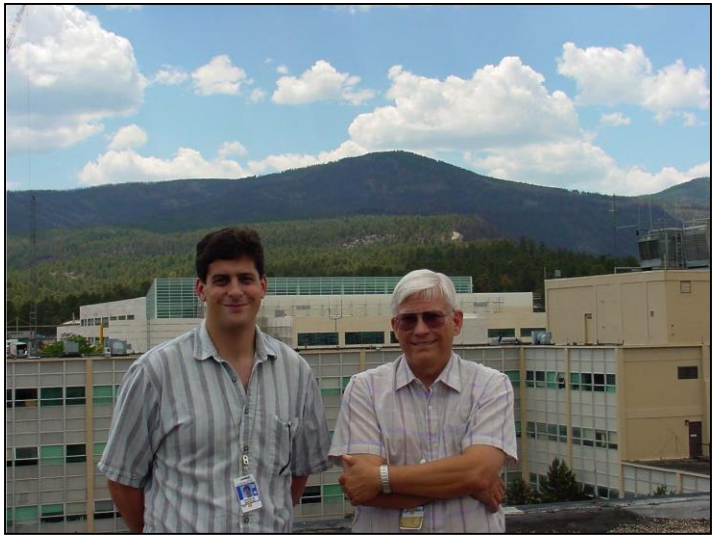


Without the integrated test (UGT), knowing how to replace and certify "irreplaceable" parts is a major challenge

- Sunset technologies
- Loss of Vendors
- ESH restrictions

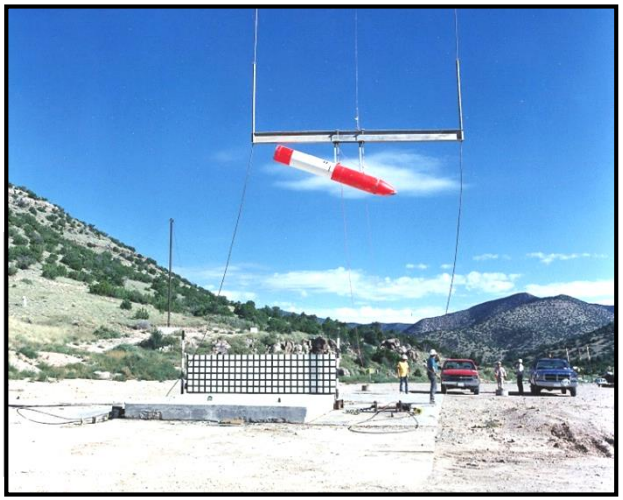
Years of highly developed techniques and acquired skills are lost or disappearing

- Plutonium Processing
- Welding and Brazing
- Special Polymers
- High Explosives



