LA-UR-18-30976
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Title:	Los Alamos National Laboratory Overview
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Intended for:	Presentation at University of Rhode Island
Issued:	2018-11-19

Los Alamos
NATIONAL LABORATORY
EST.1943

Delivering science and technology
to protect our nation
and promote world stability

NNSA
National Nuclear Security Administration

Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

Los Alamos National Laboratory Overview

University of Rhode Island

Carolynn P. Scherer, PMP

Systems Design & Analysis Group (NEN-5)
Nuclear Engineering and Nonproliferation (NEN) Division
Los Alamos National Laboratory

October 25, 2018

Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

LA-UR-17-21700, LA-UR-17-24840

Agenda

October 24, 2018

University of Rhode Island

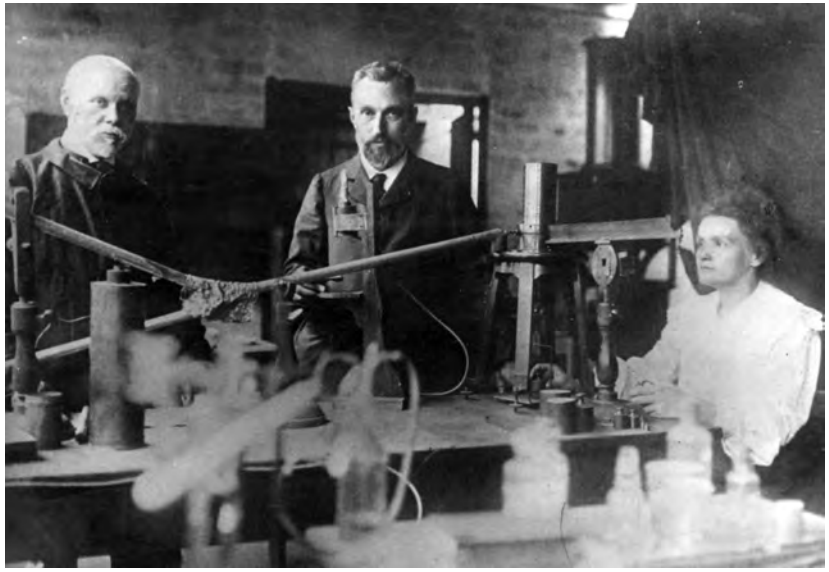
- **History of Radioactivity & Birth of Atomic Era**
- **Atoms for Peace and the IAEA**
- **Proliferation and the Cold War**
- **Los Alamos National Laboratory**
- **University Challenges**

History of Radioactivity & Birth of Atomic Era

Discovery of Radioactive Materials

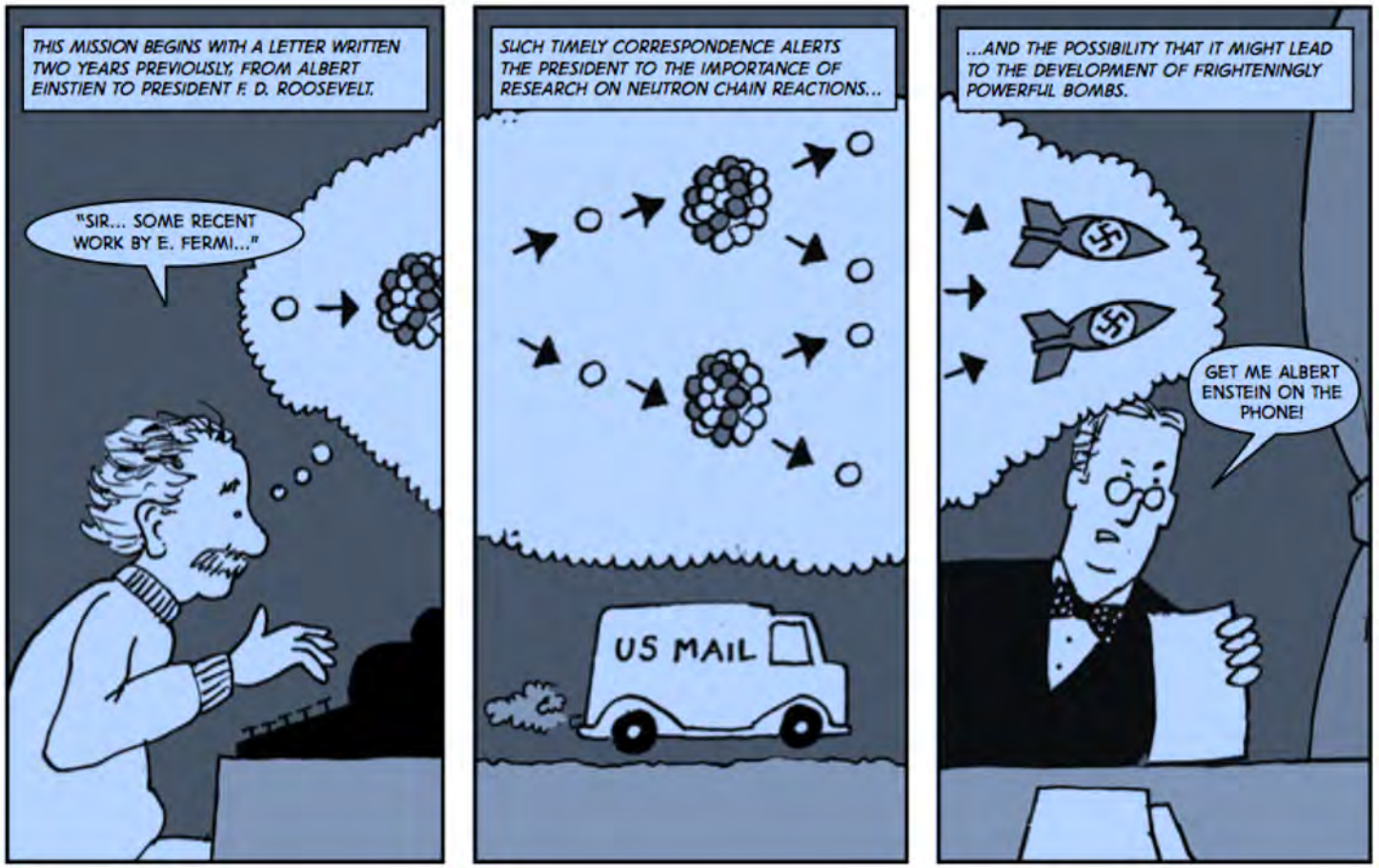
- 1895 – Wilhelm Roetengen discovered new rays (invisible light), he named X-Rays (took photo of wife's hand's skeletal structure)
- 1896 – Henri Becquerel discovered uranium salts gave off similar rays
- 1896 – Marie Curie, doctoral student named phenomenon radioactivity and did research on radioactive materials (polonium and radium) [Nobel Prizes: physics & chemistry]

Radioactivity



Marie and Pierre Curie with Henri Becquerel

Birth of Project Y



Einstein's Letter

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

-2-

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an unofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States;

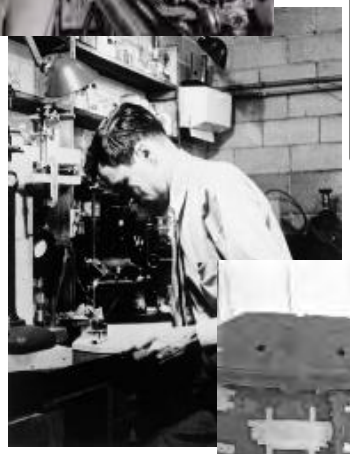
b) to speed up the experimental work,which is at present being carried on within the limits of the budgets of University laboratories, by providing funds, if such funds be required, through his contacts with private persons who are willing to make contributions for this cause, and perhaps also by obtaining the co-operation of industrial laboratories which have the necessary equipment.

