

# Reflections of a Tester



**Dr. Robert R. Brownlee**

August, 2011

# *Points To Be Covered*



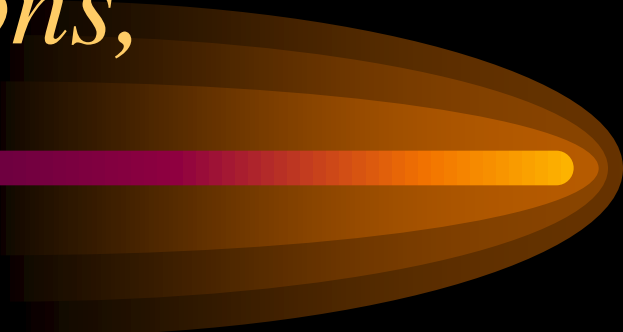
Moments in History Worth Reviewing

Short History of Atmospheric Tests

# *Introductory Thought*

- *Ralph Waldo Emerson once wrote  
“There is properly no history, only  
biography.”*
- This quote is really a truism!
- Nowhere is found a discipline derived from fewer individuals than is “atomic energy.”
- Every fact or event given here is owed to individuals whose names I can remember (maybe!).

# *Why Do We Have Nuclear Weapons, Anyway?*



- In 1943, we had ample evidence that we might not win the war! Nuclear Energy (first) was seen by some as the only way to assure victory
- In 1944, winning in Europe was likely.
- In 1944-45, winning in Japan looked torturous, and Bloody.

# *What Role Did We Envisage for the First Two Atom Bombs?*

- Slaughter in the Pacific grew day by day
- Two-thirds of deaths there occurred in last 10 months of the war
- We had killed 400,000 people in bombing raids without any offers for surrender
- **New Goal: Stop the War Before the Invasion of Japan**

# *Nuclear Explosions Appear*



- 16 July 1945 Trinity test.
- 06 Aug 1945 Hiroshima.
- 09 Aug 1945 Nagasaki.
- 02 Sept 1945 Japan surrenders!

*And,*



*That's*

*That!*

# *Well, Not Quite!*



- 16 Oct 1945 Adm. King details Navy interest, wants JCS to be in charge
- 22 Dec 1945 Nuclear test planning begins
- 07 Mar 1946 167 Bikini natives evacuated
- 01 July 1946 Crossroads Able test
- 24 July 1946 Crossroads Baker test

# *Crossroads Able, July, 1946*



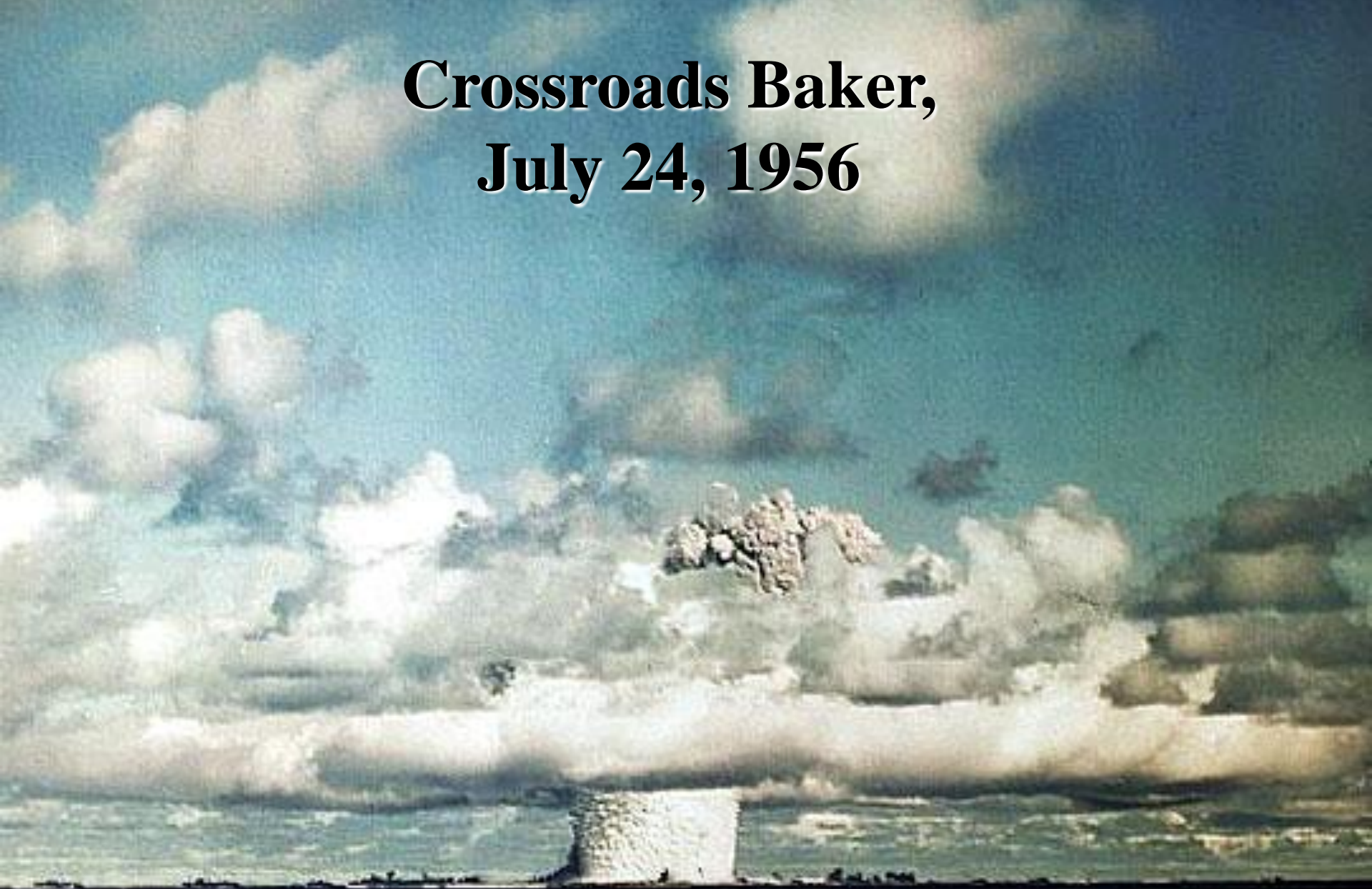
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# Crossroads Baker, July 24, 1956



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# *These Tests Were Very Frightening*

- “War” for control of atomic things waged in 1946-47
- President Truman decides who’s in charge of what

# *How Are Questions to Be Answered?*



- 01 Jan 1947 Control of Atomic Energy transferred from “military” to AEC
- 27 Jun 1947 President approves nuclear tests

# *Traumatic Post-war Events Pour In*



- In 1948, Communist Coup in Czechoslovakia.
  - Israel established.
  - Berlin Blockade begins
- 1949 Communists take over China

# *And Then, the Really Bad News*



- Soviets have first nuclear test much sooner than predicted in 1949, and had their first fusion bomb in 1953.
- Our nuclear arsenal was now for deterrence!
- And, has remained so ever since! (?)

# *As An Aside, Deterrence Can Be Made to Work!*



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# *For Example, Neutron Bombs Were a Big Success*

- Soviets had amassed thousands of tanks positioned from far north to far south.
- At any time, these tanks could have made it to the English Channel in a matter of days.
- Neutron Bombs had low yields, but reached “deep”.
- The neutralization of Tanks saved the need for massive armies, and massive costs.
- These weapons easily paid for themselves.

# *Cold War Years Were Traumatic*



- The Soviet threat grew, seemingly inexorably.
- So did our deterrent capability.
- Ultimately our nuclear stockpile contained thousands of warheads of many kinds.

# *Nuclear Device “Honed” Outputs Are Quite Varied*



- Neutrons
- X-rays
- EMP
- Dirty
- Clean, etc.

# *What Was Our Yield Rationale?*

- Early on, to the U.S., there seemed to be little use for high-yield thermonuclear bombs
- We weren't really that mad at the world
- Our biggest nuclear yield was 15 Mt
- Play down “big”, play up “accuracy”—
- A Great Advantage!