Testing Capabilities and Activities for Reliability

Drop Tower



B-2 & B61-11

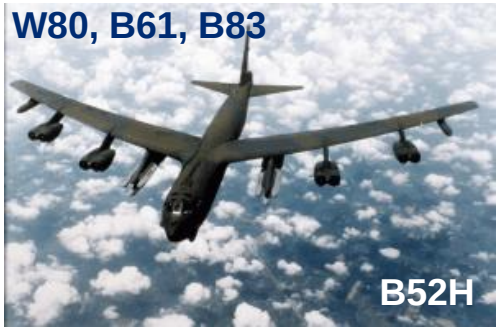
Centrifuge

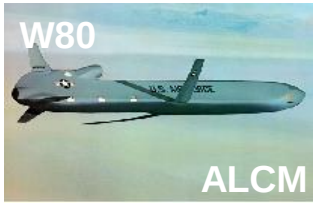
Mechanical Insult

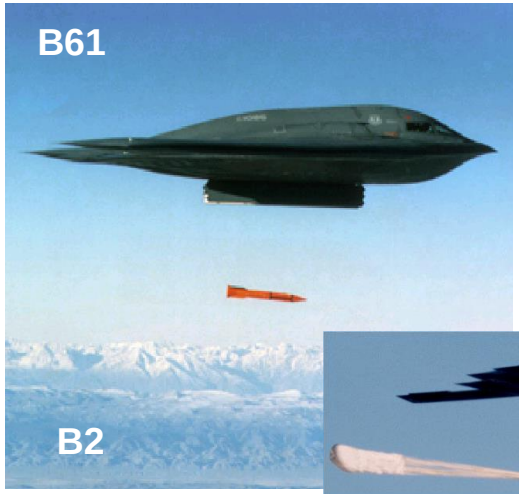
Electrohydraulic Shaker

Sled Track

Nuclear Delivery Systems

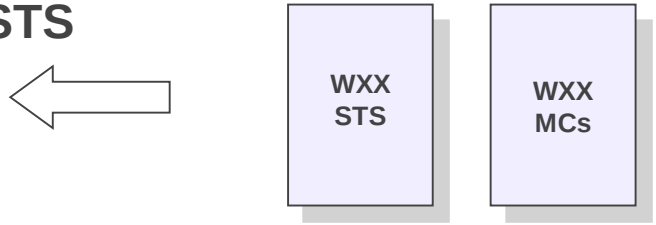






How are Requirements Established?

Requirements flow from the MCs and STS



Requirements Validation

-Interpret requirements at system level
-Translate requirements to component level

Systematic Review

-Full System
-Subsystems
-Components

Requirements	Qualification by: Test	Modeling	Model Valid. Test	Other
Reliability				
Vibration	X	x		
Shock	X	x		
Temperature	X	x		
Etc.				
Safety				
Drop	x	X	x	
Crush	x	X	x	
Impact	x	X	x	
Fire	x	X	x	
Etc.				
Surety				X

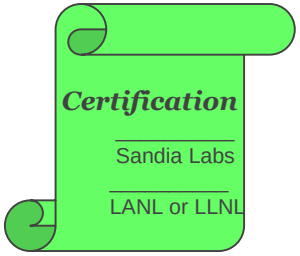
Qualification Method Decision

Test vs Modeling (or Other) decision tradeoff

Qualification Plan Goal

An integrated program of testing and modeling that in a cost and time efficient manner:

1. Qualifies against all requirements
2. Minimizes design risks
3. Understands failure modes
4. Estimates design margins



"Warhead Certification with Confidence"

