Introduction to U.S. Nuclear Testing

1945 - 1992

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Homeland Defense & Security Information Analysis Center

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Nuclear Fundamentals Orientation

Introduction to U.S. Nuclear Testing: 1945 to 1992

Los Alamos
NATIONAL LABORATORY
EST. 1943

NNSA
National Nuclear Security Administration

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Special Thanks To…

Tom Kunkle (LANL)

Peter Kuran (LLNL)

Glen McDuff (LANL)

John Moore (LANL)

Jim Moye (LLNL)

Byron Ristvet (DTRA)

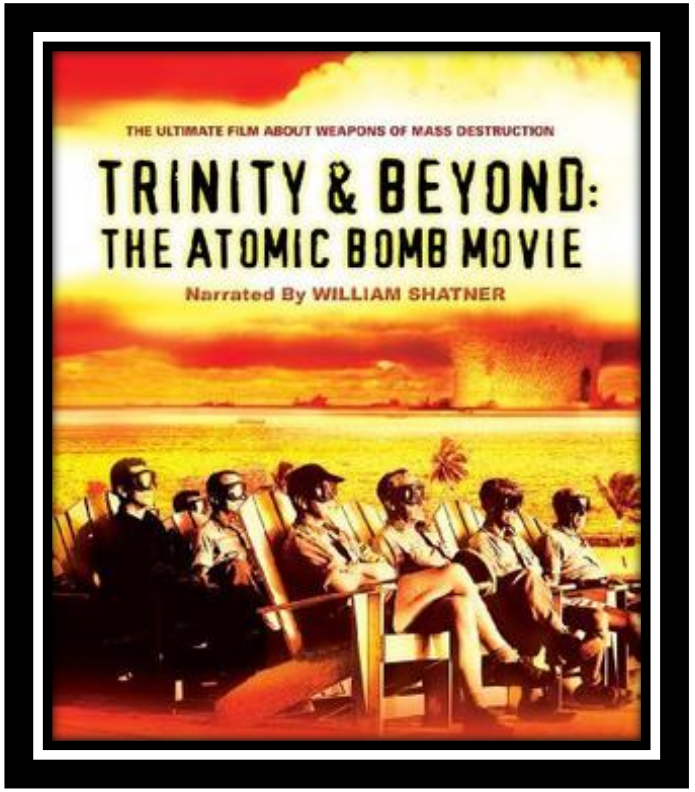
Jeff Sahaida (LLNL)

Alan Scarlett (LANL)

Greg Spriggs (LLNL)

and

The Moscow Symphony Orchestra



Available at atomcentral.com

Some of the Reasons the U.S. Tested:

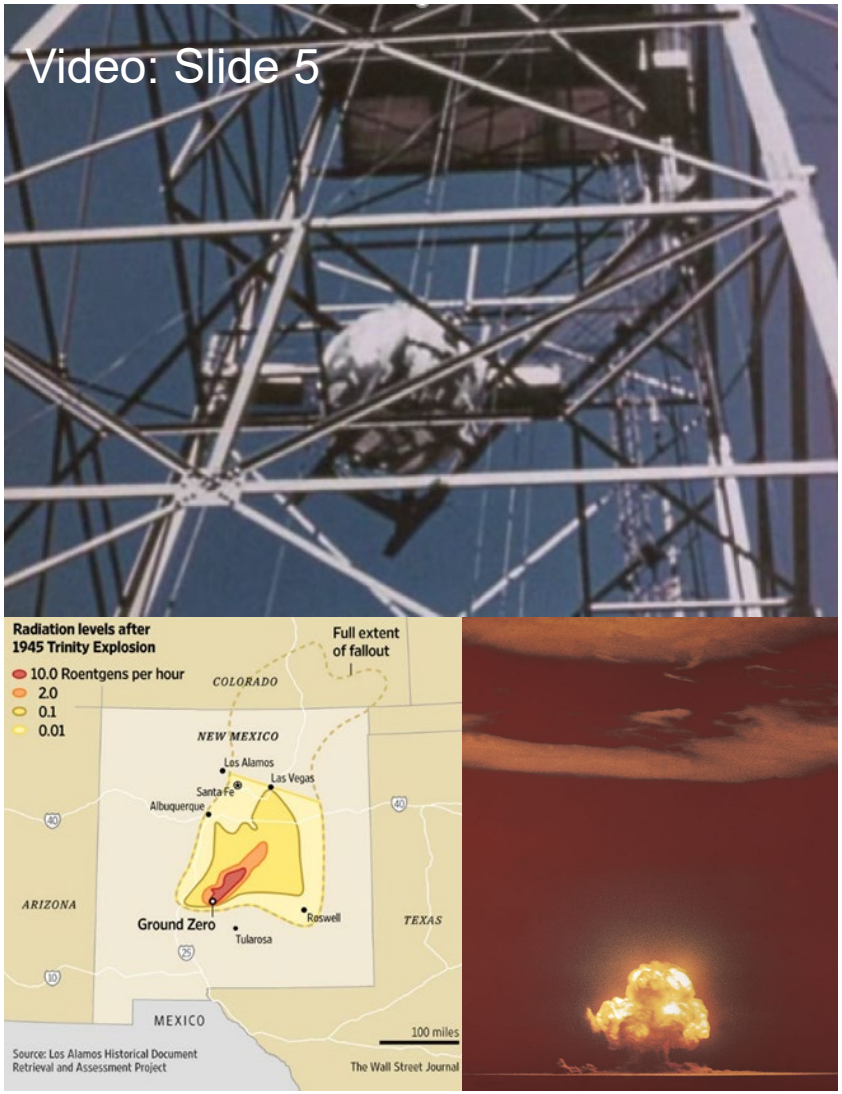
- The world's first nuclear test was conducted to ensure the implosion weapon (Fat Man) would work
- The Department of Defense sponsored weapons effects tests
- Most tests were intended to advance weapons design (e.g., adjust yields, improve efficiency, etc.)
- A handful of tests validated the reliability of weapons in the stockpile
- There were a few full-system tests
- Tests were also performed to understand and improve the safety of nuclear weapons
- Vulnerabilities needed to be assessed
- Some nuclear devices were detonated for non-weapons purposes (e.g., nuclear fracking, excavation, etc.)

The Original Reason for Testing: Will it Work?

No one was content that the first trial of a Fat Man (F.M.) gadget should be over enemy territory, where, if the gadget failed, the surprise factor would be lost and the enemy might be presented with a large amount of active material in recoverable form.

- Kenneth Bainbridge, Trinity Test Director

Trinity: History's Greatest Scientific Experiment?



- Los Alamos scientists knew Little Boy, the uranium gun weapon, would work
- However, they were not certain Fat Man, the imploding plutonium bomb, would perform in combat
- J. Robert Oppenheimer dubbed the world's first nuclear test "Trinity"
- Detonation occurred at 5:29:45 the morning of July 16, 1945
- Trinity produced a yield of 21 kt
- Unlike Little Boy, implosion weapons could be produced quickly
- On August 9th, Fat Man was dropped on Nagasaki, Japan

Our first feeling was one of elation, then we realized we were tired, and then we were worried.

– Victor Weisskopf, T Division Group Leader

Crossroads: The Navy Saves Los Alamos

- After the war, the Laboratory needed a customer
- The Navy wanted to see if the fleet could survive nuclear attack
- In Operation Crossroads, the Navy used two Los Alamos weapons against a fleet of captured and surplus ships
- Crossroads was purely a weapons effects series; it did not advance weapons design
- A relatively small number of ships sank, but many were heavily damaged/irradiated
- At that point in time, President Truman still hoped to eliminate nuclear weapons

I am not an atomic playboy!