# *The Soviets Fired a Number of Bombs With Very Large Yields*

- Their largest was 58 Mt
- There were a number of others larger than 15 Mt

# *We Should Now Look at Some Early Testing Problems*



- 1. Where should we be testing?
- 2. How frequently can we test?
- 3. What about radioactive fallout?
- 4. Can we reduce weight of bombs?
- 5. Should we, and can we achieve fusion?

# *A Nominal Yield (20kt) Is Too Big For Home*



- Alamogordo will not be used again.
- Pacific area, having been used for Crossroads, proves viable.
- Bikini and Eniwetok are FAR from home, need massive military support.
- Nevada has some special properties—close, already government-owned land.

# *Nevada Test Site (NTS)*

## *Established in December, 1950*

- NTS originally to be used as a stepping stone to the Pacific, i.e. for lower yields.
- Higher yields were planned to be at the PPG, or Pacific Proving Grounds.

# *Let's Count Shots*



- 1. Alamogordo.
- 2. Hiroshima.
- 3. Nagasaki.
- 4. Crossroads Able.
- 5. Crossroads Baker.

*Next Three Were In Enewetak, in  
1948*

*Operation Sandstone*

# *There Was Now a Pause in Testing of More Than 2 ½ Years*

- With the NTS now established, in January and February of 1951, we did 5 airdrops. In these tests, the highest yield was 22 kt.
- In April of 1951, we return to Enewetak for 4 tests, each on a tower, and two of which were quite significant.

Test George (#14--  
05/08/51) was the  
first thermonuclear  
test explosion (most  
of the yield was  
still fission)

Yield was 225 kt

The previous  
highest yield was  
Yoke, 04/30/48,  
49 kt.



# *ITEM (test #15) Was Important Because It Was the First Device to Be Boosted*

- Whereas the usual yield had been like 20 kt, with boosting, a yield of 45.5 kt was achieved.



*In Oct-Nov, 1951 We  
Accomplish Operation Buster at  
the NTS*

*In April-May, 1952,  
Operation Tumbler-Snapper*

- The total number of tests is now 30

# *Operation Ivy a Milestone*



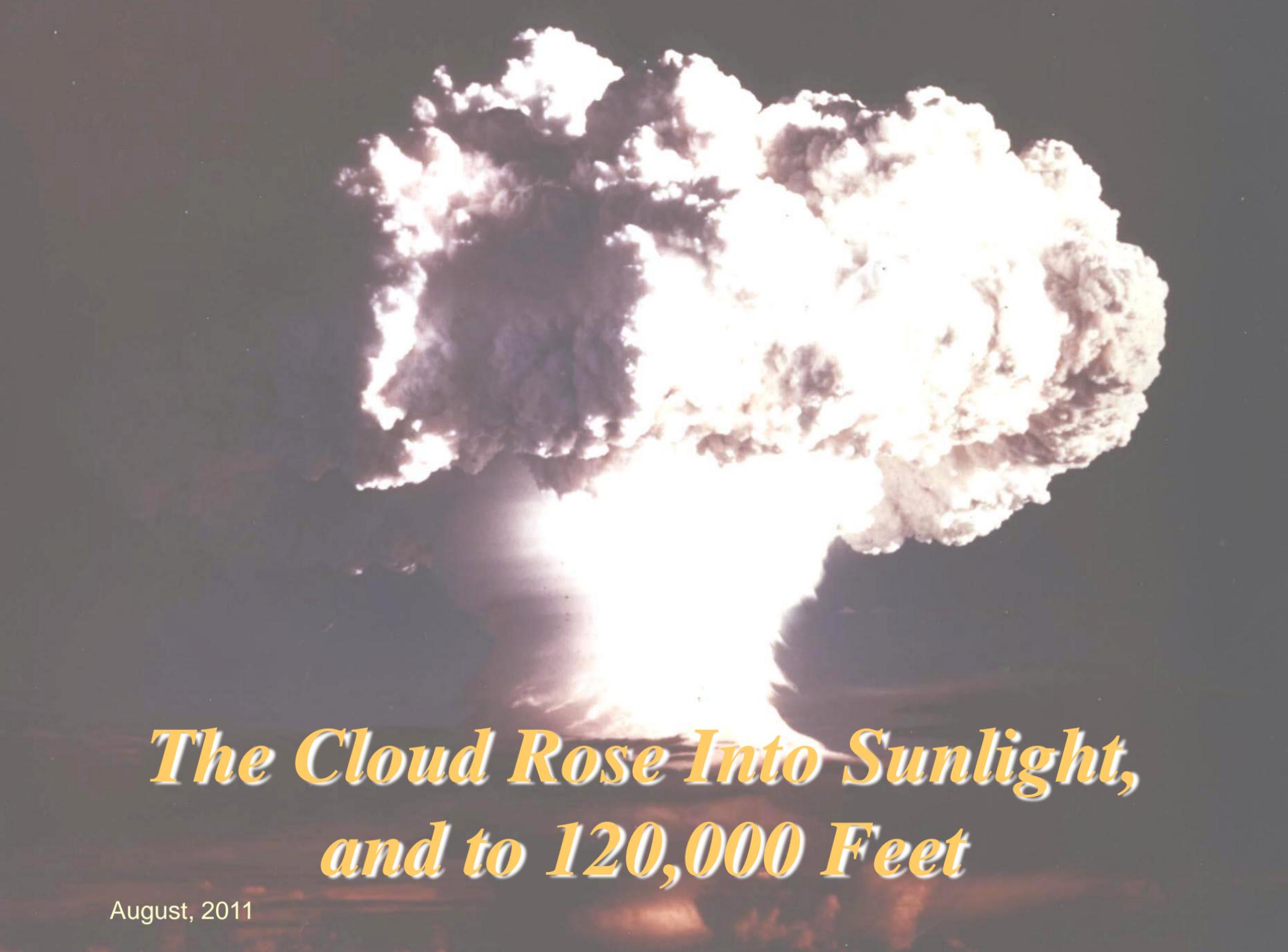
- 2 shots, 10/31/52 and 11/15/52 at Enewetak
  - 1 surface
  - 1 airdrop
- Ivy Mike First Large Thermonuclear reaction.  
Yield was 10.4 Mt
  - A weapon? size - 84 tons, 80 inches in diameter,
  - 244 inches long
- Ivy King - A very large fission bomb (500kt) for stockpile if thermonuclear designs did not work

# Ivy Mike



At H+30 minutes, upper cloud was 60 miles  
in diameter, stem had a 20 mile diameter.

