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Los Alamos
NATIONAL LABORATORY

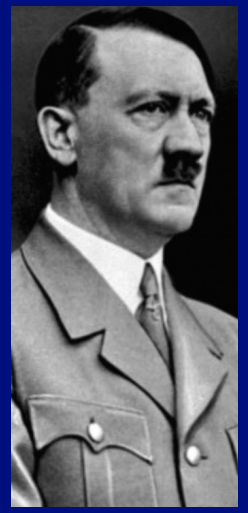
An Introduction to Los Alamos National Laboratory

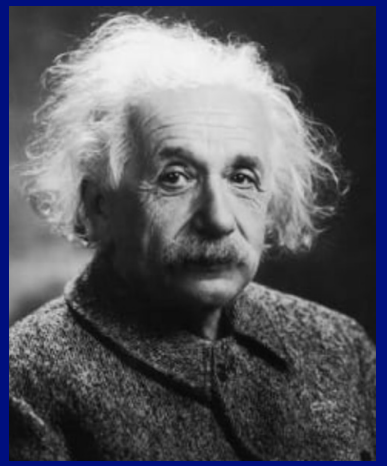
Paul D. Peterson, PhD.
Nuclear Explosives Safety Lead

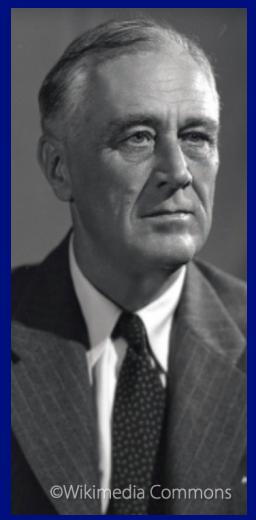
February 3, 2022

Just a little history. . . .

- September 30, 1938 Germany annexes part of Czechoslovakia (Munich Pact with England, France, and Italy).
- August 2, 1939, Albert Einstein writes a letter to Pres. Franklin Roosevelt (see below).
- September 1, 1939, Germany invades Poland. England and France then declare war on Germany.







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

August 2nd, 1939

F.D. Roosevelt,
President of the United States,

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

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)

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.

American work on uranium is now being repeated.

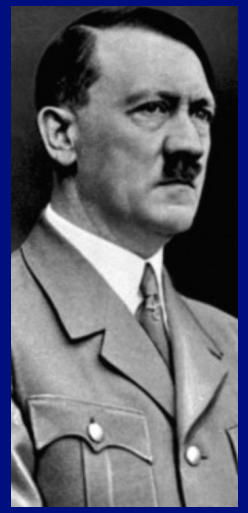
Yours very truly,

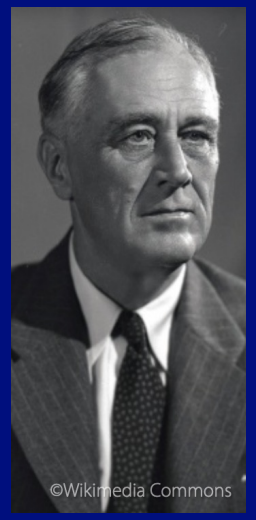
A. Einstein

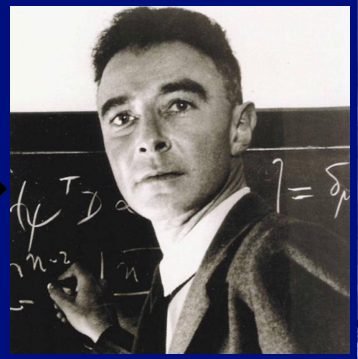
(Albert Einstein)

Just a little history. . . .

- December 7, 1941 – Japan attacks Pearl Harbor, drawing the United States into World War II
- In August 1942, General Leslie Groves and physicist Robert Oppenheimer are assigned a Top Secret Project to create a atomic bomb. Oppenheimer travels to several sites in Utah, Nevada, and New Mexico, eventually settling on a school for troubled boys in Los Alamos, New Mexico as the site for what was code-named the Manhattan Project.

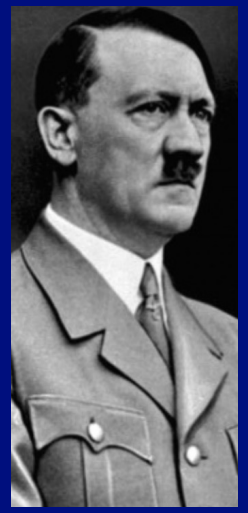


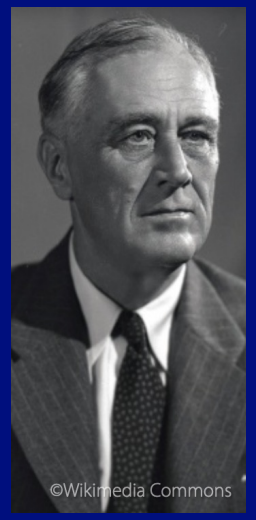


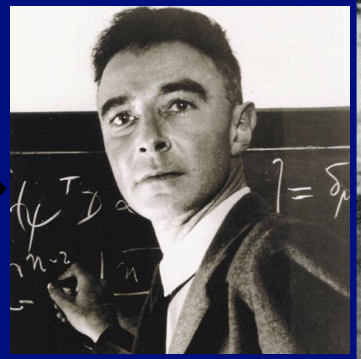


Just a little history. . . .

- January 1943 – Many of the leading U.S. Physicists, Chemists, and Engineers are recruited by the government and told to report to P.O. Box 1663, Santa Fe, NM. From there, they disappeared into the Jemez Mountains west of Santa Fe.
- Three different nuclear bomb designs were investigated – ~~Thin Man~~, **Little Boy**, and **Fat Man**.