- Vice Admiral W.H.P. Blandy

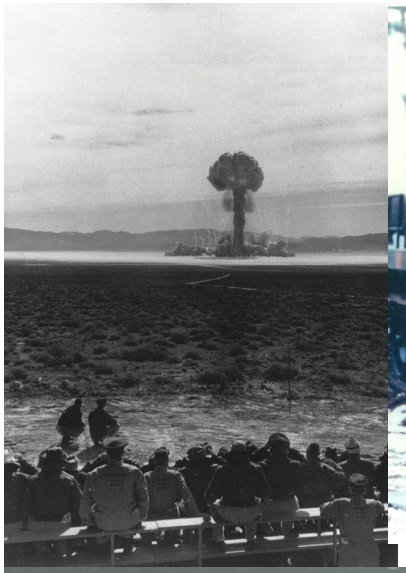
Milestones in the Early Days of Testing

- As the Cold War solidified, so too did the Laboratory's future
- In 1948, Operation Sandstone was the first series to advance weapons design; the yield basically doubled
- In August 1949, the Soviet Union tested its first weapon: a copy of Fat Man made possible by Los Alamos spies
- In 1951 the Nevada Test Site (originally the Nevada Proving Ground and today NNSS) was established
- The first test conducted there was Ranger-able on January 27th
- Greenhouse-George, on May 8, 1951, was the first test to produce thermonuclear burn (225 kt)
- Greenhouse-Item, on May 24th, was the first test of boosting (45.5 kt)

1952: Operation IVY

- Enrico Fermi first proposed the idea of a thermonuclear bomb in September 1941
- Such a weapon would use a fission bomb to start a vastly more powerful fusion reaction
- Though there was a wartime “super” group, it made little progress
- Edward Teller and Stan Ulam jointly produced a breakthrough concept
- On October 31, 1952 Ivy Mike became the world’s first full-scale thermonuclear device (**10.4 Mt: 700 x more powerful than Little Boy!**)
- On November 15, Ivy King was tested
- At 500 kt, it was the largest fission-only device the U.S. ever tested

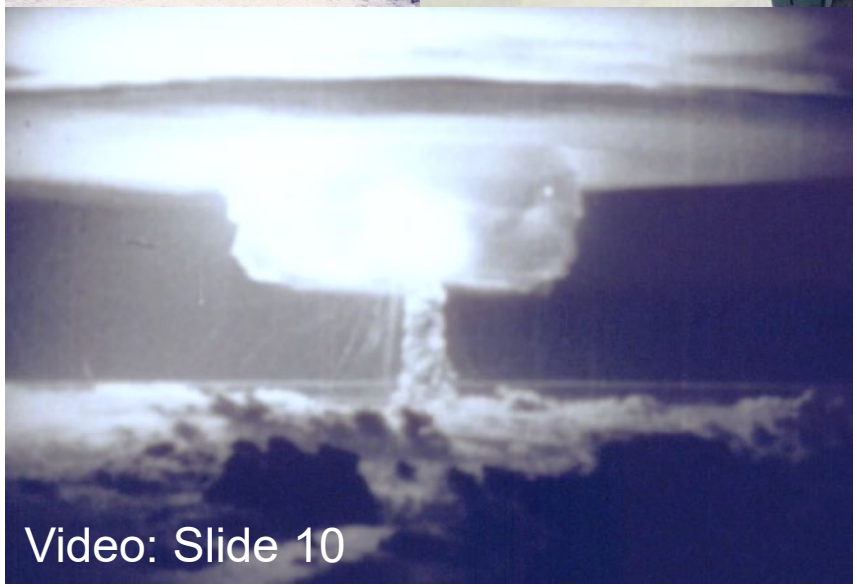
The Advent of Tactical Nuclear Weapons



- As the arms race accelerated, the Soviet Union continued to rely heavily on conventional numerical superiority
- In response, the United States relied on superior technology and firepower
- Part of that doctrine included the development of atomic artillery
- Such weapons, which could operate despite inclement weather, offered pinpoint accuracy and tactical agility
- The first tactical nuclear weapons system was an 280mm canon dubbed “Atomic Annie”
- Upshot-Knothole Grable was conducted May 25, 1953 (15 kt)
- The shell travelled seven miles before detonating 500 feet above the ground