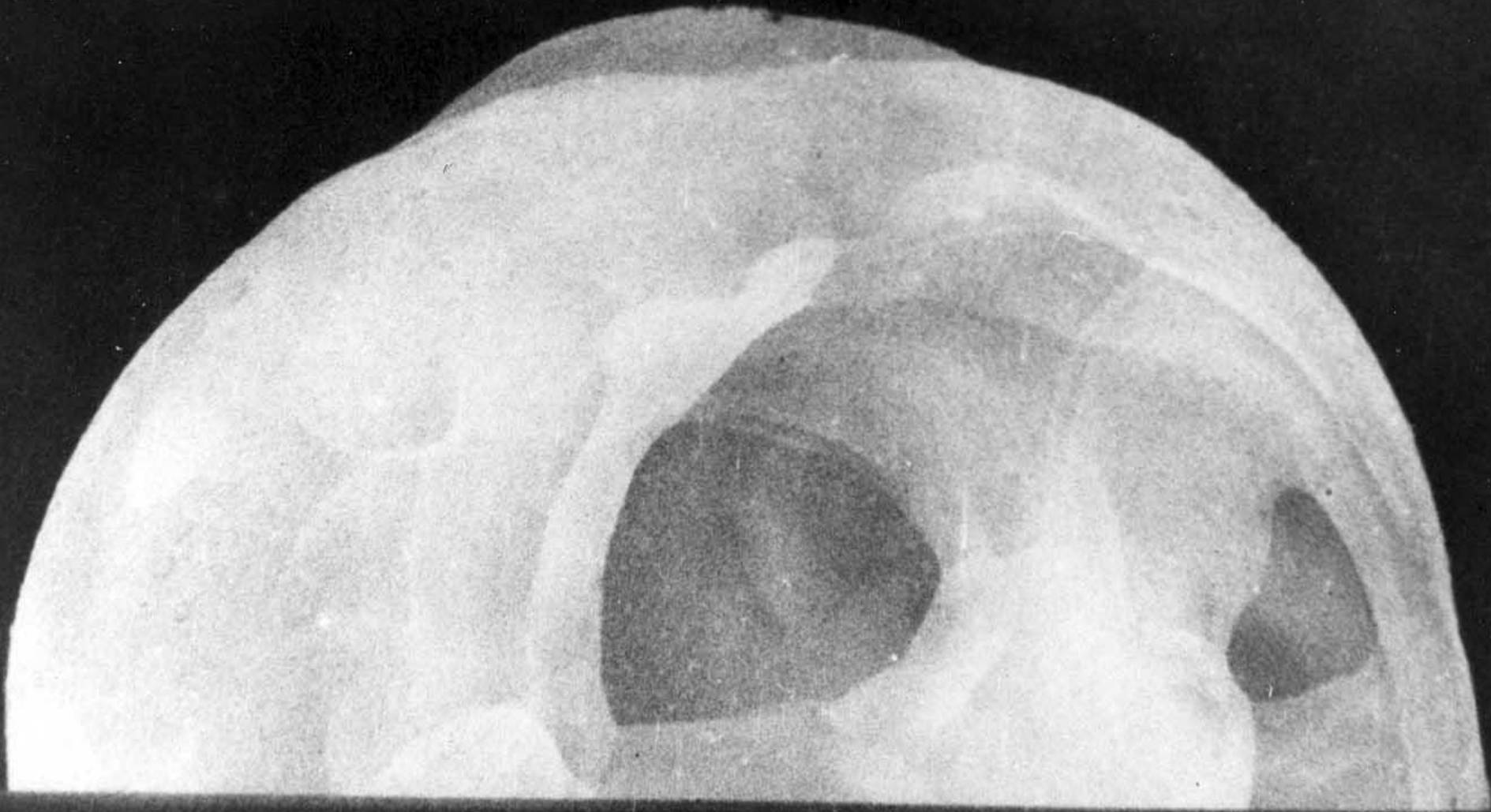
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*The Cloud Rose Into Sunlight,  
and to 120,000 Feet*

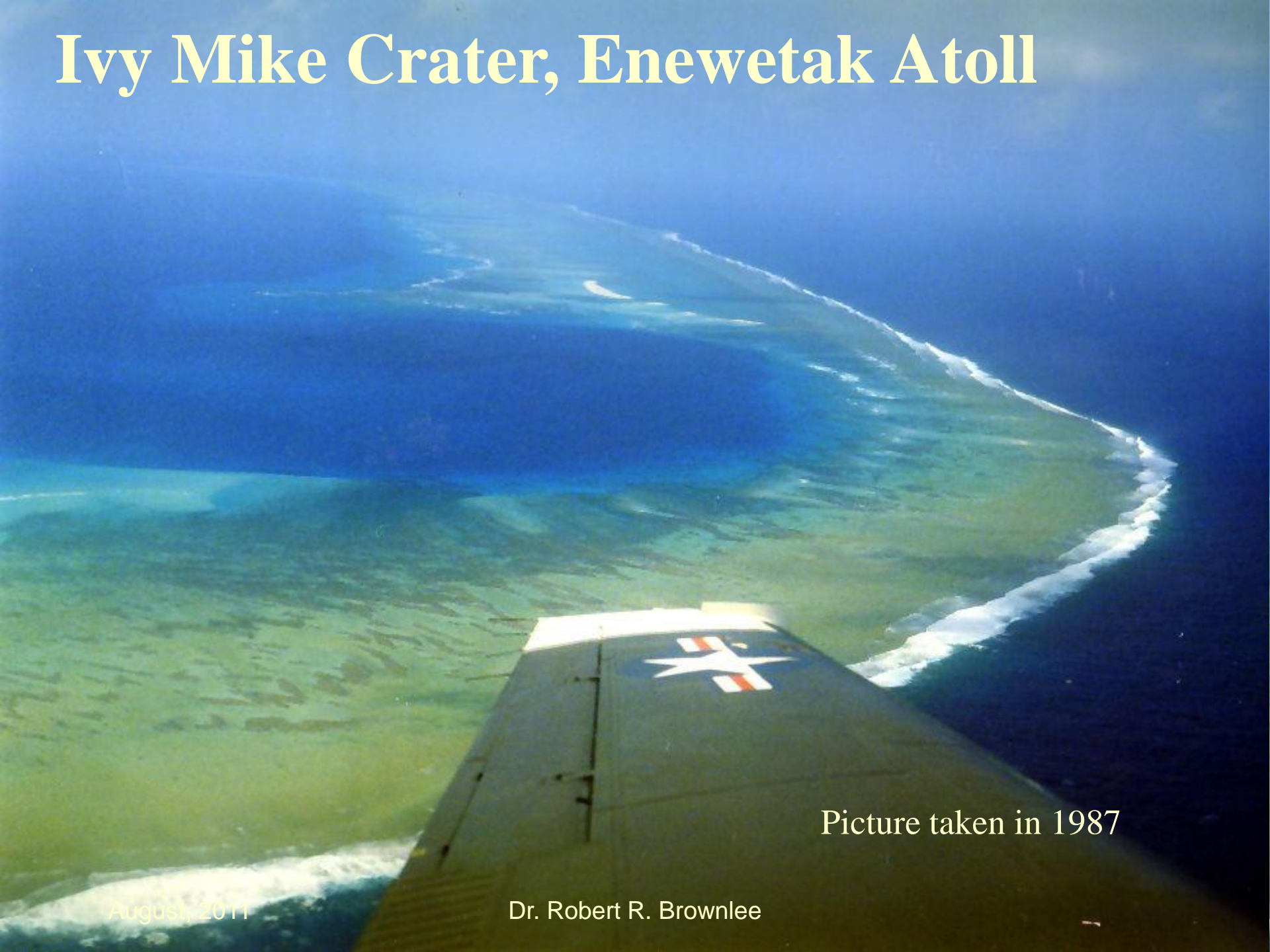
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# *Ivy Mike's Early Fireball*



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# Ivy Mike Crater, Enewetak Atoll