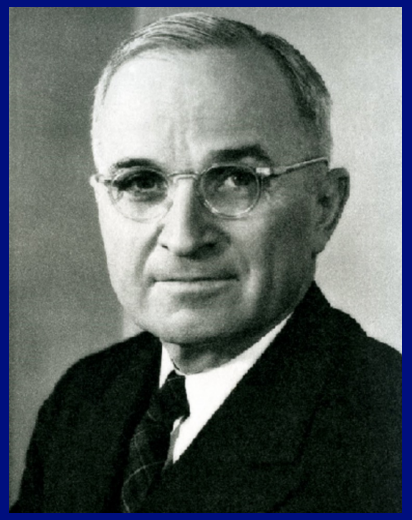




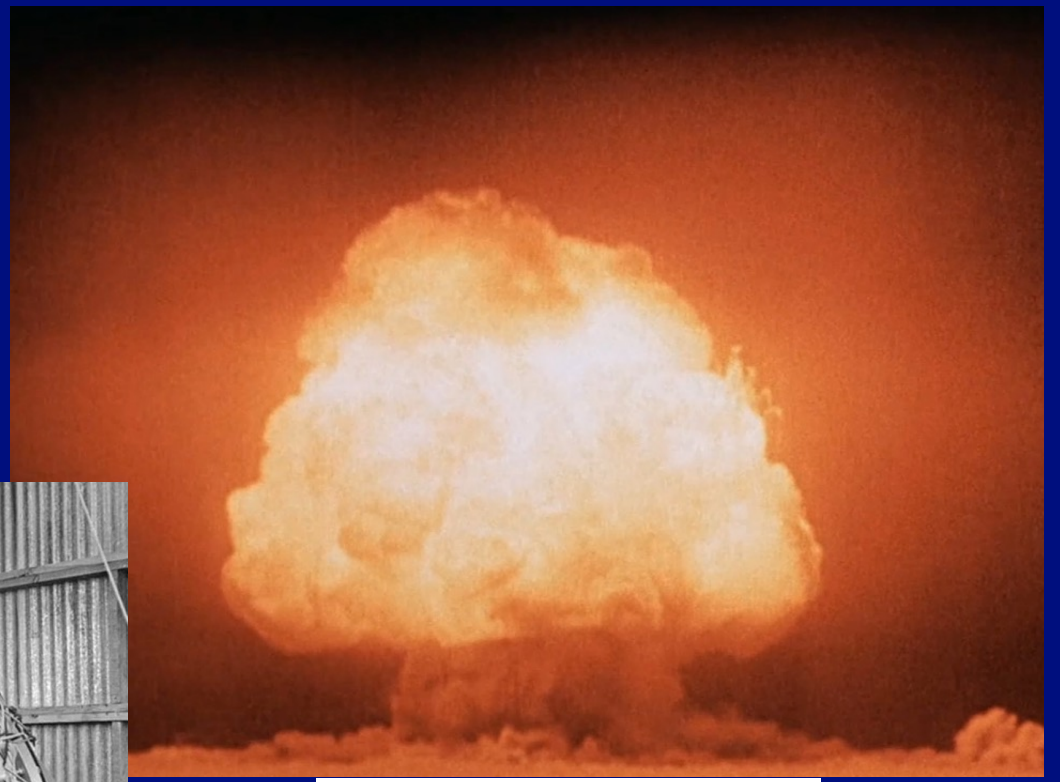


Just a little history. . . .

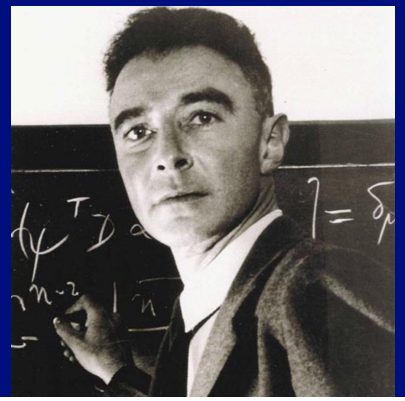
- April 12, 1945 – Roosevelt dies, Truman is sworn in as President and briefed about the of Manhattan Project for the first time.
- April 30, 1945 – Hitler is dead.
- May 8 1945 – VE Day
- July 16, 1945 – Trinity Test



The Gadget



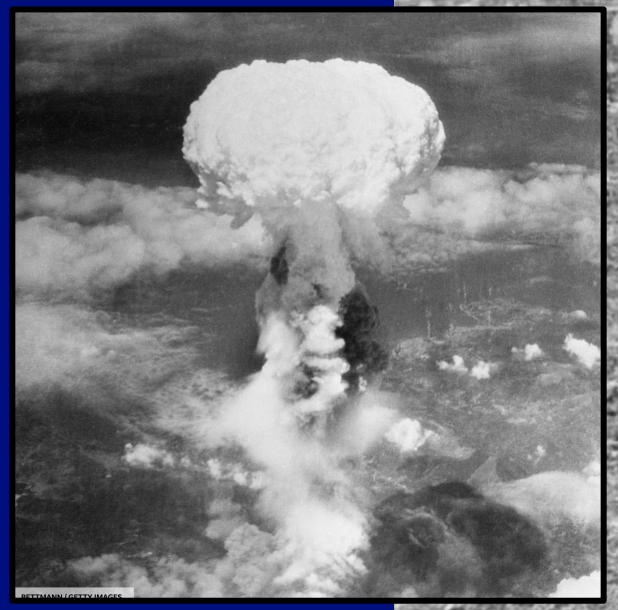
Trinity Test, July 16, 1945



"I have become death, the destroyer of worlds."