I understand that Germany has actually stopped the sale of uranium from the Czechoslovakian mines which she has taken over. That she should have taken such early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizsäcker, is attached to the Kaiser-Wilhelm-Institut in Berlin where some of the American work on uranium is now being repeated.

Yours very truly,
A. Einstein
(Albert Einstein)

Source for letter: http://hypertextbook.com/eworld/einstein.shtml
Source for photo: http://nnsa.energy.gov/aboutus/ourhistory/timeline/albert-einstein-alerts-president-roosevelt-german-atomic-energy-program

The Manhattan Project (1942-1945)

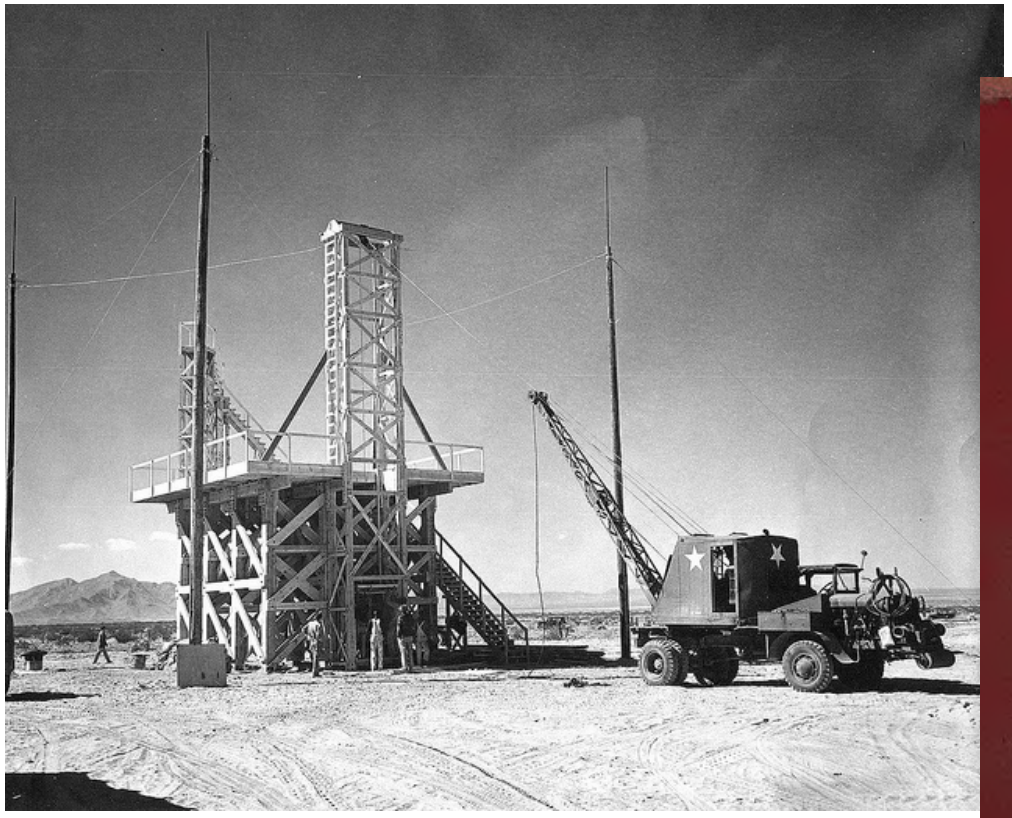


All photos DOE/public domain

M Hansen—Time Life Pictures

Established an enduring link between the Federal Government and Science

First Nuclear Explosion – Trinity Site



Alamogordo, NM, July 16, 1945

https://www.flickr.com/photos/losalamosnatlab/

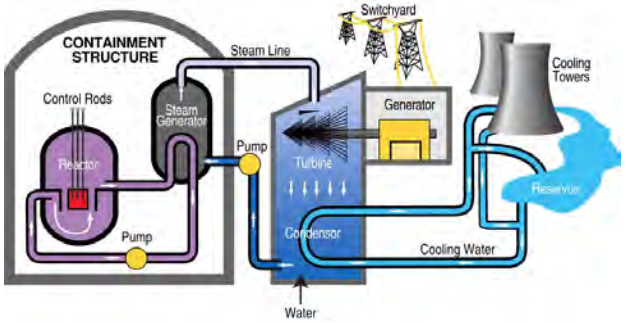
Atoms for Peace & the International Atomic Energy Agency

Atoms for Peace to International Atomic Energy Agency

- **Atoms-for-Peace Program - Dec. 8, 1953, President Dwight D. Eisenhower**
- **Treaty on the Non-Proliferation of Nuclear Weapons (NPT)**
  - Open for signatures in 1968
  - 191 States joined
  - Safeguards system under IAEA
  - 5 Nuclear Weapons States
    - USA
    - Russia - 1949
    - UK - 1952
    - France -1960
    - China - 1964
- **Proliferation**
  - India (1974), Pakistan (1983), N. Korea (2006)

https://www.armscontrol.org/factsheets/nucleartesttally
http://www.britannica.com/EBchecked/media/120679/Dwight-D-Eisenhower-delivering-his-Atoms-for-Peace-speech-to
http://archive.vod.umd.edu/EisenhowerAtomsforPeace.htm

Peaceful Uses of Nuclear Technology

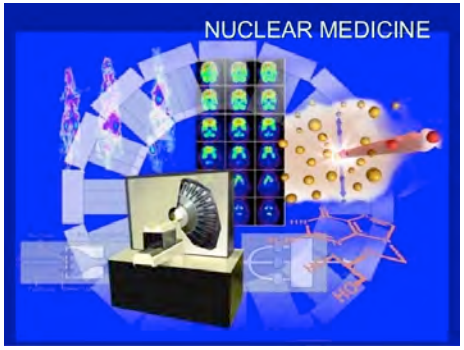


Nuclear Power Plants

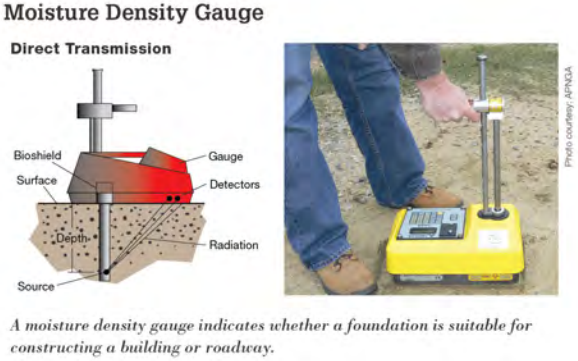
Home

Agriculture

- Food Irradiation
- Insect Control



Human Health:
Diagnostics &
Therapy



A moisture density gauge indicates whether a foundation is suitable for constructing a building or roadway.