Section 2

Nuclear Explosive Package

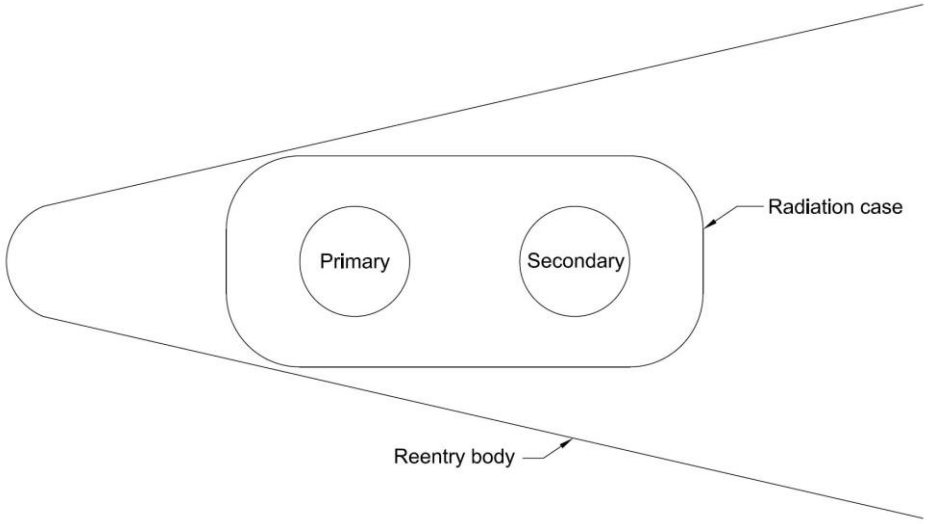
The Pit

Gloveboxes

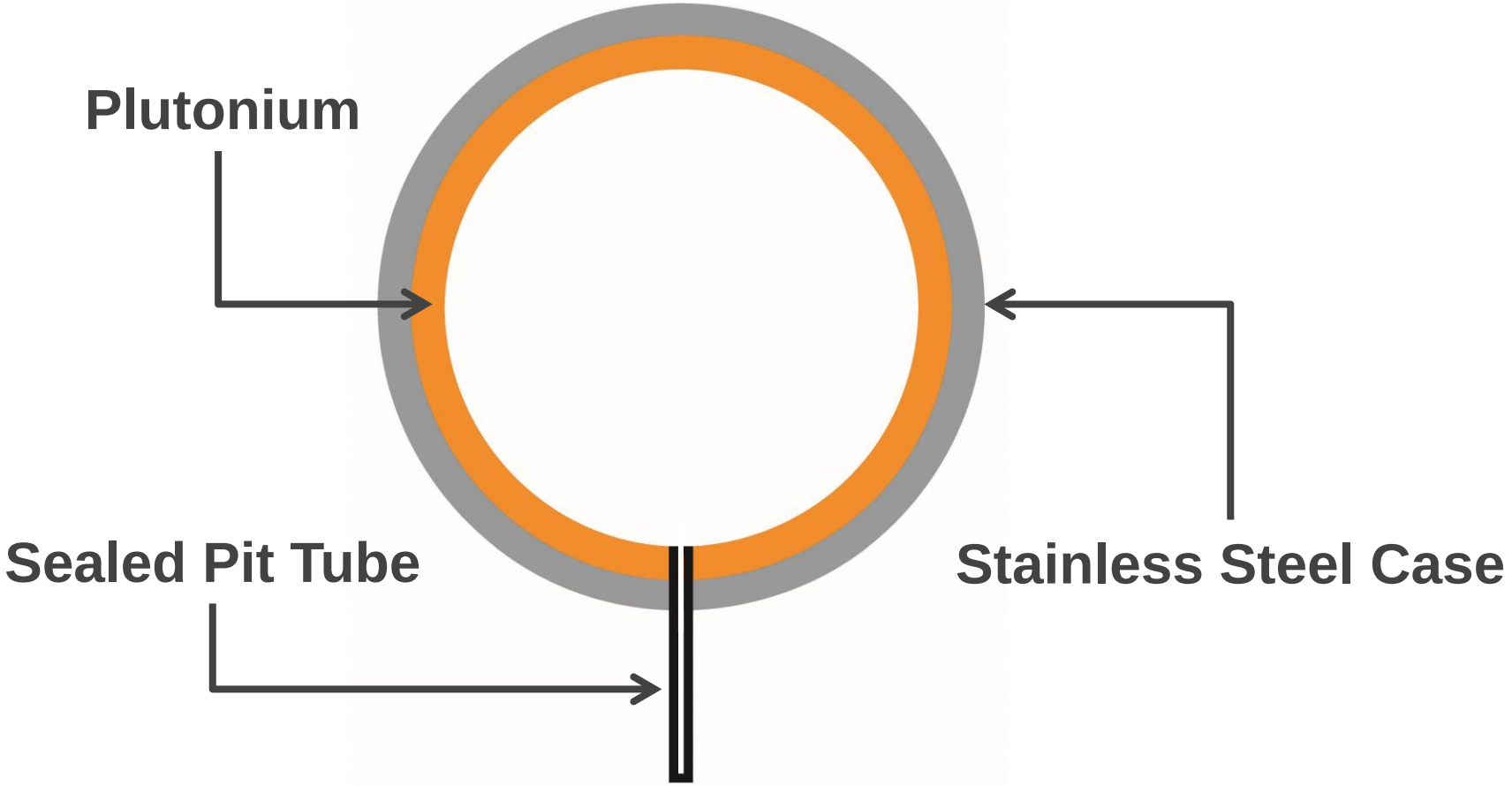
Surveillance

What is a NEP?

- A Nuclear Explosive Package (NEP) includes the Primary, Secondary, Radiation Case and related components
  - The Primary is an assembly of chemical explosives around a nuclear core (The Pit)
- The Pit (nuclear core) starts at a sub-critical state, and using explosives is quickly driven to a critical state
- The NEP is the part of the weapon that produces nuclear yield
- The NEP converts energy through various forms (electrical, chemical, mechanical, & nuclear) to produce *blast overpressure*



What is a Pit?



The Pit

- The pit is composed of materials that allow mechanical energy to be converted to nuclear energy
- Fabrication processes used are typical of any metal fabrication facility:
  - Casting
  - Forming
  - Machining
  - Welding
  - Assembly

- Some of the materials used in pits include:
  - Plutonium
  - Uranium
  - Encapsulation Materials (Non-Nuclear)

- Processing of Plutonium and other hazardous materials occurs in Gloveboxes

Why Use Gloveboxes?