Weaponizing Fusion: Operation Castle

- On August 12, 1953, the Soviet Union tested a deliverable thermonuclear weapon
- In response, the United States conducted Operation Castle in the spring of 1954
- The Castle devices were America's first deliverable thermonuclear weapons
- The first (of six) tests was Bravo
- At 15 Mt (**1,000 x more powerful than Little Boy!**), Bravo was significantly more powerful than predicted
- ~236 Marshallese Islanders were evacuated on an emergency basis
- The danger of fallout gradually eclipsed the Soviet Union as a threat



Let Bert Show YOU How to Survive a Nuclear War!

- The Civil Defense (CD) Program became an extension of deterrence
- Especially in the days prior to Mutual Assured Destruction (MAD), much thought was given to surviving nuclear war
- Many weapons tests during this era focused on the survivability of civilian and military assets
- But as nuclear stockpiles and weapons yields grew to enable MAD, CD very gradually received less emphasis

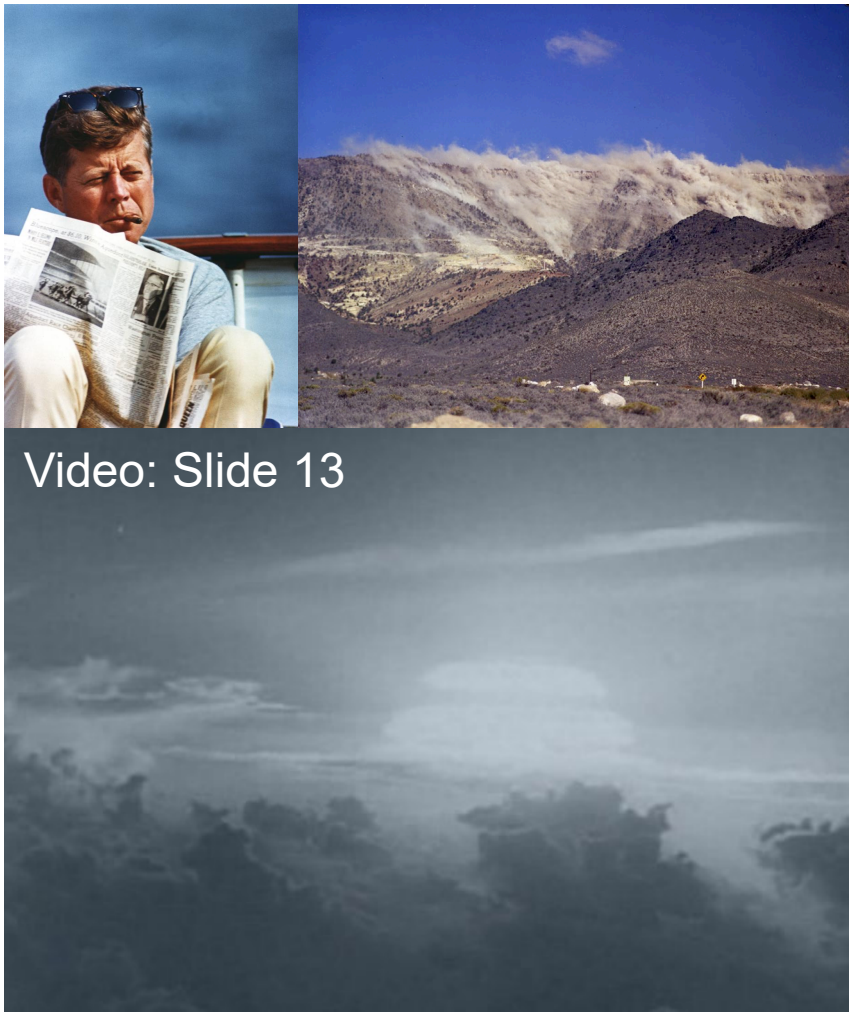
Hardtack: Running to Stand Still

- Hydrogen bombs were greatly refined in Operation Redwing (1956)
- 28 tests were performed in Plumbbob (1957), the largest series to date
- Though the Soviets entered a unilateral test moratorium, Operation Hardtack began: 34 tests between April 28 and Aug. 18, 1958
- After announcing the U.S. would enter a test moratorium at the end of October, Hardtack II began: 36 tests in 49 days!
- Most shots were safety tests
- In November 1958, the Soviet Union and the United States entered a year-to-year test moratorium
- Nonetheless, in the years 1959 through 1962, the U.S. built nearly **24,000 pits!**

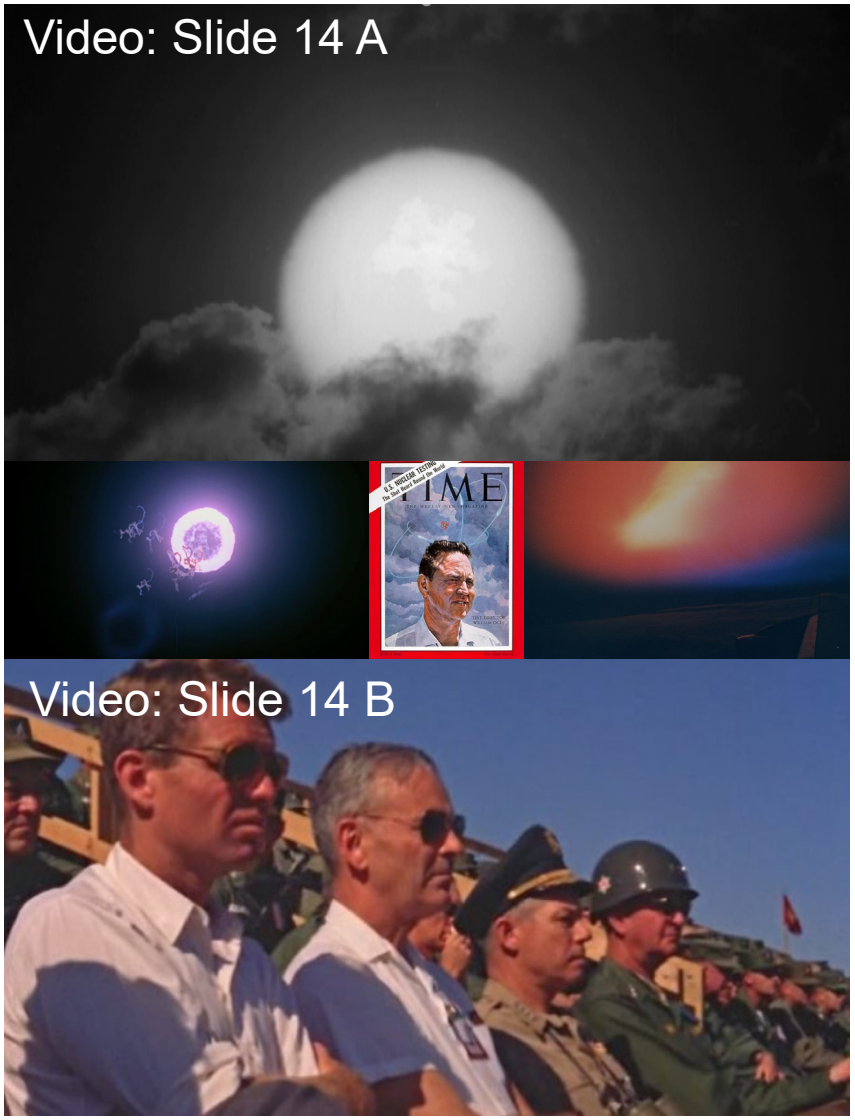
(*what's taking so long, TA-55???*)