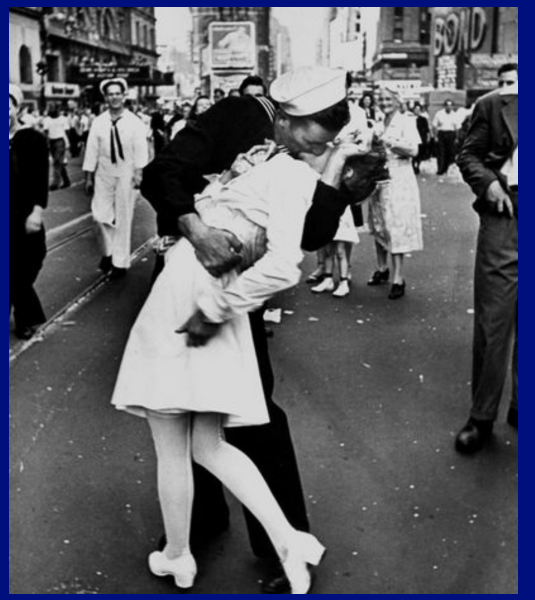
Just a little history. . . .

August 6, 1945 – Hiroshima
August 9, 1945 – Nagasaki
August 15, 1945 – VJ Day



A study done for Secretary of War Henry Stimson's staff by William Shockley estimated that invading Japan would cost **400,000–800,000 fatalities**, and **five to ten million Japanese fatalities.**

It's estimated that a total of **100,000 - 210,000 people** died in Hiroshima and Nagasaki either immediately or due to after effects such as radiation poisoning.



Los Alamos National Laboratory Today

- 11,000 employees
  - 2,200 PhDs
  - 1,100 veterans
  - 1,200 – 2,000 summer students
- $4B budget (FY2022)
- 36 square miles
- 1,280 buildings / 9M sq. feet
  - 11 nuclear facilities

Our world-class staff solves grand challenges on earth and in space

- Scientific capabilities developed in the course of LANL's stockpile research are applied to:
  - Climate change
  - Vaccine development & epidemic prediction
  - Cybersecurity, including disaster modeling for the energy grid
  - Space exploration and monitoring
- Flagship facilities—for plutonium, explosives, simulations, chemistry, and more—enable work that's impossible anywhere else

SuperCam, an instrument on the newest Mars Rover (photo by NASA/JPL – CalTech. At right, scientist Elizabeth Hunke holds an ice core.

2020 scientific output

22	2,168	8
Awards & fellows	Peer-reviewed publications	R&D 100 awards

There are only two types of engineers

- those who build bombs,

- and those who build targets.

92% of the Weapons in the Current US Stockpile

The Weapon Systems Engineering Division (W) provides the system engineering and program management necessary to sustain the safety, reliability, and security of the Los Alamos National Laboratory's assets in the active United States nuclear stockpile - the B61, W76, W78 and W88. The Division generates key certification data for Annual Assessment supporting the Laboratory Director's letter to the President on the health of those warheads. This role demands ongoing surveillance of the active stockpile and evaluation of the potential impact of any issues through design, engineering, fabrication, testing using state-of-the-art computational simulation tools and engineering test facilities. The Division works in close liaison with the several production facilities across the nuclear security complex as well as with the customers in the US Navy and Air Force.

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Los Alamos Nat'l Lab Weapon Systems Engineering Division (W)

Offices

- W-EP, Engineering Programs
- W-UCSC, Use Control Coordinator
- ***W-NES, Nuclear Explosive Safety***
- W-MSO, Military and Stockpile Ops
- W-DES, Digital Engineering Strategy

Groups

- W-1 , B61 Systems Engineering
- W-2, W76 Systems Engineering
- W-3, W78 Systems Engineering
- W-4, W88 Systems Engineering
- W-8, Production Liaison
- W-9, Weapon System Surveillance
- W-10, Weapon System Safety Analysis
- W-11, Weapon Production Definition
- W-13, Advanced Engineering Analysis

B61 Thermonuclear Gravity Bomb (first designed and produced in 1968)

- It has not been started since 1992 (Implementation of the Test Ban Treaty)
- You can disassemble it and put it back together.
- You can test all the sub-systems (Battery, Starter, Pistons, Gasoline, Etc)
- HOWEVER – YOU CANNOT START IT!!
- Can you guarantee the President of the United States that it will start on the very first try?

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Can you also guarantee the President of the United States:

- **It <u>will not</u> go of in an <u>accident.</u>**

AND

- **It <u>will</u> go off <u>only if we really, really want it to.</u>**

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Nuclear Explosive Safety Office (W-NES)

Prevent unintended nuclear detonation!

1. For all nuclear explosive operations, there must be a positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation.
2. For all nuclear explosive operations, there must be a second independent positive measure that will effectively interrupt each credible scenario that leads to an unintended nuclear explosive detonation.
3. There must be positive measures to prevent unauthorized access, intentional physical damage, misuse, and theft of nuclear explosives.
4. There must be positive measures (a combination of site, facility, or nuclear explosive operation-specific as appropriate) to prevent malevolent acts that could lead to deliberate unauthorized use.

Per DOE O 452.1,

- "The probability of a premature nuclear explosive detonation must not exceed one-in-a-billion per nuclear weapon lifetime."