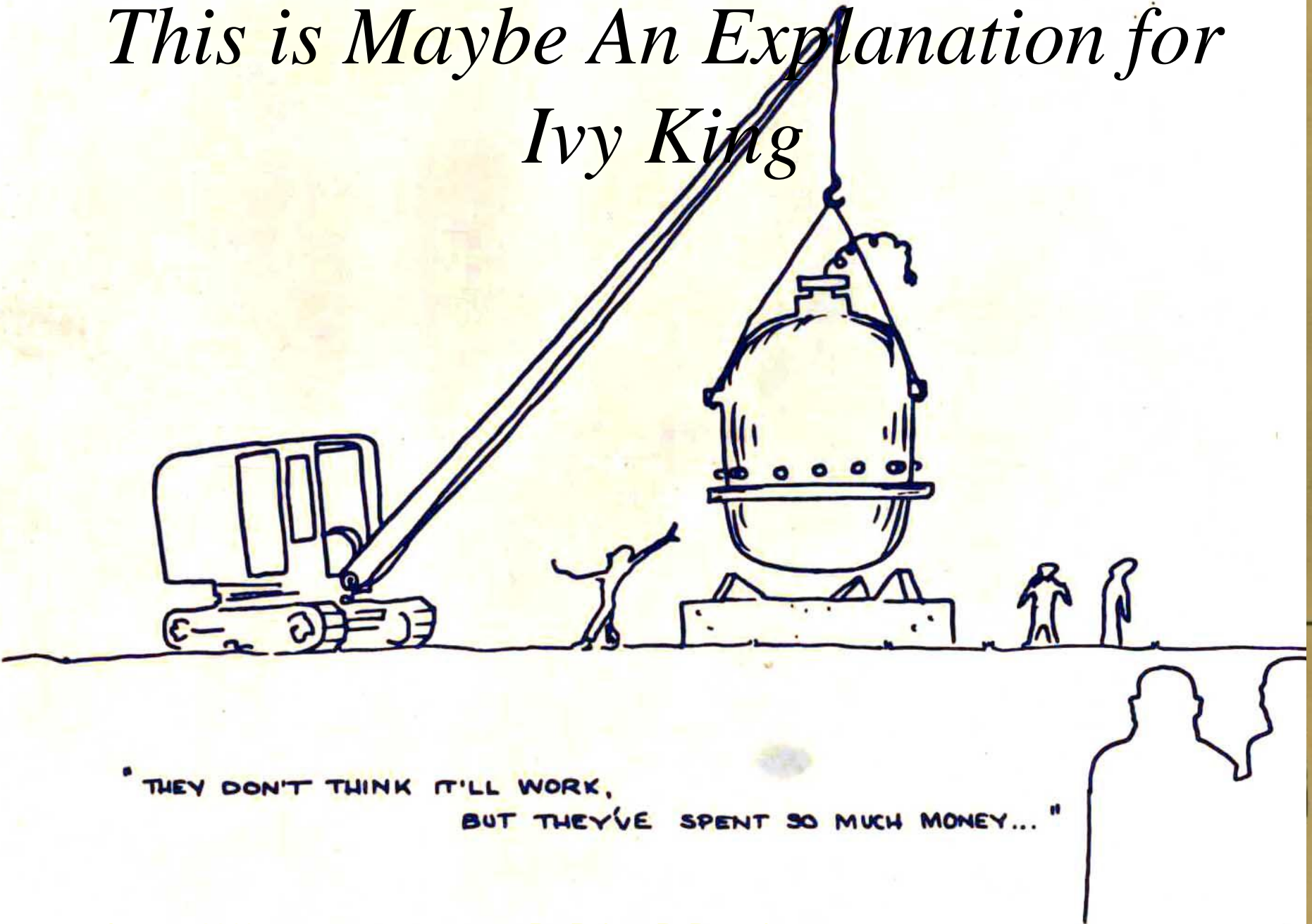


Picture taken in 1987

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# *This is Maybe An Explanation for Ivy King*



# *1953 Saw 11 Tests at the NTS*

- All tests were weapons related.
- One test, Grable, was fired from a 280mm gun.



*GRABLE 05/25/53 Atomic  
Canon*

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# *Operation Castle Produced Surprises*

- 6 shots fired between 2/28/54 and 5/13/54
- Tests to provide emergency capability after Soviets first TN test
- Bravo has big yield, as did others

A large, bright orange and yellow mushroom cloud from the Bravo nuclear test is centered in the upper half of the image. The cloud has a thick, glowing stem and a wide, flat, disc-like top. The background is a deep red-orange sky. Below the main cloud, there is a layer of darker, more textured clouds. The overall image has a grainy, historical quality.

***Bravo Seen From Many Miles  
Away***

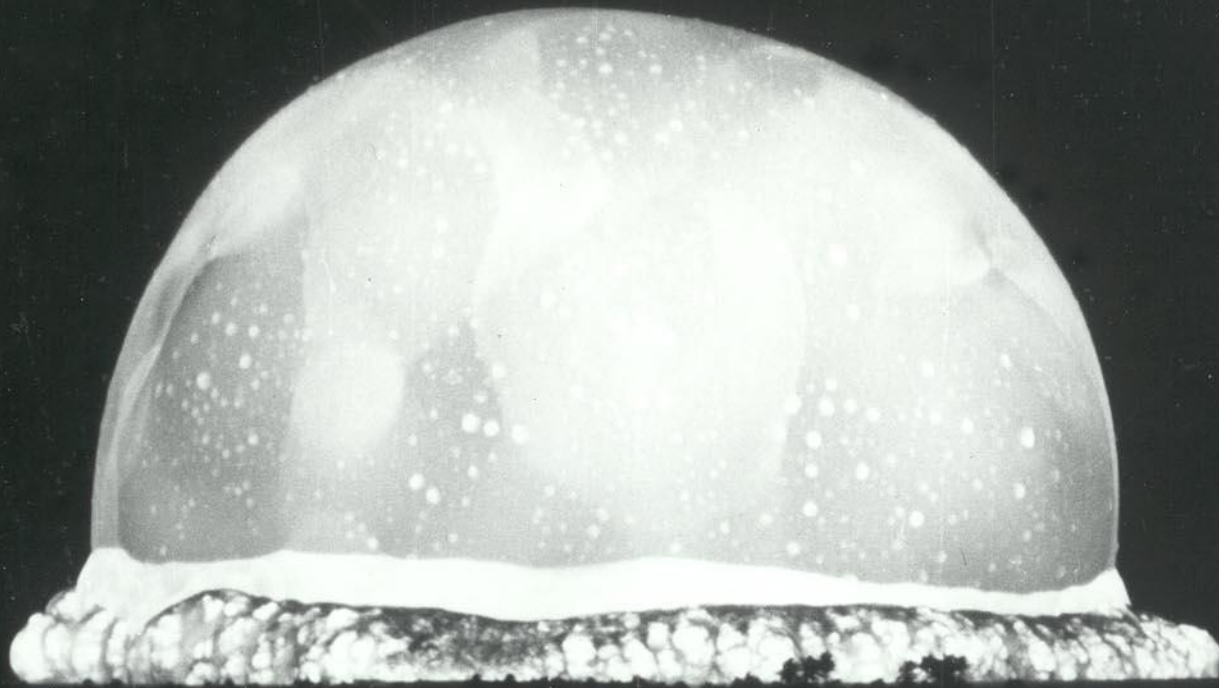
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# *Bravo, Another View*

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# *Bravo Fireball Reached 3.4 Miles in Diameter*



Yield was 15 Mt

# ***BRAVO STORY NOW AVAILABLE***



- Definitive account authored by  
Tom Kunkle and Byron Ristvet

“Castle Bravo. Fifty Years of Legend  
and Lore.”

# *Teapot, in Nevada, Started High-altitude Tests*

- First test was # 50, named WASP
- 14 shots fired between 2/18/55 and 5/15/55
- 3 were airdrops
- 10 were on towers
- 1 was a cratering test



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Wasp Test, Feb 18, 1955

# *Upon My Arrival at the Lab*



54 hour week

We needed to know:

Everything about our mission

testing

safety

security

# *Safety and Security Have to Get Into the BLOOD*



- Not a particularly normal place for them.
- It takes hard effort, and training.

# *Purpose of Blood is not Safety and Security*

- Blood's purpose—  
Life, Achievement and taking risks

Which, for J-Division,  
meant blowing things up!