Nougat: “The LASL Goes Underground”

- **SURPRISE**: The Soviet Union resumed testing (with only one day’s notice) on September 1, 1961
- They would go on to perform **59 tests in the next 65 days**: the largest series by megatonnage in history!
- September 15: The first U.S. test was Nougat Antler, a Livermore shot (2.6 kt)
- It leaked! … but all 10 of the tests conducted in 1961 leaked
- Los Alamos fired Shrew the next day (“low” yield)
- On October 30th, the Soviet Union tested the largest bomb of all time: the **~50 Mt** “Tsar Bomba”
- 50 Mt is the equivalent of nearly 3,500 Little Boys!



The Final Days of Atmospheric Testing

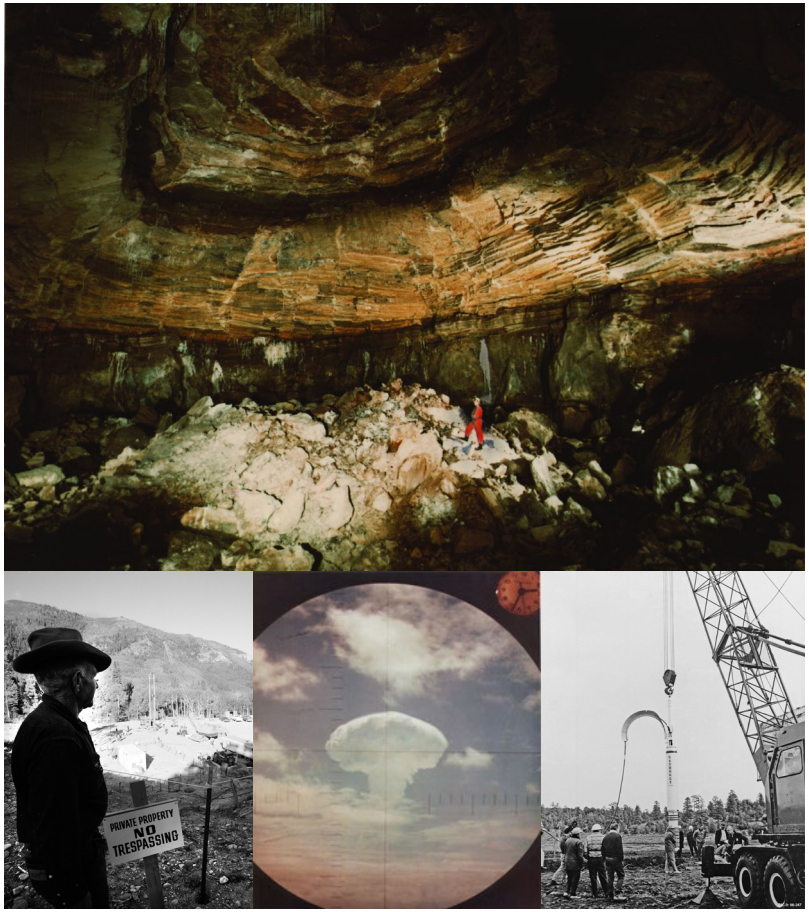


- Spurred by the Tsar Bomba test and the fear of lagging in EMP research, the U.S. resumed atmospheric testing
- The final days of U.S. atmospheric testing ran from April 25, 1962 to Nov. 4, 1962
- Little Feller I: Last atmospheric test at Nevada, a full-system test of a Davy Crocket, was conducted July 17
- The Cuban Missile Crisis unfolded; nuclear war was narrowly averted
- Dominic-Tightrope: A week after the crisis ended, LASL performed the final U.S. atmospheric test (Nov. 4)
- Less than a year later came the Limited Test Ban Treaty (Oct. 10)
- Testing continued underground