~ 1 in 200 million / day

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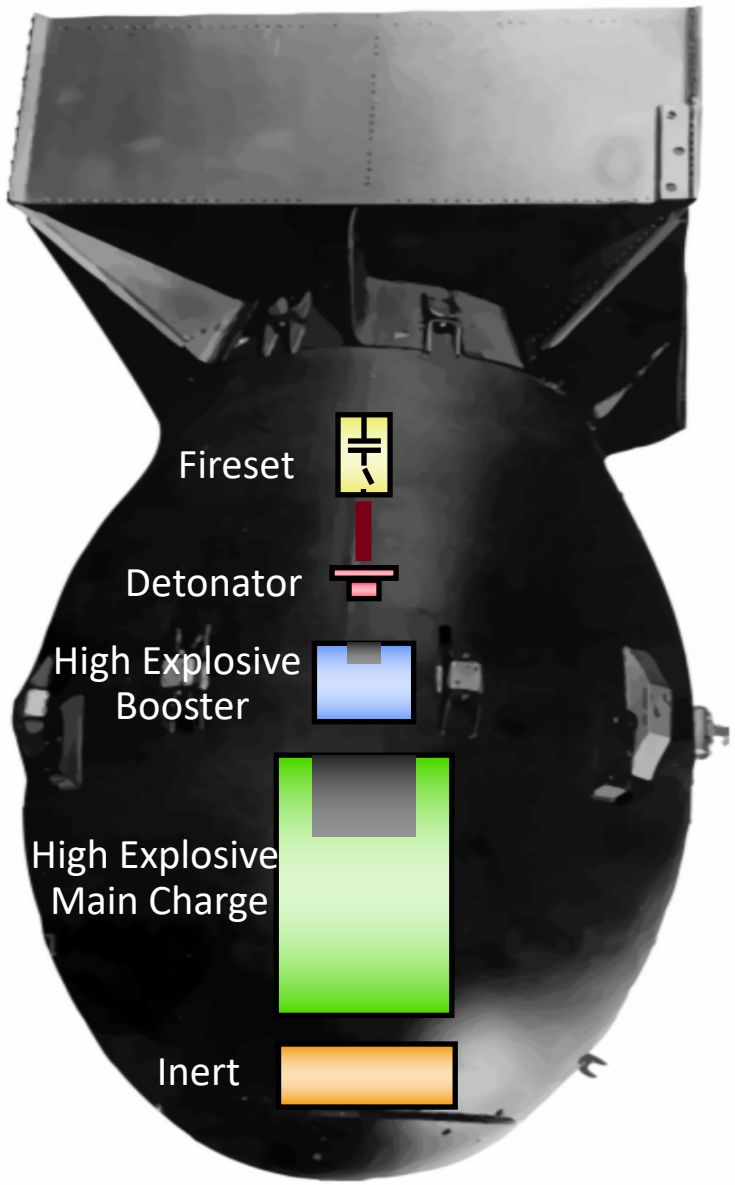
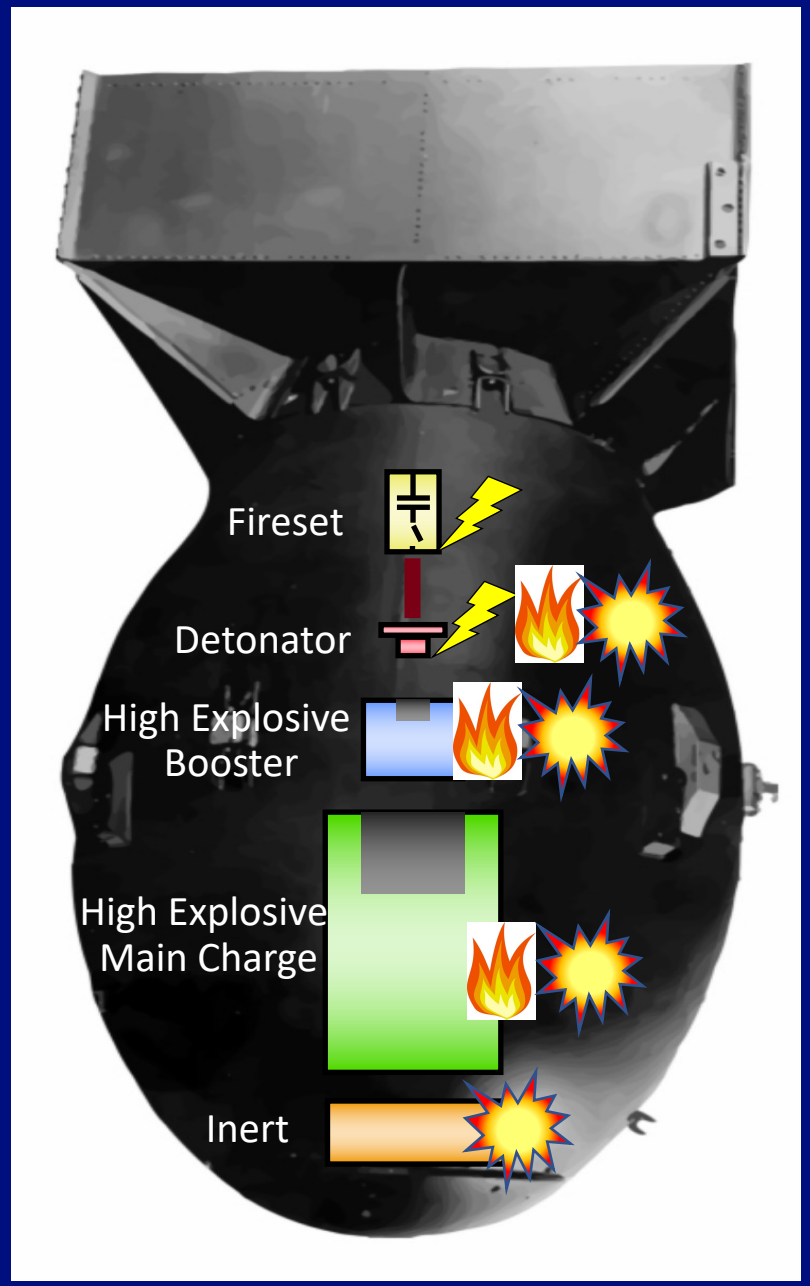
How Nuclear Weapons Work



- Firesets provide the initial electrical energy to a detonator
- Detonators provide the first detonation
  - Matched to initiate the booster (when functioned normally)
- Boosters provide a stronger detonation
  - Matched to initiate the Main Charge (when functioned normally)
- Main Charge High Explosive detonation provides the energy and power to move the inert in a specific direction and velocity
- The Inert is moved, compressed, or damaged by design
  - Rock or soil in a mining bore hole
  - Steel case on a bomb or grenade
  - Compress the nuclear material in an A-bomb

How Nuclear Weapons Work. . . When We Don't Want Them To!