# *Project 56 - a Look at Safety*

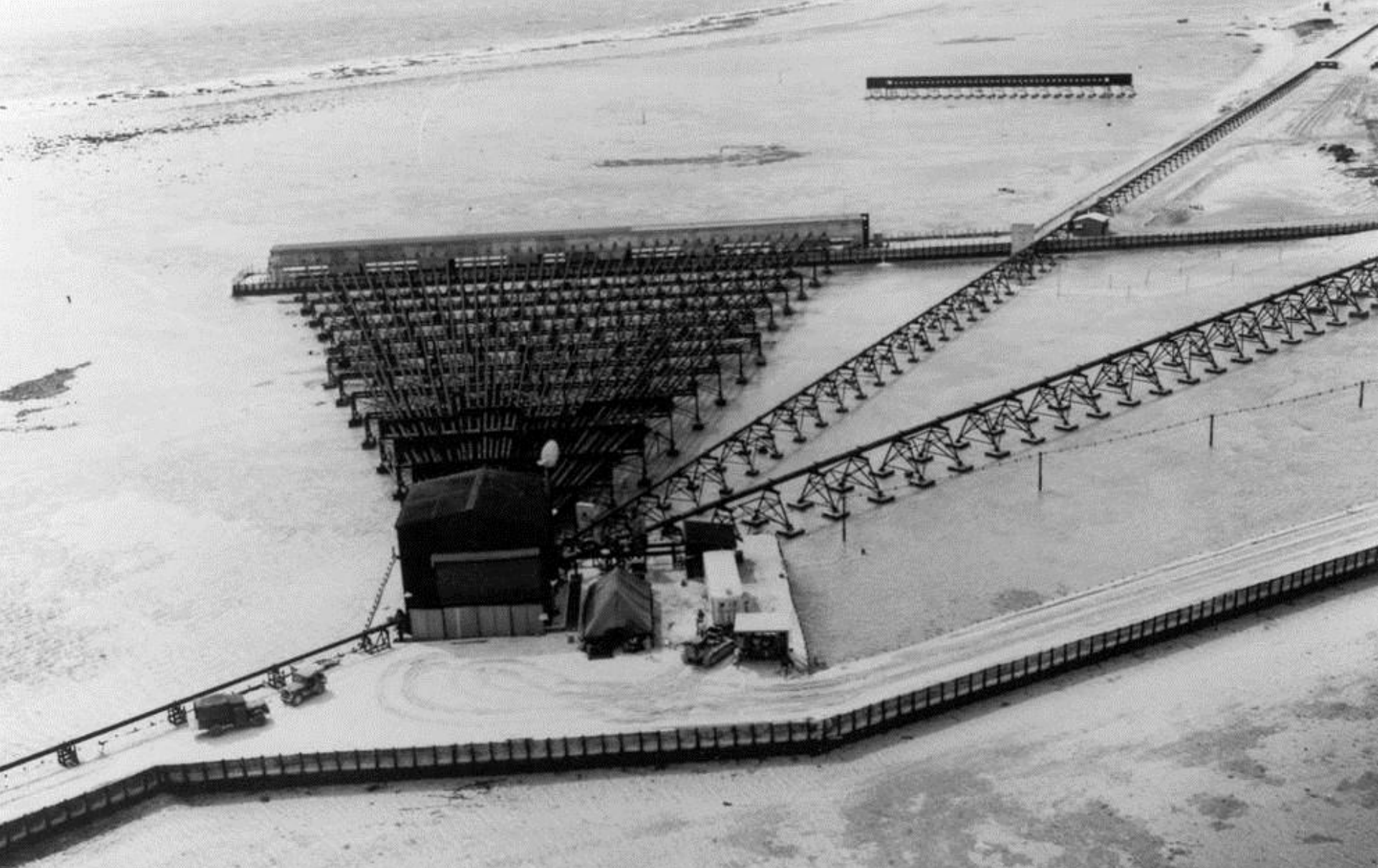


- 4 shots fired between 11/1/55 and 1/18/56, Nevada
- “One-point” tests of previously-tested devices
- Lower probabilities of nuclear yields desired

# *Redwing - An Ambitious Test Program*



- 17 SHOTS FIRED BETWEEN 5/4/56 AND 7/2/56
  - 6 BIKINI
  - 11 ENIWETOK
  - 6 TOWER
  - 2 AIRDROP
  - 3 SURFACE
  - 6 BARGE
- ALL WEAPONS RELATED, TO REDUCE SIZE AND COMPLEXITY OF TN DEVICE



# *La Crosse Test (# 69)*

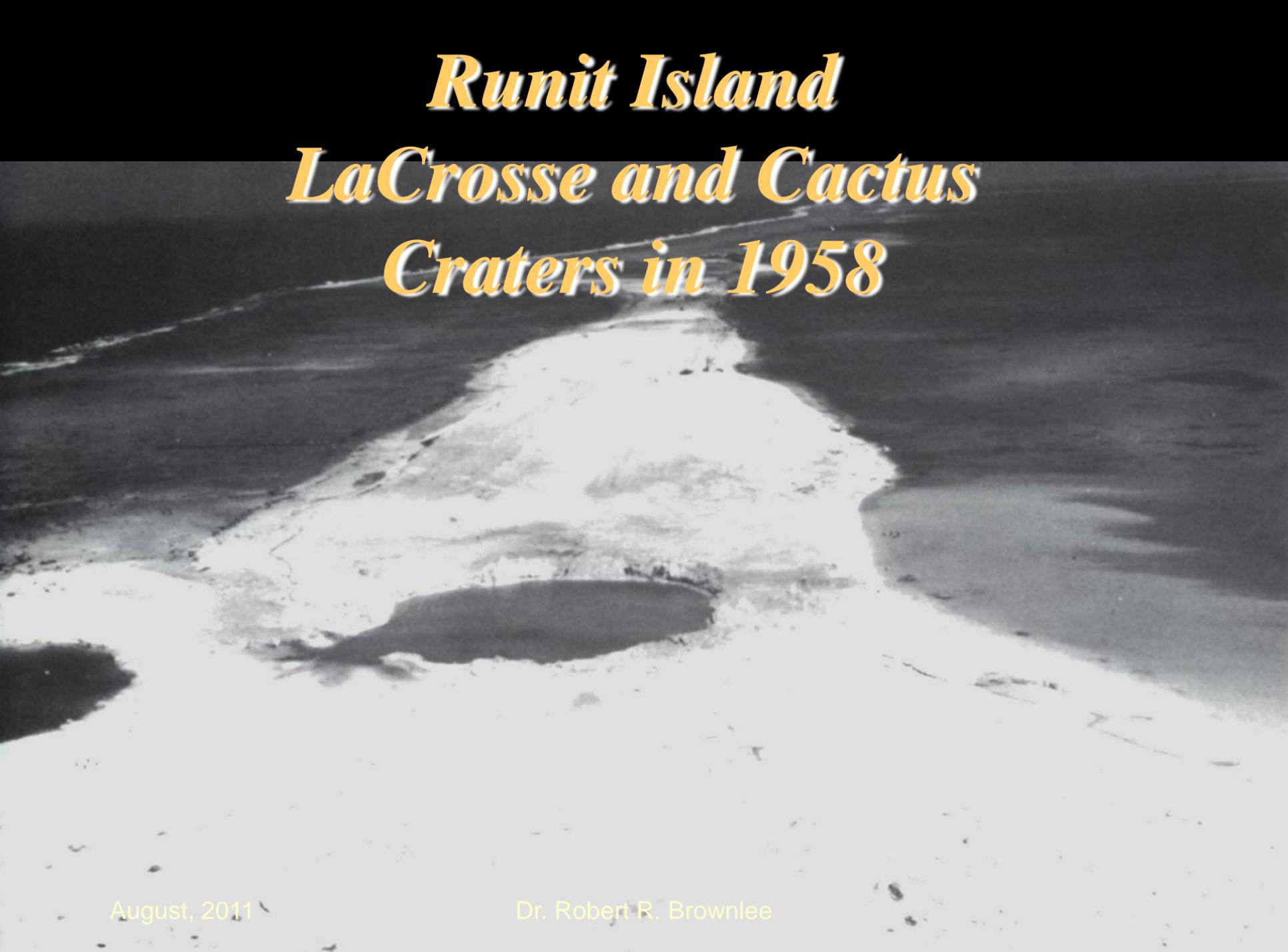
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E-100-8

LaCrosse; crater  
and coral-filled  
water easily seen

Some remains of  
mirror stations  
exist





***Runit Island  
LaCrosse and Cactus  
Craters in 1958***

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A large, bright, orange-yellow mushroom cloud from a nuclear explosion, set against a dark, cloudy sky. The cloud has a thick, billowing stem and a large, rounded, and somewhat irregular top. The colors range from bright yellow in the center to deep orange and red at the edges.

# *Mohawk, 360 kt*

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Redwing/Mohawk  
7/2/56 520' Tower

This test was  
Umbrella

June 8, 1958

9 kt





# *Seminole Early Fireball*

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*Seminole Was Fired in a Tank of  
Water*