Industry

- Carbon Dating
- Oil Industry
- Civil Engineering

International Atomic Energy Agency (IAEA)

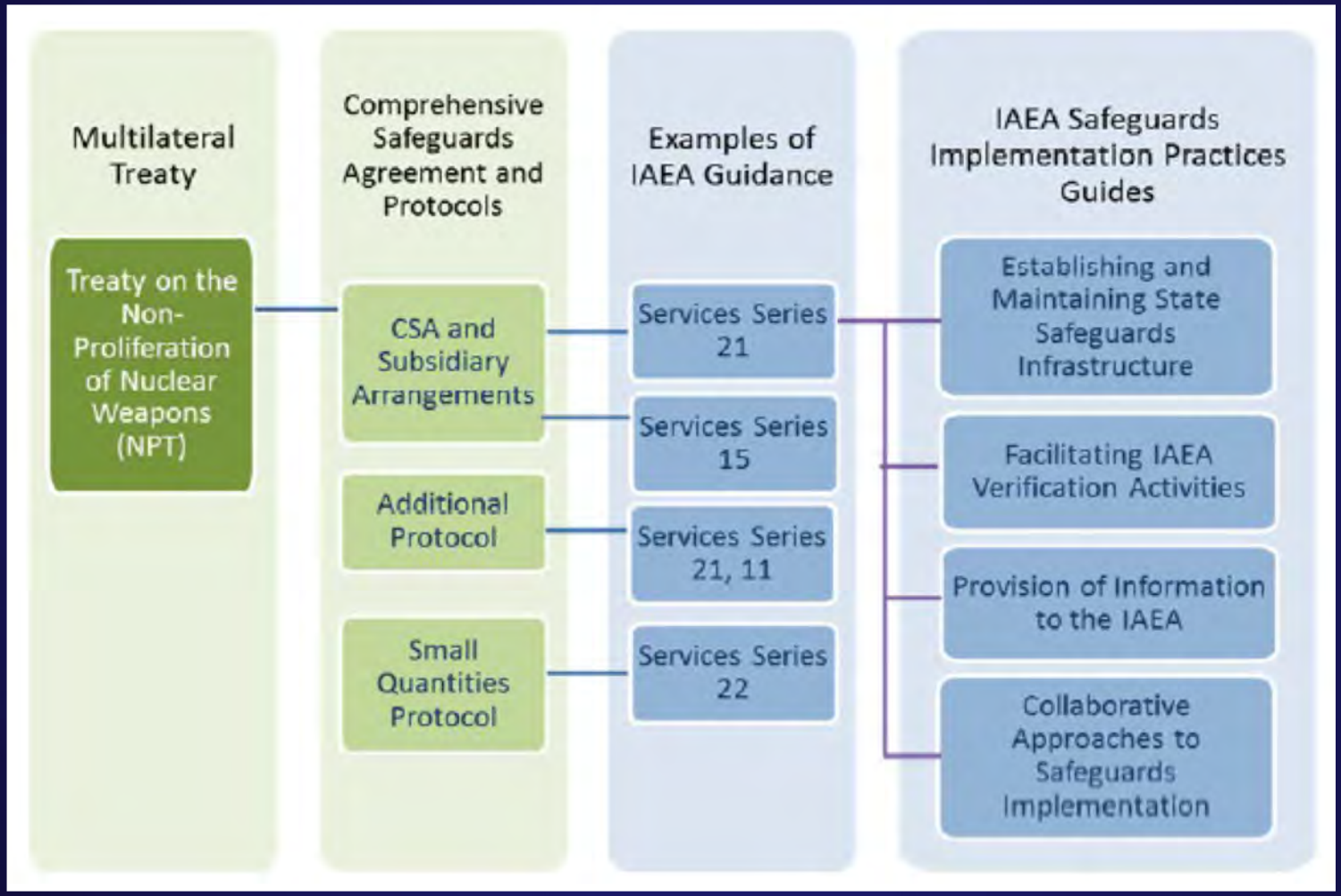
- **Within the United Nations (UN)**
- **Established in 29 July 1957**
- **International Organization**
  - Promote peaceful use of nuclear energy
  - Inhibit its use for military purposes, including nuclear weapons
- **Located in Vienna, Austria**

International Atomic Energy Agency
IAEA

https://www.flickr.com/photos/iaea_imagebank/

https://www.iaea.org/newscenter/multimedia/photoessays/60-years-60-pictures-an-overview-of-the-iaeas-work

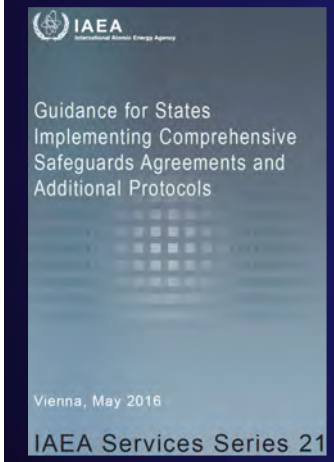
IAEA Safeguards Agreements



Nuclear Requirements – 3Ss

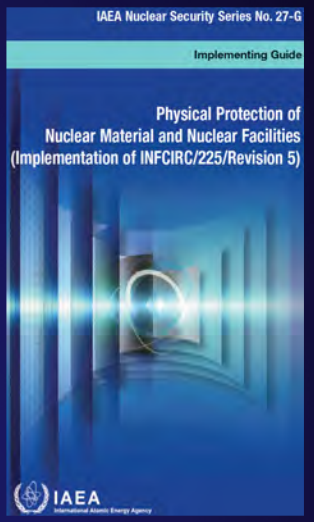
Safeguards

- IAEA thru Comprehensive Safeguards Agreements
- State reports to IAEA
- IAEA verifies with inspections