EXPLOSIVE – A reactive chemical substance that contains a great amount of potential energy, and which can release that energy in a rapid expansion of mass motion (work), pressure, heat, light, and sound.

$$\beta\text{-HMX} \underset{k_1}{\longleftrightarrow} \delta\text{-HMX}$$

$$\beta\text{-HMX} + \delta\text{-HMX} \longleftrightarrow 2\,\delta\text{-HMX}$$

$$\delta\text{-HMX} \underset{k_{2b}}{\overset{k_{2a}}{\longleftrightarrow}} g\text{-HMX}$$

$$\underset{\text{vaporization}}{\overset{\text{sublimation}}{a}} \underset{k_{2b}}{\overset{k_{2a}}{\longleftrightarrow}} b$$

$$\delta\text{-HMX} \xrightarrow[k_{2a}]{k_{2b}} \begin{cases} 4CH_2O + 2NO_2 + 3N_2 \\ 4HCN + 3NO_2 + 2H_2O + (1/2)N_2 \end{cases}$$

$$CH_2O + NO_2 \underset{}{\overset{k_3}{\longleftrightarrow}} CO_2 + H_2O + (1/2)N_2$$

$$HCN + M \xrightarrow{k_4} HNC + M$$

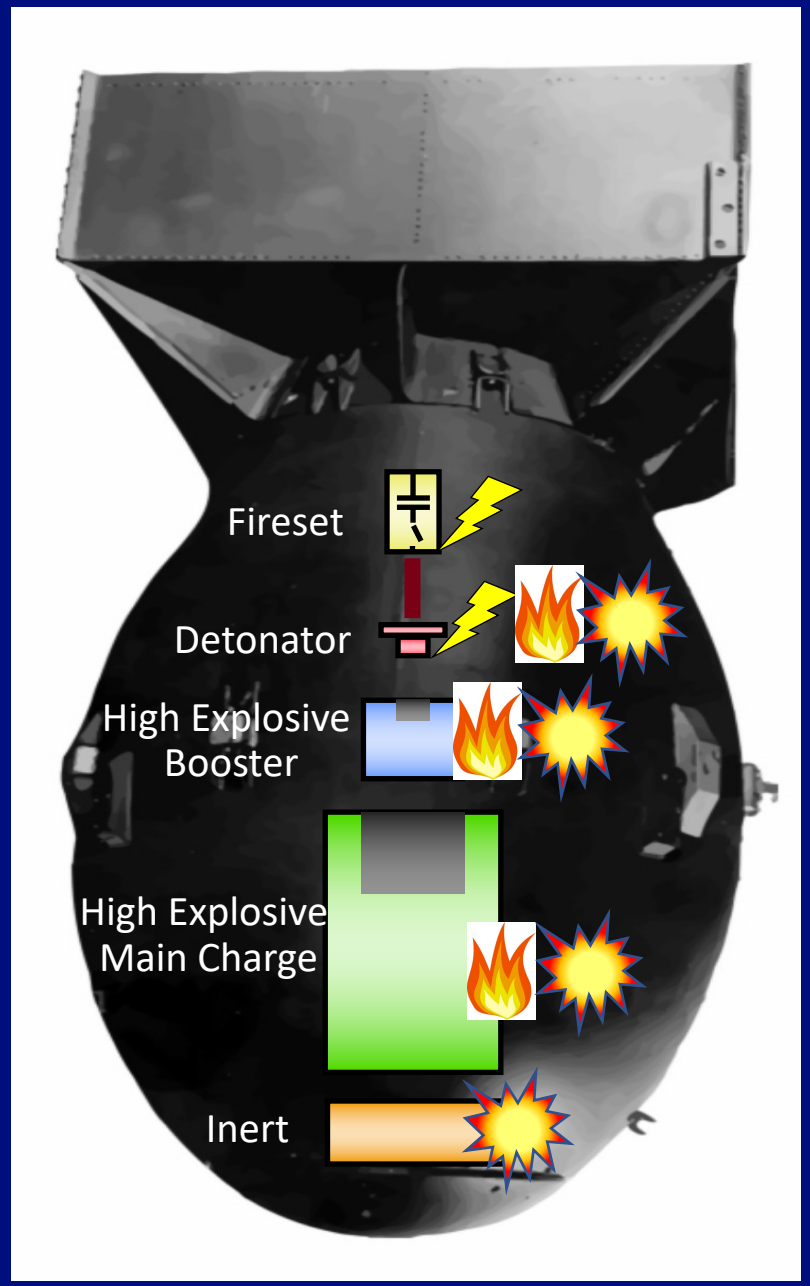
$$HNC + NO_2 \xrightarrow{k_{4a}} HNCO + NO$$

$$HNCO + NO_2 \xrightarrow{k_{4b}} H + N_2O + CO_2$$

$$2H + N_2O \xrightarrow{k_{4b}} H_2O + N_2$$

$$HNC + HCNO + 2NO \xrightarrow{k_{4b}} H_2O + 2CO + 2N_2$$

How Nuclear Weapons Work



. . . when we don't want them to!

EXPLOSIVE – A reactive chemical substance that contains a great amount of potential energy, and which can release that energy in a rapid expansion of mass motion (work), pressure, heat, light, and sound.

What could have made this “mishap” into a “*REALLY BAD DAY*”?

Accidents

Wait! What?
We have accidents??!!!

- The U.S. Department of Defense reports that 1,243 “nuclear weapon mishaps” had occurred before 1973.
- 32 of these “nuclear weapon mishaps” are officially designated as accidents (***Broken Arrows***).