Gloveboxes are used for four reasons:

- Protect workers and public from easily transported, finely divided plutonium oxides
  - Plutonium is very reactive and produces very fine particulate oxides
  - While not the “Most dangerous material in the world” of Manhattan Project lore, plutonium is hazardous to health of workers if not properly controlled
- Protect plutonium from chemical/nuclear reactions
  - Plutonium is extremely reactive at ambient conditions with several components found in air: oxygen, water, hydrogen
  - As with most reactive metals, reactions with these materials may be violent and difficult to control
  - As with most fabricated metal products, corrosion may significantly affect the mechanical, chemical, and physical properties of the product
  - Gloveboxes also help provide inherent spacing between quantities of material (criticality safety)
- Provide shielding from radioactive decay products: α, γ, and η are commonly associated with plutonium decay, as well as highly radioactive materials such as ^{241}Am and ^{238}Pu
- Provide security and control of the material

How Do We Ensure Stockpile Viability?

- The NNSA has a Stockpile Surveillance program to support the Annual Assessment
- Various major components from weapons are disassembled and sent to their plant of origin (or the plant that now controls that production mission) for testing and analysis
- Major components:
  - Pits: LANL and SRS
  - Detonators: LANL
  - Secondaries: Y-12
  - Neutron Generators: Sandia
  - Main Charge Explosives: Pantex
  - Electronics/Guidance: NSC
  - Gas Transfer Systems: NSC

Nondestructive Testing for Pit Surveillance

- Several nondestructive tests are performed on pits upon arrival at LANL
- These include:
  - Buoyancy-corrected weighing
  - Gas sampling and analysis
  - Radiography
  - Leak testing
  - Dye penetrant testing
  - Ultrasonic testing
  - Dimensional inspection

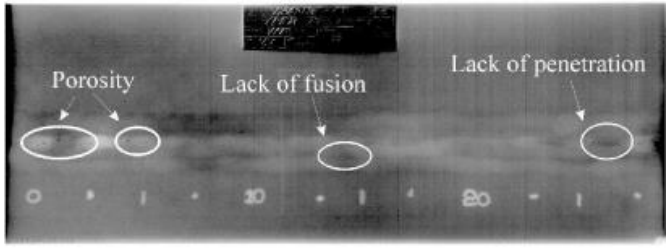
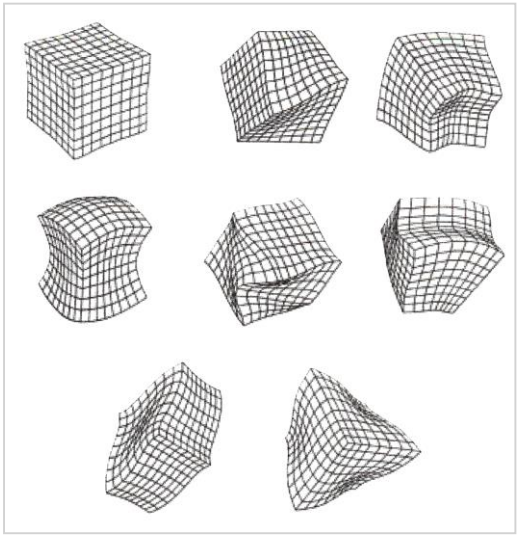
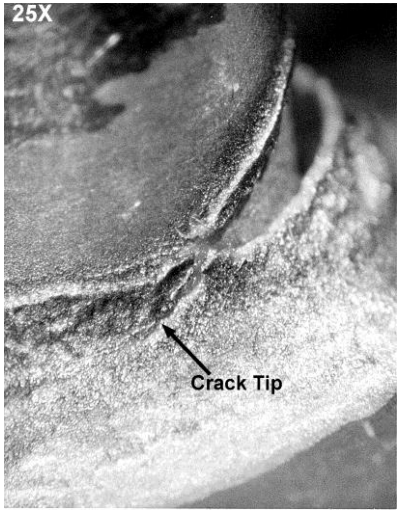


Figure 6. Radiography of the welded join.





Summary

- Hopefully this presentation has given you a clearer picture of how our mission fits into the big picture.
- Nuclear weapons and our work here is important both militarily and politically.
- The bottom line from a world perspective – Deterrence works.