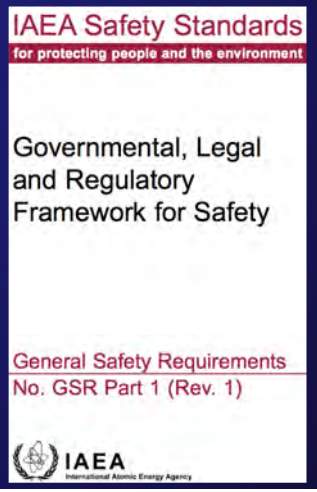
Security

- State regulator
- Recommendations from the IAEA
  - Guards/Gates/Guns
  - Nuclear material accounting and control
  - Facility reports to the State
- State inspections



Safety

- Protecting people and the environment
- Legal and Regulatory framework
- Usually based on international best practices
- State regulator
- Recommendations from the IAEA



IAEA Safeguards Agreements - Verification

- **Legally Binding Agreements**
- **Verifications and Inspections**
  - **States Reports of Inventories**
    - Accounting inspections at facilities
    - Nuclear material measurements
    - Sample analysis
  - **Design Information (DIV)**
    - Compare design information of State with in-field inspections
    - Environmental sampling

https://www.flickr.com/photos/iaea_imagebank

https://www.iaea.org/newscenter/multimedia/photoessays/60-years-60-pictures-an-overview-of-the-iaeas-work

Proliferation and The Cold War

Nuclear Weapons Testing (1945-1996)

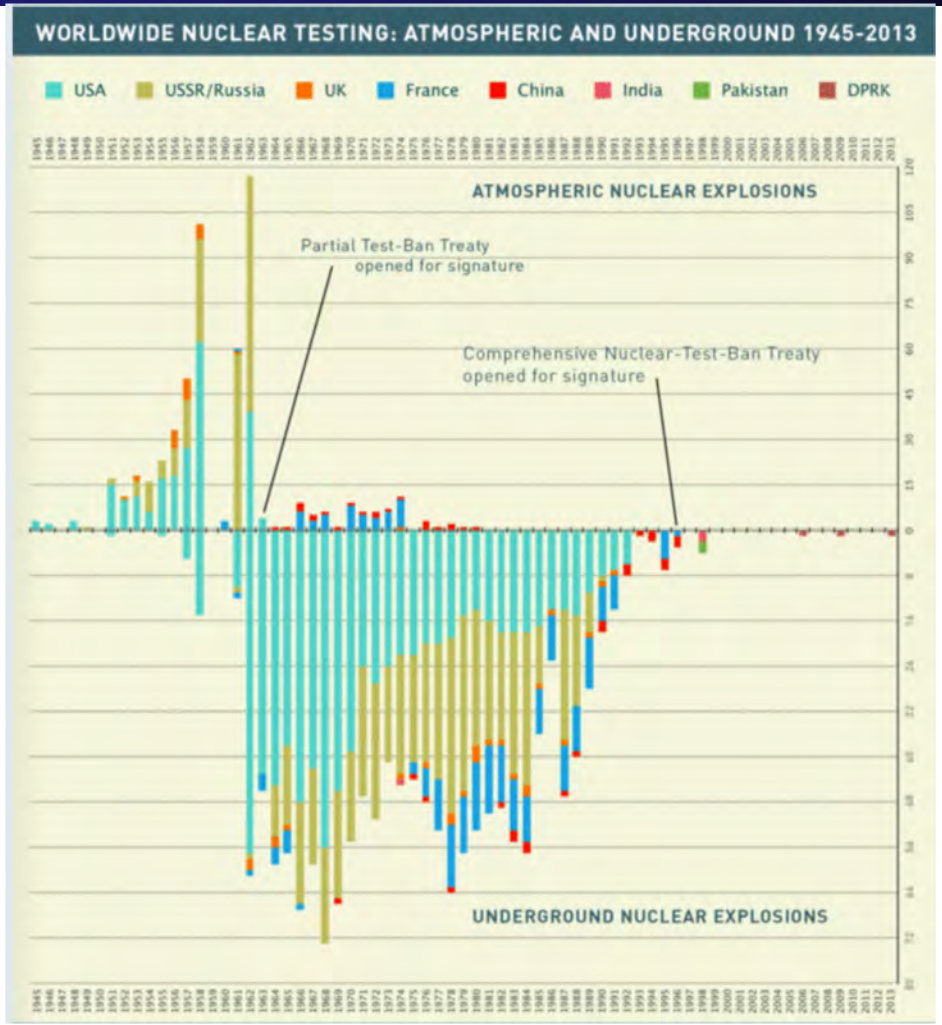

US Navy/Public Domain


NNSA/Public Domain

Worldwide Nuclear Testing, 1945-2013

- **Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water,(1963) [Also called: Limited Test Ban Treaty or LTBT]**

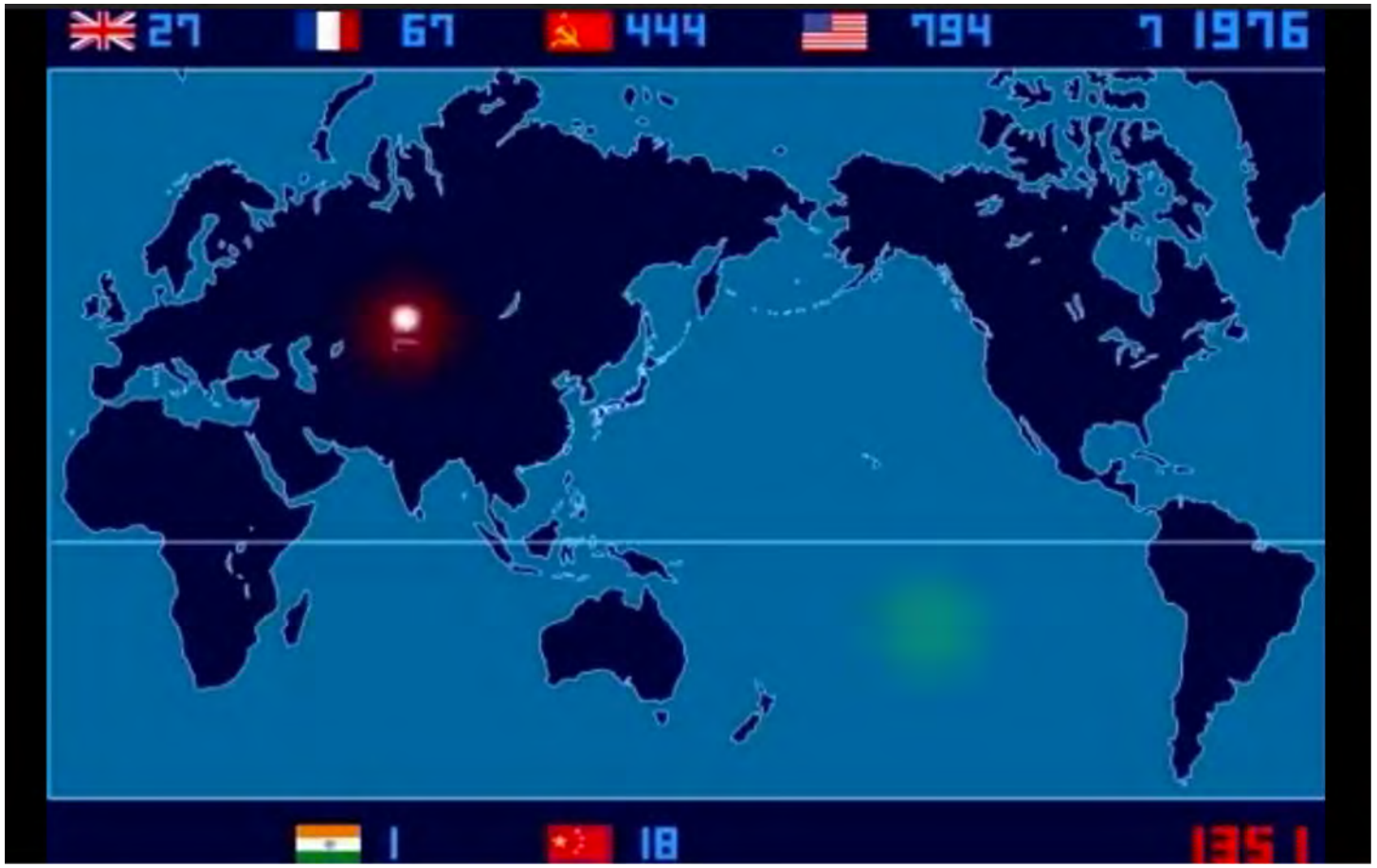
- **Comprehensive Nuclear-Test Ban Treat (CTBT), 1996**