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Accident Number	Date	Location	Weapon	Type of Accident
1	02/13/50	Puget Sound, WA	B4	Jettison 8000’
2	04/11/50	Manzano Base, NM	B4	Crash into mountain
3	07/13/50	Lebanon, OH	B4	Crash in dive
4	08/05/50	Fairfield-Sulsan AFB, CA	B4	Emergency landing , fire
5	11/10/50	Over Water outside U.S.	B4	Jettison
6	03/10/56	Mediterranean	Component	Aircraft lost
7	07/27/56	SAC Base	B47	B47 crashed into bunker
8	05/22/57	Kirtland AFB, NM	B-17	Inadvertent jettison
9	07/28/57	Atlantic	B5	Jettisons at 4500’ & 2500’
10	10/11/57	Homestead AFB, FL	Mk15-0	Crash on takeoff, fire
11	01/31/58	SAC Base overseas	B36	Taxi exercise
12	02/05/58	Savannah, GA	Mk15-0	Mid-air collision, jettison
13	03/11/58	Florence, SC	Mk6	Accidental jettison
14	11/06/58	Dyess AFB, TX	B39	Crash on takeoff
15	11/26/58	Chenault AFB, LA	Mk15-2	Fire on ground
16	01/08/59	US base Pacific	B7	Fuel tank fire
17	07/06/59	Barksdale AFB, LA	B39	Crash on takeoff, fire
18	09/25/59	Off Whidbey, Is, WA	B7	Navy aircraft ditched
19	10/15/59	Hardinsburg, KY	Mk15-2	Mid-air collision, impact
20	06/07/60	McGuire AFB, NJ	W40	Missile fire
21	01/24/61	Goldsboro, NC	B39	Mid-air breakup
22	03/14/61	Yuba City, CA	B39	Crash after abandonment
23	11/13/63	Medina Base		Storage igloo at AEC base
24	01/11/64	Cumberland, MO	B53	Mid-air breakup, crash
25	12/05/64	Ellsworth AFB, SD	W56	Missile RV fell
26	12/08/64	Bunker Hill AFB, IN	B43 & B53	Taxi crash, fire
27	10/11/65	Wright Patterson AFB, OH	Component	Transport aircraft fire
28	12/5/65	At sea, Pacific	2 x B43	Aircraft rolled off elevator
29	01/17/66	Palomares Spain	4 x B28	Mid air collision, crash
30	01/21/68	Thule Greenland		Crash of abandonment
31	Spring 68	At sea, Atlantic	2 x W34	Lost weapons
32	09/19/80	Damascus, AK	W53	Missile fuel explosion

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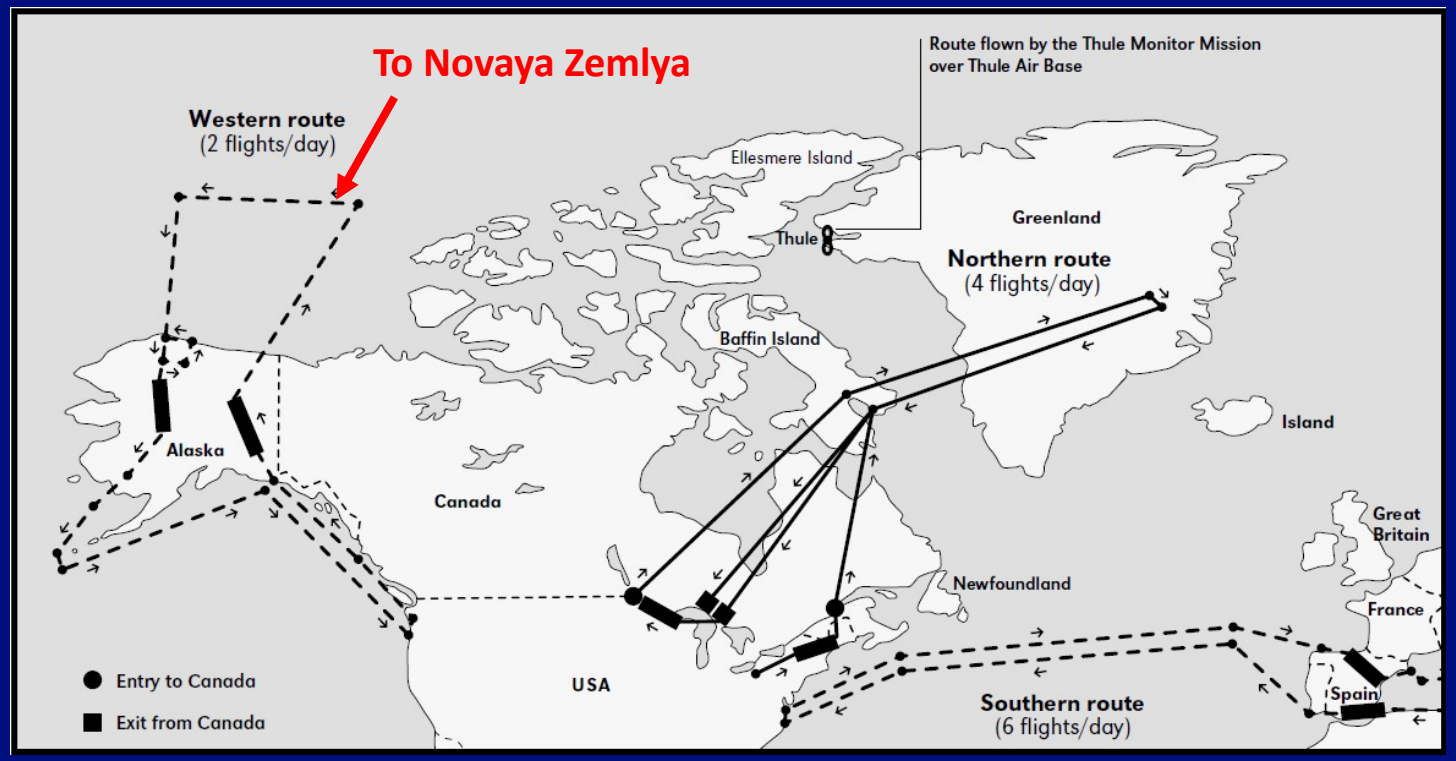

OPERATION CHROME DOME

Operation Chrome Dome was a United States Air Force Cold War-era mission from 1960 to 1968 in which B-52 strategic bomber aircraft armed with thermonuclear weapons remained on continuous airborne alert and flew routes to points on the Soviet Union's border.