Going Underground for Good (*...kinda!*)

- A vast majority of tests were conducted underground in Nevada
- Boxcar (4/26/68) was the largest test at NTS (UGT or otherwise): 1.3 Mt
- 158 vertical shafts leaked (39 LANL, 119 LLNL) during the era of testing
- A Livermore test, Emery-Baneberry, changed everything (12/18/70)
- Only a few tests leaked after the Baneberry disaster; those were relatively minor
- 1974: The Threshold Test Ban Treaty limited explosions to 150 kt, but didn't enter force until 1990
- The last Soviet test was conducted on October 24, 1990
- NTS hosted 904 tests (804 UGTs)

Where Else Did We Test?



The U.S. also performed tests in central Nevada; near Fallon, Nevada; in the Johnston Island area; in the Christmas Island area; and at sea in the Pacific.

- In the late summer of 1958, Los Alamos performed three tests in the South Atlantic (Operation Argus)
- In addition to Trinity, New Mexico hosted two more tests: Gnome (12/61) and Gasbuggy (12/67)
- Both were Livermore Plowshares tests
- In 1964 and 1966, Livermore performed Vela Uniform tests near Hattiesburg, Mississippi
- In 1969, Los Alamos performed a Plowshares test called Rulison near Colorado's Grand Valley
- Los Alamos and Livermore performed three tests near Amchitka, Alaska
- In 1973, Livermore detonated three devices simultaneously near Rifle, Colorado; another Plowshares test

The Last Act: Operation Julin

- Between 1945 and 1992, the U.S. conducted 1054 nuclear tests
- By the late 1980s, it was becoming clear testing would end
- Weapons in the stockpile were (***are!***) robust, sophisticated and could fulfill all the missions set forth by the military
- But they were not designed to last forever: enter Stockpile Stewardship
- The Senate voted for a nine-month testing moratorium on September 13, 1992; it would go into effect at the end of that month
- What proved to be the last U.S. full-scale test was conducted September 23, 1992
- During the era of testing, it has been estimated the U.S. produced ~190 Mt of energy (USSR, ~285 Mt)

How Do We Test Today?

- It's been nearly 30 years since the U.S. performed a full-scale test!
- Full-scale testing was an enormous advantage your predecessors had!
- They didn't need to fully understand phenomena associated with testing
- In the past, Los Alamos performed fission-producing hydronuclear tests
- Today, we use a variety of tools to assess the stockpile:

  -DARHT
  -Subcritical Testing in Nevada
  -The Centrifuge Facility
  -The Blast Tube Facility
  -The Trinity Supercomputer
  -Approximately 1000 experiments each year

- And it's a good thing we have these tools: **Today's technical challenges, are both exciting and essentially unprecedented!**

Nuclear testing was a wonderful tool. It was also the world's biggest shortcut. It meant that we didn't have to understand all the details of a nuclear weapon and how it functions.

- Joe Martz, RRW Program Manager

Testing Trivia

- The U.S. conducted1,054 full-scale nuclear tests (1,033 + 24 joint U.S.-U.K.)
- More tests were conducted in 1962 than in any other year: 96
- There were 210 atmospheric tests, 815 underground tests and 5 underwater tests
- 106 tests were performed in the Pacific; 3 in the Atlantic
- 904 tests were conducted at the Nevada Test Site, an area larger than Rhode Island (1,351 vs. 1,212 square miles)
- Jangle-Uncle was the first “official” underground test (UGT) according to DOE
- Pascal-A was the first *real* UGT
- Livermore’s Rainier test (1.7 kt) of 9/57 was the first successfully contained UGT
- Plumbbob-Hood (74 kt) was the largest atmospheric test at the Nevada Test Site

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