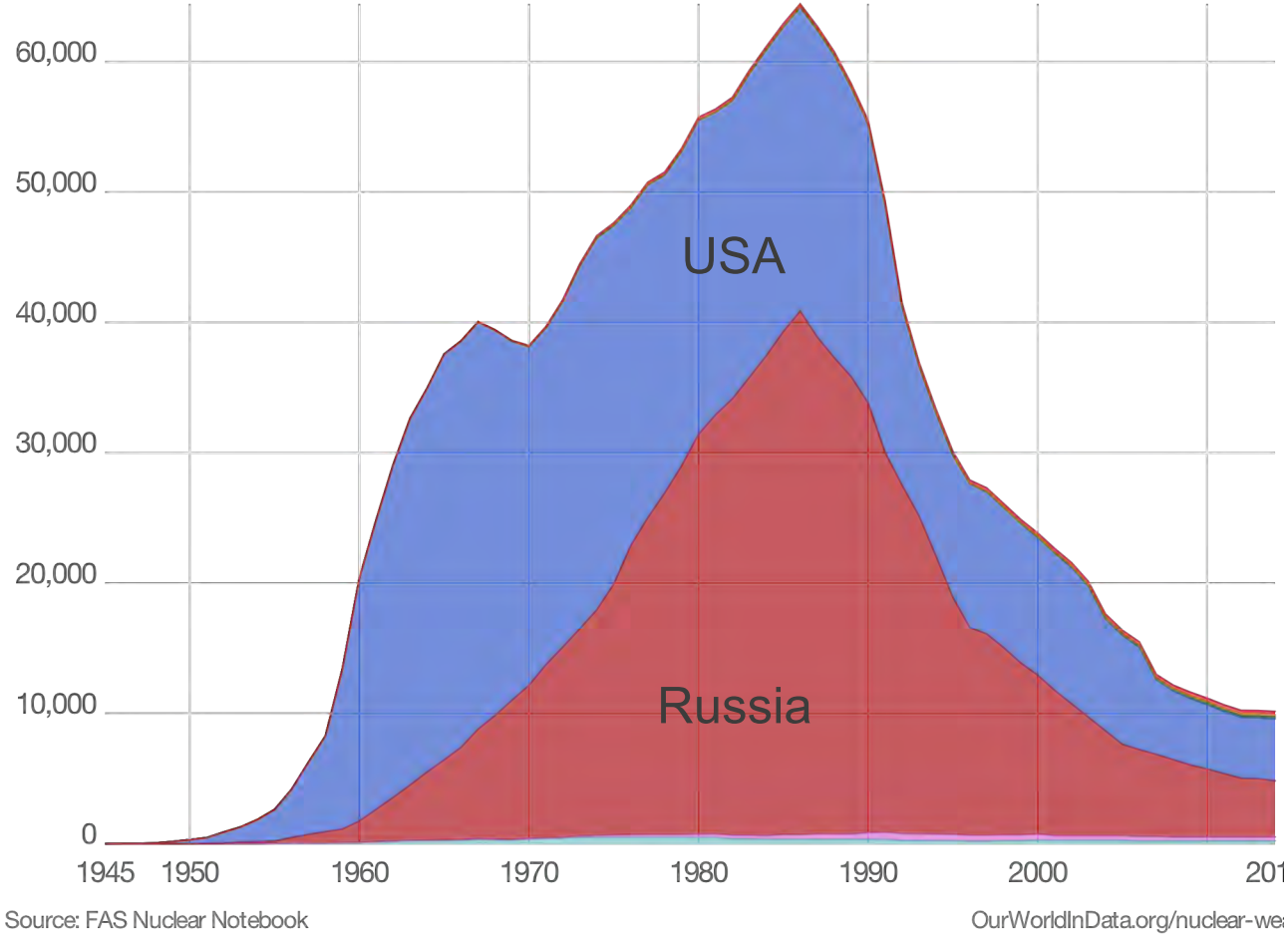
https://www.ctbto.org/nuclear-testing/history-of-nuclear-testing/nuclear-testing-1945-today/