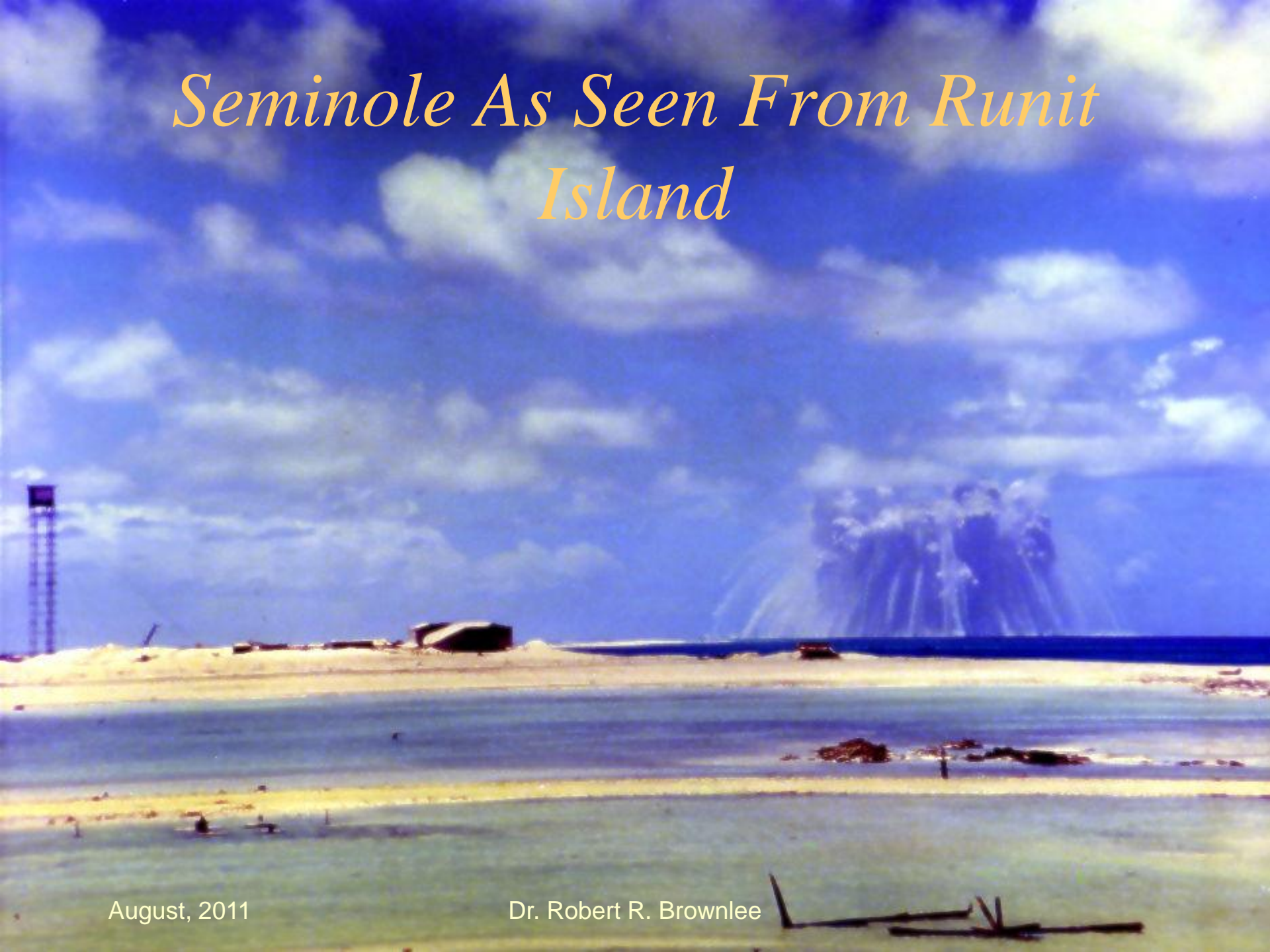
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*Seminole was 13.7 kt*

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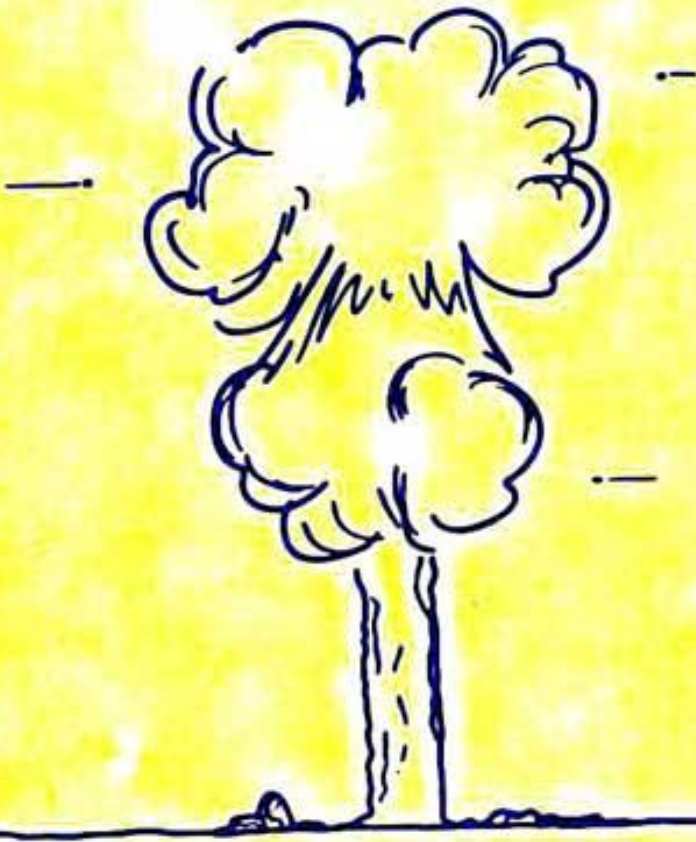
# *Seminole As Seen From Runit Island*



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— LOOKOUT MOUNTAIN —



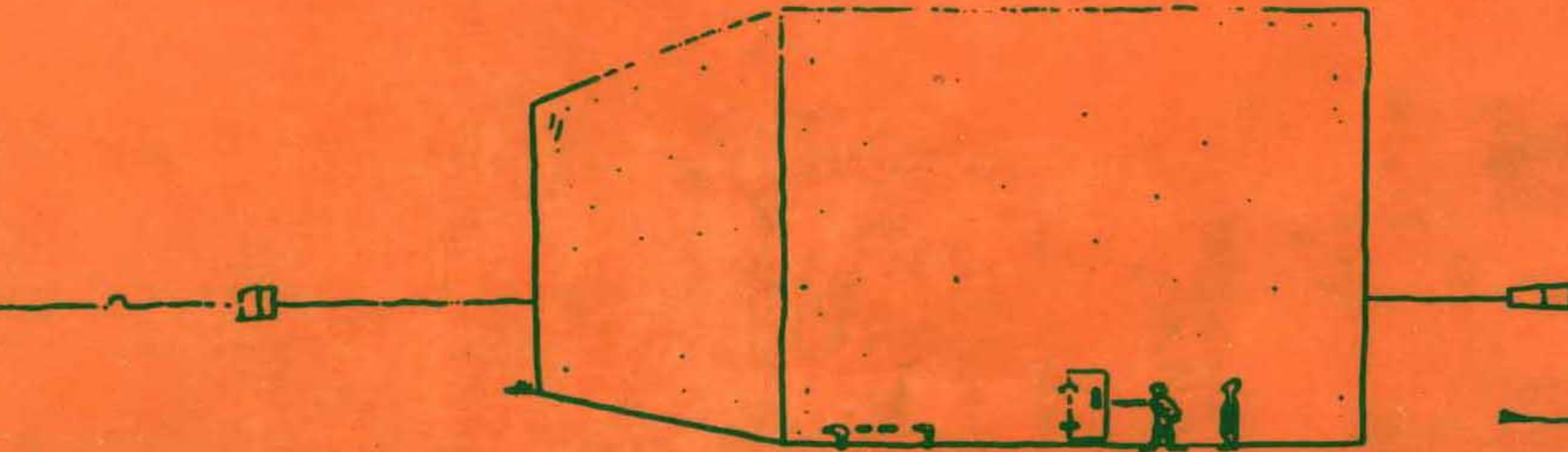
" STAN, LET'S RUN THROUGH THAT AGAIN .... NO FILM IN OUR CAMERA. "

**Cherokee 3.8 Mt**

**First Thermonuclear Airdrop**

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# *This Just Has to Be Twenty Yards Closer, Jack!*