Side Note: During this time the Air Force performed an in-flight refueling somewhere in the world about every 6 minutes. (risk?)

The Day We Bombed Goldsborough, NC

January 24, 1961

Florence Morning News

READER'S TIP
OTHER PICTURES on the "bombing" at Mars Bluff yesterday afternoon are on Page 10.

VOL. XXXIV—NO. 355 FLORENCE, S. C., WEDNESDAY MORNING, MARCH 12, 1958 DAILY 5c; SUNDAY 10c

ATOM BOMB WITHOUT WARHEAD DROPS IN MARS BLUFF SECTION

SCENE OF DISASTER — Walter Gregg was peacefully working near this truck at the back of his home in the Mars Bluff community when an explosion disrupted the tranquility. Here's what was left after the smoke cleared. At right was garage, which was shattered, and back of house behind the truck. Even some of the clothes hanging at left were shredded on the line. (Morning News photo by Ballard)

Nobody Quite Believed It, Others Were Just Too Close

By JOHN RAY
Morning News Staff Writer

The tremendous blast and mushrooming column of smoke at Mars Bluff yesterday spread a rumor that an atomic bomb had been dropped — but nobody could quite believe it, at first.

Many shrugged the explosion off as another sonic boom created by a fast jet. Others heard the explosion, yet felt no effect. Only a few persons in Florence reported hearing it.

from the plane, felt the jars and heard the plane fly over. The chimney on his house was leveled and windows broken. He said he knew at about a dozen houses with broken windows. Locke were blown off doors in others.

Highway Patm. D. D. Mobley, one of the first at the scene, was enroute to his office from a station near Dillon when his car became overheated, forcing him to stop on the side of Highway 301.

"I pulled off the road and heard the explosion," he said. "It was like a whoosh, a tremendous blast that shook my car. It shook me for an instant. I didn't know what happened. I saw a big halo and went about halfway up but stayed away from it. I returned to the car and made my report by radio."

J. W. PRICE, service station

Continued on Page 10

Officials Say 'No Danger' Of Atom Blast

By C. YATES MCDANIEL

WASHINGTON (AP)—Defense Department officials said Tuesday night there was no danger of an atomic explosion and only a "remote" danger of nuclear contamination in the accidental dropping of an unarmed atomic bomb.

The explosion that damaged six houses and a church in the outskirts of Florence, S.C., today came not from any nuclear reaction but from conventional TNT, which is a part of the trigger mechanism of the bomb.

The remote danger of contamination referred to by the officials could arise from the exploding TNT scattering nuclear materials. The danger to humans in such a case, could occur if atomic dust were taken internally—by breating it in or through an open cut in the skin.

Such atomic materials, however, cannot explode except when the chain reaction required for detonation is deliberately started by crew members in the atomic bomber.

Officials said the small area which would be contaminated in such a case could be cleaned up through a simple washing process.

An unarmed atomic bomb, such as the one dropped at Florence, is one in which the complicated mechanisms required to set off a nuclear explosion reaction have not been connected and therefore cannot produce a "nuclear" explosion. The bomb which fell near Florence, however, contained all of the element that would be used in an actual military attack except the warhead.

Air officials have repeatedly said that a certain portion of the

HERE'S WHERE BOMB STRUCK . . . reported 20 feet deep (Morning News photo by Kirkland)

Six Injured By Explosion; Windows Shake

A B-47 bomber dropped a nuclear weapon — minus its atomic warhead — into the garden of Walter Gregg's home at Mars Bluff yesterday afternoon, setting off an explosion that injured six persons. Its psychological impact, was heard around the world.

The explosion shattered windows of at least a dozen homes and stores in the thinly populated rural area.

Mount Mizpah Baptist Church looked like vandals had worked it over. Benches were collapsed, glass was strewn like powder over the auditorium, and portions of the roof were sticking jaggedly into the air.

A Florence salesman, J. A. Sanders, traveling on Highway 301, said the concussion was so great it turned his auto around in the road.

Portions of the weapon were found 700 yards from the crater.

Newsmen got in for a close inspection before the Air Force arrived and sealed off the area.

Through it all, one Negro family, living in an unpainted tenant house some 600 yards from the blast, stayed indoors. The children played nonchalantly.

THE AIR FORCE would provide few details about the incident other than to say the weapon dropped because of a "mechanical malfunction of the plane bomb lock system."

However, a private pilot flying into Florence about the time of the explosion reported a radio conversation between the Air Force plane and the CAA.

The Air Force plane reported

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A B-52 Stratofortress carrying two Mark 39 nuclear bombs broke up in mid-air, dropping its nuclear payload in the process. Information declassified in 2013 showed that one of the bombs came very close to detonating.

What could have made this "mishap" into a "*REALLY BAD DAY*"?

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The Day We Bombed Palomares, Spain

January 17, 1966

Mid-air refueling of a B-52

During mid-air refueling, a KC-135 tanker collided with a B-52 Bomber carrying four Mk28 warheads.

During a mid-air refueling operation the KC-135 tanker and the B-52 collide and explode.