Time Lapse of Nuclear Explosions Since 1945

https://www.youtube.com/watch?v=LLCF7vPanrY



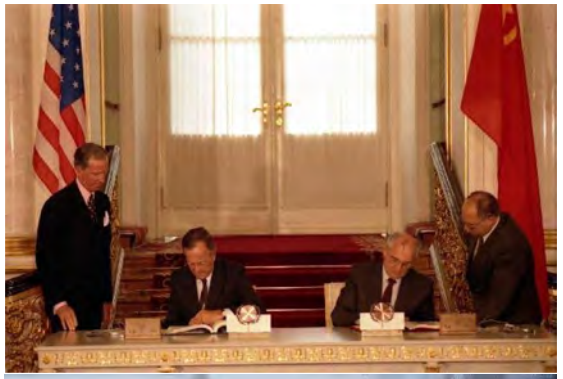
Nuclear Warheads by the Numbers



https://ourworldindata.org/nuclear-weapons

Cold War and Arms Reduction

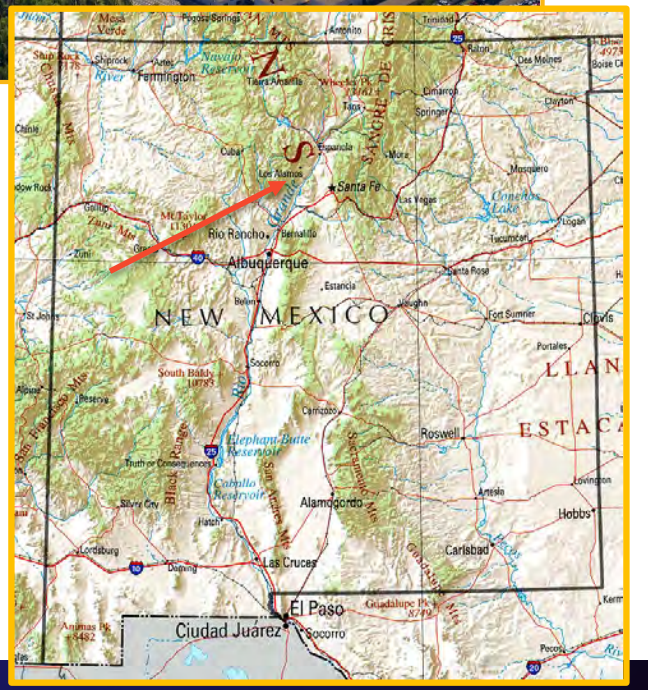
- **1947-1991: Cold War**
  - Between Soviet Union and United States
  - Escalation in nuclear weapons stockpiles
- **1987 – Intermediate-Range Nuclear Forces Treaty (INF)**
  - Signed by Gorbachev and Regan
  - Eliminated short (500-1000 km) and intermediate (1,500-5,500 km) range nuclear and conventional missiles, and launchers
  - Allowed on site verification inspections
- **1991 – Strategic Arms Reduction Treaty (START I)**
  - Signed by Gorbachev and GHW Bush
  - Reduction and limitation of strategic offensive arms
- **1993 – START II**
  - Singed by GHW Bush and B Yeltsin
  - Banned multiple independently targetable reentry vehicles (MIRV) on intercontinental ballistic missiles (ICBM)
  - Never entered into effect



http://www.reagan.utexas.edu/archives/photographs/large/c44071-15a.jpg
By Susan Biddle - http://bushlibrary.tamu.edu/research/gallery.php?id=37, Public Domain, https://commons.wikimedia.org/w/index.php?curid=9967743
https://upload.wikimedia.org/wikipedia/commons/a/ad/George_H._W._Bush_and_Boris_Yeltsin_1993.jpg

Manhattan Project (Site Y) - 1943
Los Alamos Scientific Laboratory – 1943-1981
Los Alamos National Laboratory – 1981-

Los Alamos National Laboratory



Atomic Energy Commission (AEC) to DOE/NNSA

- 1946-1975: Atomic Energy Commission (AEC) – to foster and control the peacetime development of atomic science & technology
- 1974: Nuclear Regulatory Commission (NRC) and Energy Research and Development Administration (ERDA)
- 1977: Department of Energy (DOE) created, assumed responsibilities of ERDA
- 2000: National Nuclear Security Administration (NNSA) under DOE

Signing the Atomic Energy Act. On August 1, 1946, President Harry S. Truman signed the bill creating the U.S. Atomic Energy Commission. The members of the Senate Special Committeee on Atomic Energy attended the signing ceremony in the President's oval office at the White House. Ranged around the President are left to right: Senators Tom Connally, Eugene D. Millikin, Edwin C. Johnson, Thomas C. Hart, Brien McMahon, Warren R. Austin, Richard B. Russell.

https://www.energy.gov/sites/prod/files/AEC%20History.pdf

LANL is a DOE/NNSA Laboratory

Office of Science Laboratories

1. **Ames Laboratory**
   Ames, Iowa
2. **Argonne National Laboratory**
   Argonne, Illinois
3. **Brookhaven National Laboratory**
   Upton, New York
4. **Fermi National Accelerator Laboratory**
   Batavia, Illinois
5. **Lawrence Berkeley National Laboratory**
   Berkeley, California
6. **Oak Ridge National Laboratory**
   Oak Ridge, Tennessee
7. **Pacific Northwest National Laboratory**
   Richland, Washington
8. **Princeton Plasma Physics Laboratory**
   Princeton, New Jersey
9. **SLAC National Accelerator Laboratory**
   Menlo Park, California
10. **Thomas Jefferson National Accelerator Facility**
    Newport News, Virginia

Other DOE Laboratories

1. **Idaho National Laboratory**
   Idaho Falls, Idaho
2. **National Energy Technology Laboratory**
   Morgantown, West Virginia
   Pittsburgh, Pennsylvania
   Albany, Oregon
3. **National Renewable Energy Laboratory**
   Golden, Colorado
4. **Savannah River National Laboratory**
   Aiken, South Carolina

NNSA Laboratories

1. **Lawrence Livermore National Laboratory**
   Livermore, California
2. **Los Alamos National Laboratory**
   Los Alamos, New Mexico
3. **Sandia National Laboratory**
   Albuquerque, New Mexico
   Livermore, California

Nuclear Security Enterprise

1. Kansas City Plant
2. Lawrence Livermore National Laboratory
3. Los Alamos National Laboratory
4. Nevada National Security Site
5. Pantex Plant
6. Sandia National Laboratories
7. Savannah River Site
8. Y-12 National Security Complex

LANL Mission, Vision & Values

MISSION

To solve national security challenges through scientific excellence

VISION

To deliver science and technology to protect our nation and promote world stability

VALUES

- » *Excellence*
- » *Integrity*
- » *Teamwork*
- » *Stewardship*
- » *Safety & Security*

GOAL

We will deliver nuclear security and broader global security mission solutions

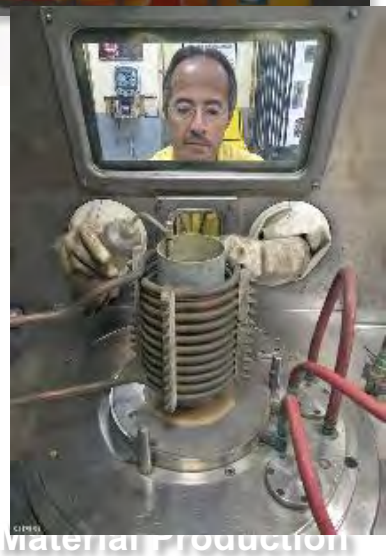
Our Capabilities are Essential to the U.S. Nuclear Deterrent

We use science-based stockpile stewardship to annually assure the Secretary of Energy, Secretary of Defense, and the President that the stockpile is

- **Safe,**
- **Secure, and**
- **Reliable**

Supercomputing

DARHT – Dual Axis Hydrodynamic Test Facility



Material Production

Global Security Program Spans Entire Nuclear Threat Spectrum

Three Principal Directorates

From Los Alamos National Security (LANS) to TRIAD National Security

Mission & Enabling Science, Tech., & Eng. (STE)