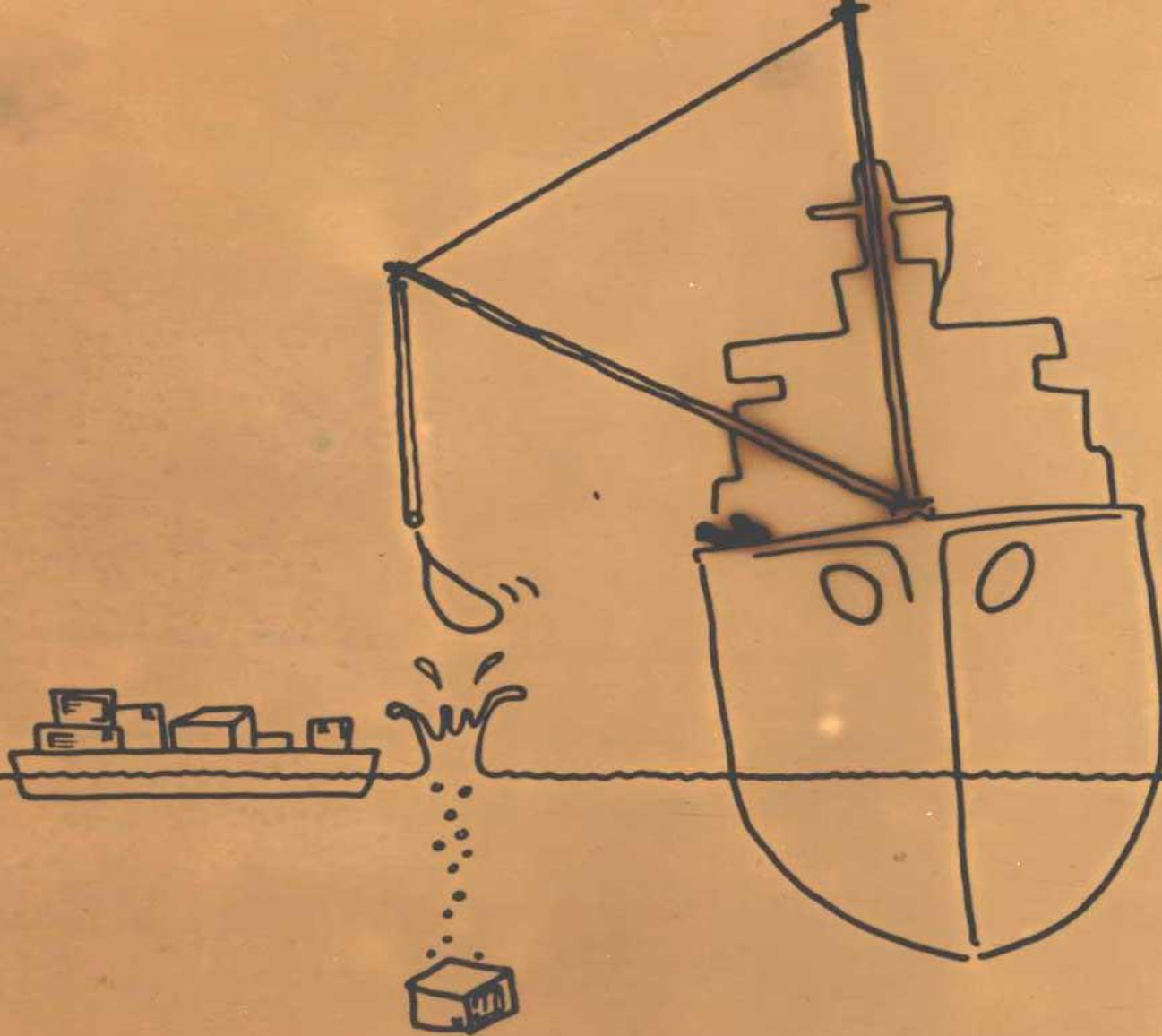


"WE JUST HAVE TO BE TWENTY YARDS CLOSER, JACK!"

**What makes you think we're  
rushed?**



**"WHAT MAKES YOU THINK WE'RE RUSHED?"**



**Well, there goes program 3.9.2.1.6**

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"WELL, THERE GOES PROGRAM 3.9.2.1.6."

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# Proposed Full JTF 7 Troop Review

PROPOSED FULL JTF TROOP REVIEW

7.2.

7.3

7.4

7.1

7.2

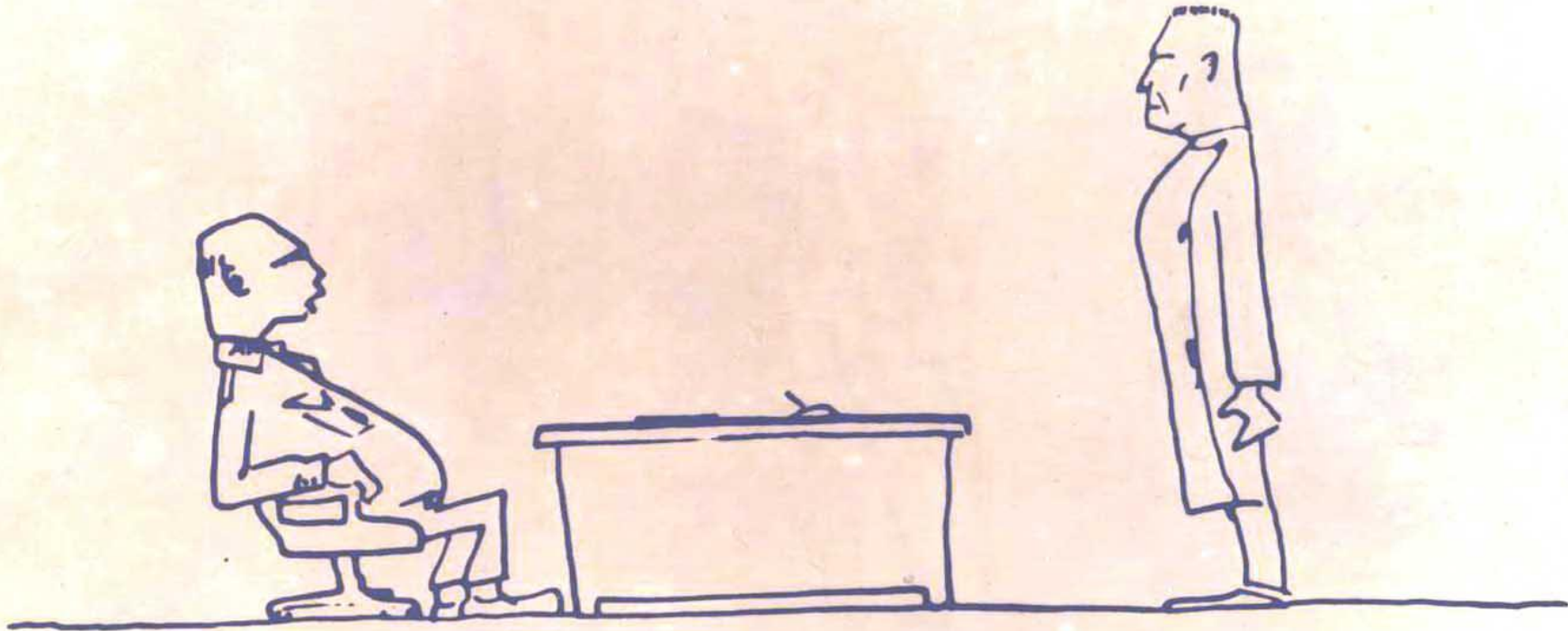
7.3

7.4

7.1

MILITARY  
INTELLIGENCE

**“Your assignment is to mingle unobtrusively with 7.1 scientists...”**



“YOUR ASSIGNMENT IS TO MINGLE UNOBTUSIVELY  
WITH 7.1 SCIENTISTS...”

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**Bikini/ Tewa  
07/20/56**

**This test caused  
considerable fallout  
on Enewetak Atoll,  
over 200 miles distant**

**Some layers of wind  
were not as expected.**



# ***PLUMBOB - Progress In Weapon Design Continues***

- 30 SHOTS FIRED BETWEEN 5/28/57  
AND 2/22/58 IN NEVADA
  - 9 TOWER
  - 2 SURFACE
  - 13 BALLOON
  - 3 SHAFT
  - 2 TUNNEL
  - 1 ROCKET

Diablo 07/15/57



*Fireball mixing of materials is  
bad*

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The “solution”  
was to use towers,  
first at 200 feet,  
then 300, then  
500 feet. One  
tower was 700  
feet.