- 1 Mk28 falls into the Mediterranean Sea.
- 1 Mk28 falls to earth (parachute) but does not explode.
- The other 2 Mk28 warheads impact the ground in a farmer's field near Palomares, Spain. The High Explosives detonate. spreading nuclear radiation, but without nuclear yield.
- 1,400 tons of contaminated soil and vegetation were eventually removed to the United States (Savannah River, GA) for permanent radioactive storage. (The United States bought the farm!)
- After a massive 3-month search mission, the 4th bomb was finally located in the Mediterranean

2 Mk28 from Palomares (ABQ Museum)

Aircraft wreckage at Palomares

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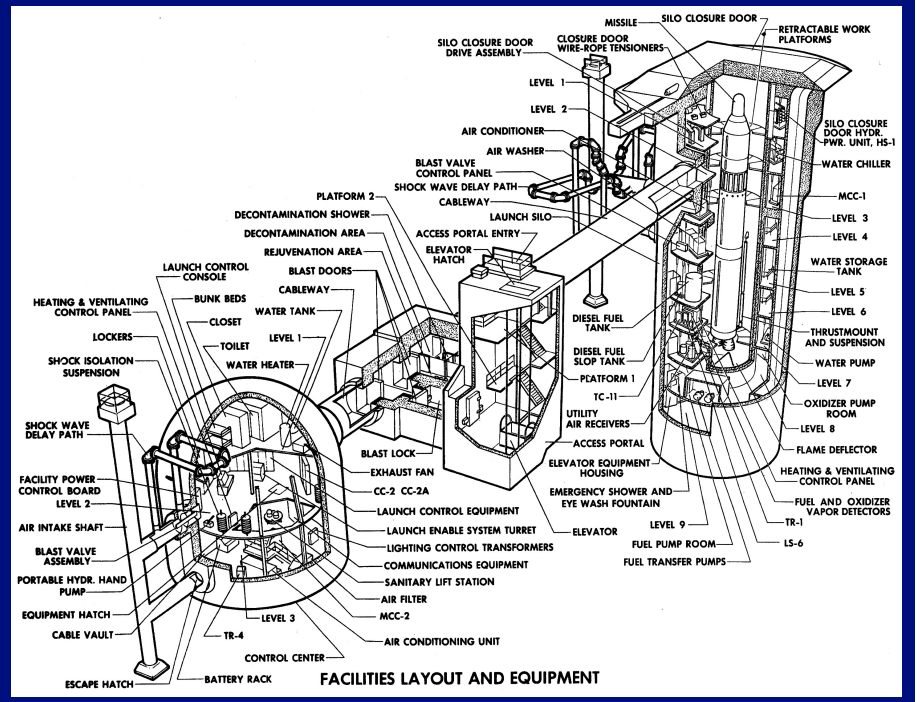
W53 Warhead

Complex 374-7 Before Explosion

W53 Warhead on Titan II missile in a silo



The Day We Bombed Damascus, Arkansas

September 18-19, 1980

- ***Titan II Missile***
  - Designed to launch after Russian 1st Wave
  - Liquid fuel rocket
    - *Fuel provides part of structure*
  - 2-part fuel that is toxic
  - 100+ feet tall
  - ~340,000 lbs
- ***W53 Warhead***
  - ~9 MT* (Hiroshima was ~15kT)
  - BIG thermo-nuclear warhead!!!

*Declassified 28 Nov 2014

Los Alamos NATIONAL LABORATORY

Complex 374-7
Damascus, Arkansas, U.S.A
September 18-19, 1980

- @ 1827: During maintenance on the missile a socket was dropped (wrong tool). Note socket weighed ~ 8 lbs The socket fell ~ 80 ft striking the missile causing a significant toxic fuel leak from the missile.
- @ ~0100: 2 airmen enter facility
  - Sensors showed explosive environment
  - Crew evacuated
  - Concern over rocket collapsing
- @ 0300: Airman Livingston re-enters facility to turn-on exhaust fan.
  - **Rocket Fuel explodes**
  - Sr Airman Livingston killed instantly
  - 21 others injured
  - 740 ton Blast door thrown ~ 200 yards
  - Upper stages ejected from silo including warhead
  - 2nd stage rocket explodes above silo
  - Warhead propelled 600 feet out of the silo, not found until daylight.

Damascus, Arkansas, U.S.A

September 18-19, 1980

During routine maintenance operations, an airman dropped a 6-inch (8-lbs) socket wrench. The socket punctures the side of the Titan missile. Liquid fuel from missile ignites and explodes, throwing ~9MT warhead out of silo.

ABQ Museum

What could have happened?

Air Force Punishes 70 Airmen For Accidental Nuke-Armed B-52 Flight

Published October 20, 2007 · Associated Press

WASHINGTON – The Air Force said Friday it has punished 70 airmen involved in the accidental, cross-country flight of a nuclear-armed B-52 bomber following an investigation that found widespread disregard for the rules on handling such munitions.

"There has been an erosion of adherence to weapons-handling standards at Minot Air Force Base and Barksdale Air Force Base," said Maj. Gen. Richard Newton, the Air Force deputy chief of staff for operations.

Newton was announcing the results of a six-week probe into the Aug. 29-30 incident in which the B-52 was inadvertently armed with six nuclear-tipped cruise missiles and flown from Minot in North Dakota to Barksdale in Louisiana without anyone noticing the mistake for more than a day.

The missiles were supposed to be taken to Louisiana, but the warheads were supposed to have been removed beforehand.

Central United States

August 29-30, 2007

A B-52 Bomber mistakenly transported six nuclear-tipped cruise missiles from Minot AFB to Barksdale AFB. No one noticed the mistake for more than a day!

What could have happened?

What about today?

What environments might a weapon experience today?

- high humidity for years or decades
- being in a flooded bunker
- next to a heater such that it is heated on one side
- in an un-air conditioned bunker where temperatures may reach >180F
- bounced around on runways full of cracks, patches, and pot holes.
- DROPPED

https://www.lanl.gov/careers/index.php

Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico

Elevation – 7,300 ft (10,440 ft ski hill)

Population – 13,200

% of people with PhDs – 17.7% (highest in US)

% of millionaires (13.2%, highest in U.S.)

Nearest ski hill – 5 miles from downtown Los Alamos, 40 trails on 300 acres.

Hiking: 150 miles of hiking trails

Swimming: Olympic-sized aquatic center

Nearest mega-volcano – 7 miles

Nearest Walmart – 21 miles

# of McDonald's Fast Food Restaurants – 1

Most common question – "Red or Green?"
Most correct answer – "Christmas"

No – We do not glow at night! (Most of us.)