Weapons Mission

Mission Operations

Battelle Memorial Institute, The Texas A&M Univ. System & Univ. of California

Facts and Figures

Metropolis Center for Modeling & Simulation

High Explosive Laboratories

Los Alamos Neutron Science Center

Plutonium Processing Facility (TA-55)

SIGMA Building

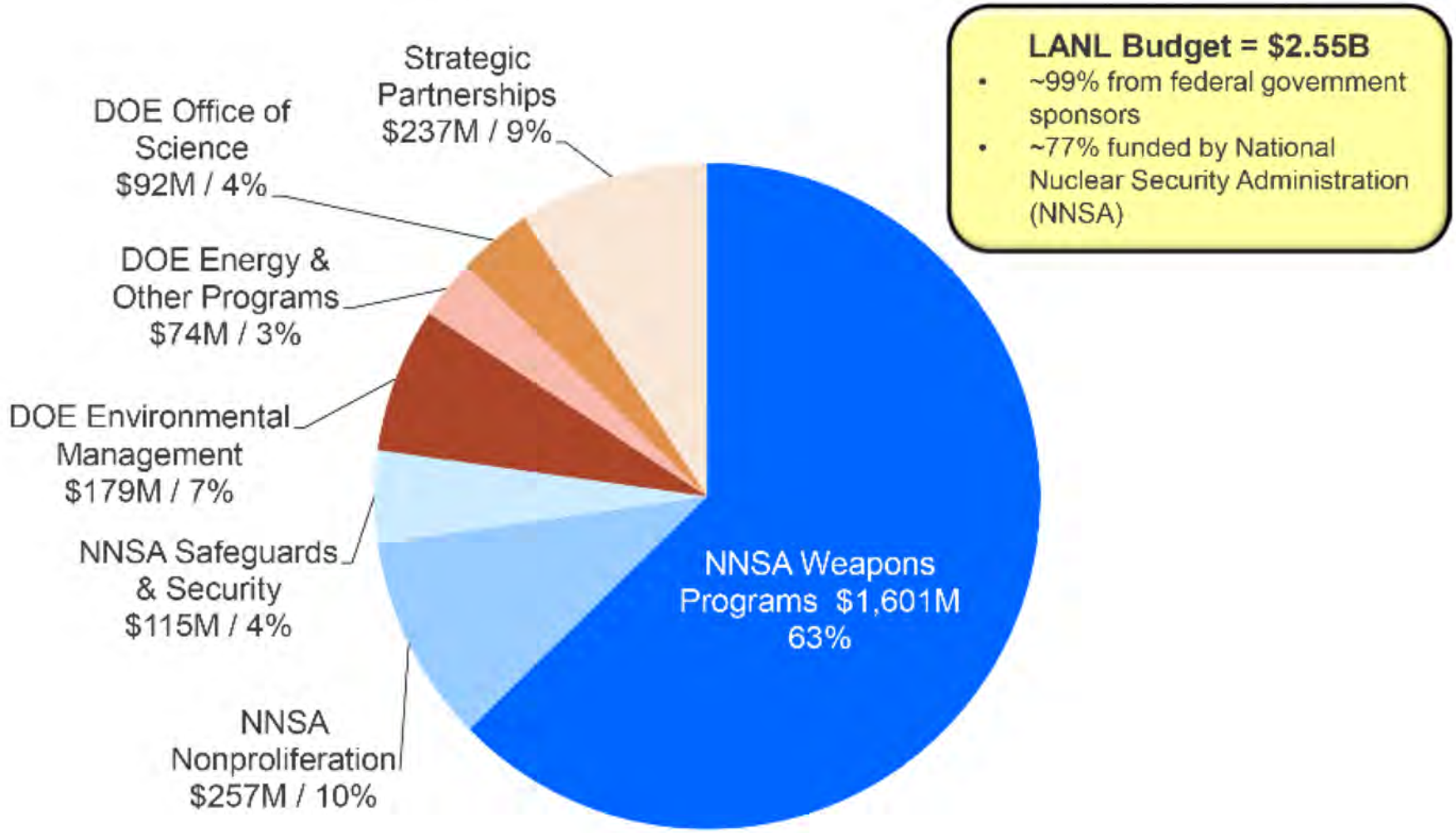
Dual Axis Radiographic Hydrotest Facility (DARHT)

- 40 square miles
- 47 technical areas
- 8.2 million ft^2 under roof
- 1,000 buildings
- 13 nuclear facilities
- 268 miles of road (100 paved)

Chemistry and Metallurgy Research (CMR) Building

Radiological Laboratory Utility Office Building (RLUOB)

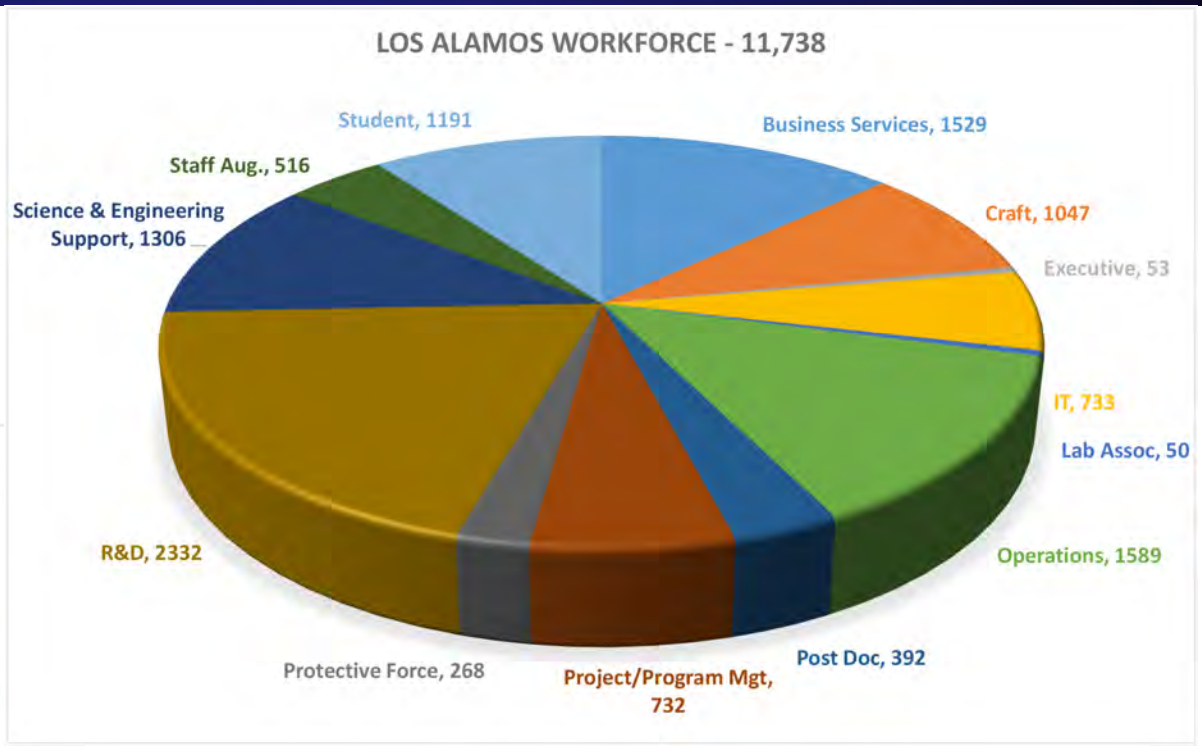
LANL – FY17 Budgets

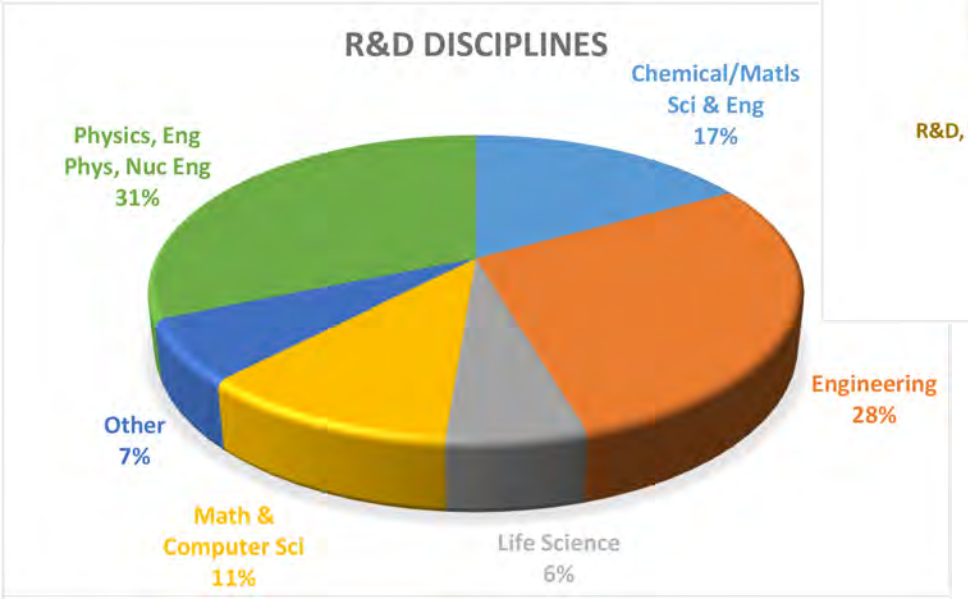


People are the Strongest Asset

March 2018:

- R&D and STE - 3638
- Students – 1191
- Post Docs 392



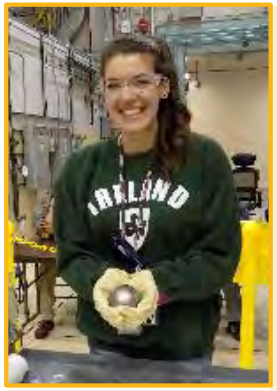


~36% of all Lab employees are former Lab students or postdocs
(61% for R&D scientists and engineers)

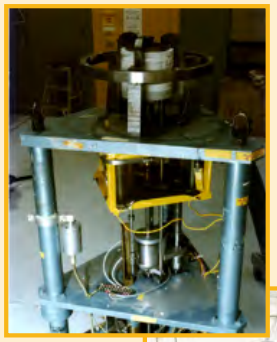
National Criticality Experiment Research Center (NCERC)

- **Mission**
  - Conduct experiments on critical assemblies with fissile material at or near criticality in order to explore reactivity phenomena, and to operate the assemblies in the regions from sub-critical through delayed critical.

- **Facility/Capabilities**
  - Cat I Special Nuclear Material (SNM)
  - Subject Matter Expertise
    - Critical experiments: Planet, Comet, Godiva IV, and Flat-Top
    - Sub-critical Experiments and Radiation Test Object Operations
- **Location**
  - At the Nevada National Security Site (NNSS)
  - Outside Las Vegas



4 Critical Assemblies and Lots and Lots of Special Nuclear Material



New Mexico: The Land of Enchantment

University Challenges

Safeguards by Design (SBD) 2016

University Engagement

Challenge #1:

Plutonium Waste Item Measurement System

Design a method for determining the nuclear material content of waste drums before they are moved to the NDA lab

Challenge #2:

Marine-Based Modular Reactor

Design marine-based modular reactor safeguards considering physical security, material control and accounting, nuclear security infrastructure, & IAEA inspections

Challenge #3:

Floating Nuclear Power Plant

Design FNPP safeguards considering physical security, material control and accountability, nuclear security infrastructure, & IAEA inspections

Challenge #4:

Spent Fuel Dry Cask Storage Design

Design a new cask for measuring signatures from spent fuel for improved monitoring of cask's nuclear material content, improve ALARA for workers

SBD University Challenges 2017-18

Transfer of Fuel Between Containment and Storage

- Extreme radiation and thermal environment
- Maintain continuity of knowledge of fuel

Automated HEPA Filter Replacement Method

- Online Filter Replacement
- Allow for measurement
- Limit exposure to workers

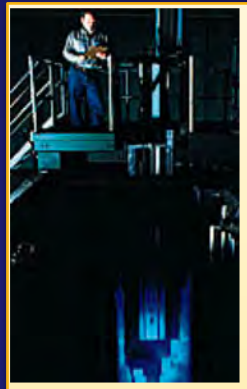
SBD University Challenges 2018-19

Challenge #1: Underwater Drone for Fuel Inspection (Team 25)

Design an underwater nuclear fuel inspection remotely operated vehicle for safeguards and safety

Challenge #2: Neutron Radiography Facility Design for RINSC (Team 26)

Design a neutron radiography facility for RINSC (Rhode Island: Nuclear Science Center)



Challenge #3: Nuclear Fuel Handling Device for Pool Research Reactors (Team 27)

Design a nuclear fuel handling device for pool research reactors for safeguards and safety

Los Alamos National Laboratory staff look forward to collaborating with students, and staff from University of Rhode Island and RINSC on safeguards by design challenge projects

References

- Map of NM: https://legacy.lib.utexas.edu/maps/new_mexico.html
- Smoke Detector: https://www.indiamart.com/proddetail/bosch-smoke-detector-and-bosch-fire-alarm-panel-15737382333.html
- Nuclear Power Plant: https://www.kisspng.com/png-nuclear-power-plant-electricity-generation-power-s-4955024/download-png.html#
- Nuclear medicine: https://www.slideshare.net/GauravKatheriya/nuclear-medicine-79955026
- Moisture Gauge: https://www.nrc.gov/materials/miau/industrial.html