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*Most Towers at the NTS were  
500 feet high*

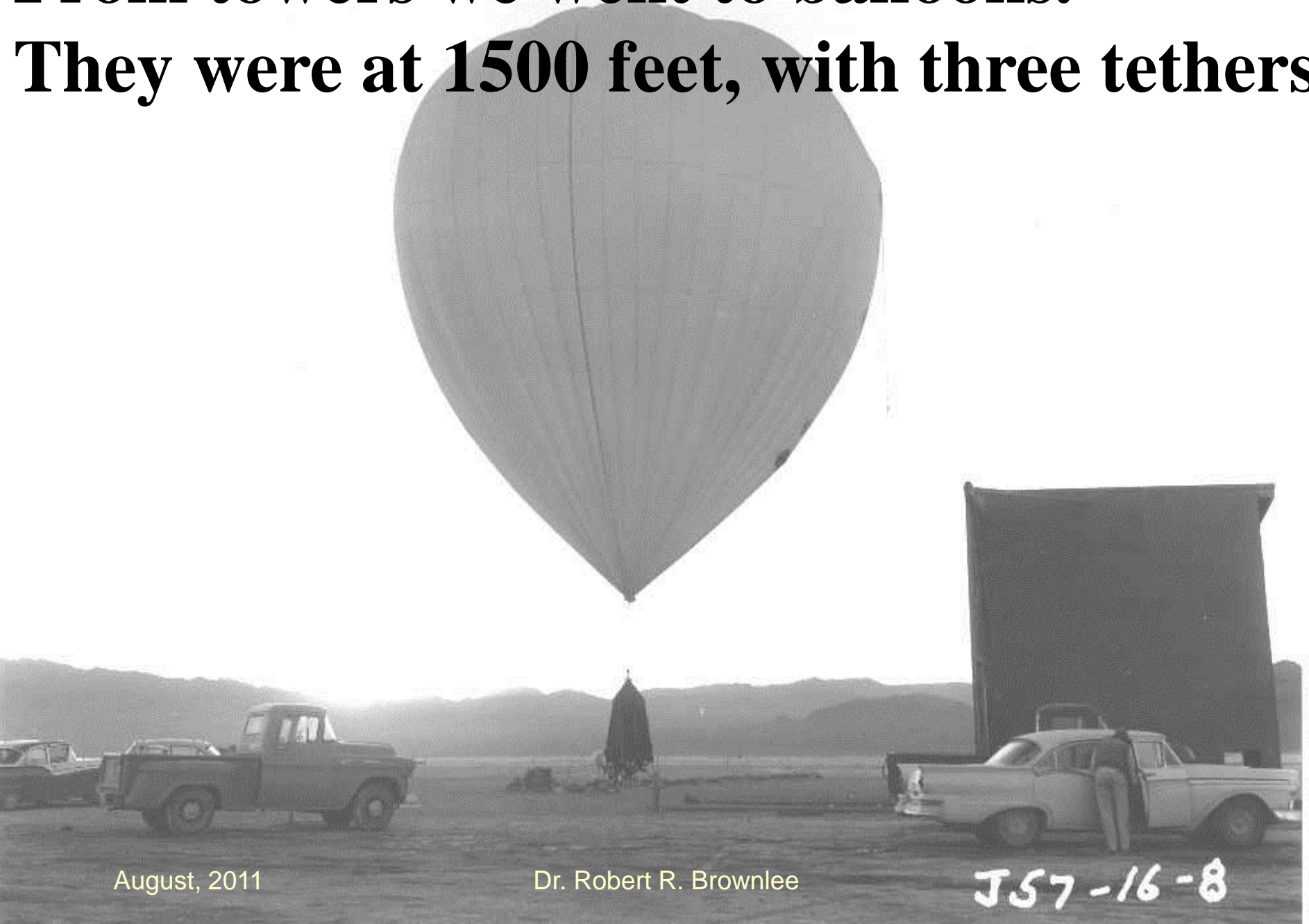


*The area surrounding ground zero was  
sometimes paved to reduce fallout*

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**From towers we went to balloons.**  
**They were at 1500 feet, with three tethers.**



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J57-16-8

# *Heat From Fireballs Also a Problem*



- The ground immediately below the fireball is heated, even vaporized, and rises to join the fun.
- The fireball also rises quickly.
- Can the rising “stem” catch up?
- There is a combination of height and yield when the answer is “No.”

**Stokes, 19 kt on a balloon, was a “winner**



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**So was Charleston, 12 kt**



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A photograph of the atomic bombing of Nagasaki on August 9, 1945. The image shows a massive, glowing orange and yellow mushroom cloud rising from the city. The cloud has a bright, intense core at its base, which is the fireball from the atomic bomb. The cloud is surrounded by a thick, dark smoke plume that rises from the ground. The background is dark, and the overall scene is one of destruction and devastation.

**Climax, 61 kt, was an airdrop**  
**But the stem caught the fireball**

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# *Project 57 - a One Shot Deal*



- Fired 4/24/57, on the surface, Nevada  
Zero yield
- Purpose: the safety aspects of Pu dispersal

# ***PLUMBOB – 29 Tests, Progress In Weapon Design Continues***



- Proof tests of new weapon models
- Exploratory testing of new concepts
- Experimental determination of fundamental matters of design interest

# *Project 58, NTS Tries To Answer Continuing Safety Questions*



- 4 shots fired between
  - 12/06/57 and 3/14/58
  - 1 surface (SURPRISE—500 tons)
  - 1 shaft
  - 2 tunnel
- All safety experiments

# *Hardtack Phase One Was in the Pacific*



- 35 tests between April 28 and Aug 18, 1958.
- Largest yield was POPLAR, July 12.  
9.3 Mt.
- Preparations were being made for a big series in Nevada at the same time. Lab people were really being pressed.

# *Argus - a Test Series for High Altitude*



- 3 shots fired between 8/27/58 and 9/6/58,
  - Each was 1-2 kt
- All rocket borne, about 300 miles above the south Atlantic

# *Hardtack, Phase Two— At the NTS*

- 37 SHOTS FIRED BETWEEN 9/12/58  
AND 10/30/58
  - 10 TOWER, 3 SURFACE
  - 11 BALLOON, 6 SHAFT
  - 7 TUNNEL, 18 SAFETY
  - 19 WEAPONS RELATED

# *Hardtack, Phase Two— At the NTS*



- A NEARLY FRANTIC ATTEMPT BY BOTH LABS TO FIND SMALL-SIZED DEVICES THAT WERE ALSO ONE-POINT SAFE

# ***Talk About Hustle!!***

- Twenty-nine (29) tests fired in October, 1958
- Eighteen (18) of these were in the last 11 days
- Four on October 22, and four on October 30
- The fifth one on the last day was not quite ready at midnight. There was a debate about whose midnight should be observed!

# *October 31, 1958 Eisenhower's Test Moratorium Begins*

- First order of business—try to remember who we were
- Next priority—rest

# Resting Leads to Indolence

- Many activities died
- Example:
- Air force special weapon center:
  - ~1000 personnel, 1958
  - ~14 personnel, 1961
  - Task force 7 “disappears

# *But There Were Good Things, Too*



- Some activities grew
  - Computers
  - Data analysis
  - Satellites
  - Plowshare
  - H. E. CRATERING
- HOWEVER, by and large, our ability to test dribbled off into the sand

# *August 13, 1961- The Berlin Wall*



- AUG 30, 1961: Soviets announce return to testing
- The Soviet spokesman surprised the Soviet Delegation in Geneva
- The Soviets tested on Sept 1, and fired in quick order ~50 shots, the largest being 58 Mt
- Last test in their series was on Nov 4

# *Kennedy Administration Not Happy With the Labs' Readiness*

- The labs weren't either, being badly surprised
- There were just too many requirements
- Soviets did everything possible to keep us from doing any atmospheric testing after they completed their series
- Our atmospheric tests did not begin until 25 April, '62

# *We DID Start Testing Underground*

- Livermore tested on Sept 15—2.6 kt
- Los Alamos responded on Sept 16—yield too low to call, as were the next three tests by both labs
- Meanwhile the Soviets were setting off many big bangs!
- We won no friends, nor influenced people

# *Atmospheric Testing Resumes With Operation Nougat*

- Quest for safer, smaller, more efficient devices
- Beginning of continuous testing in Nevada

# ***Dominic Was A Tester's Dream (Nightmare—where Will We Be When We Awake?)***

- 40 shots fired between 4/25/62 and 11/4/62
  - 24 CHRISTMAS island
  - 10 JOHNSTON island
  - 4 NEVADA
  - 2 pacific (n4.83 e149.42) and (n31.23 e124.22)
  - 29 airdrop
  - 1 underwater, 2 surface, 1 crater, 1 tunnel
  - 6 rocket

# *The Extent of Our Ignorance Caused Some Sudden Awakenings*

- 30 weapons related
  - 10 effects
- Stockpile weapons not previously tested in weaponized form
- New concepts leading to major weapon advances
- Major operational systems tests

# *Soviets Began Another Test Series of the Fall of 1962*

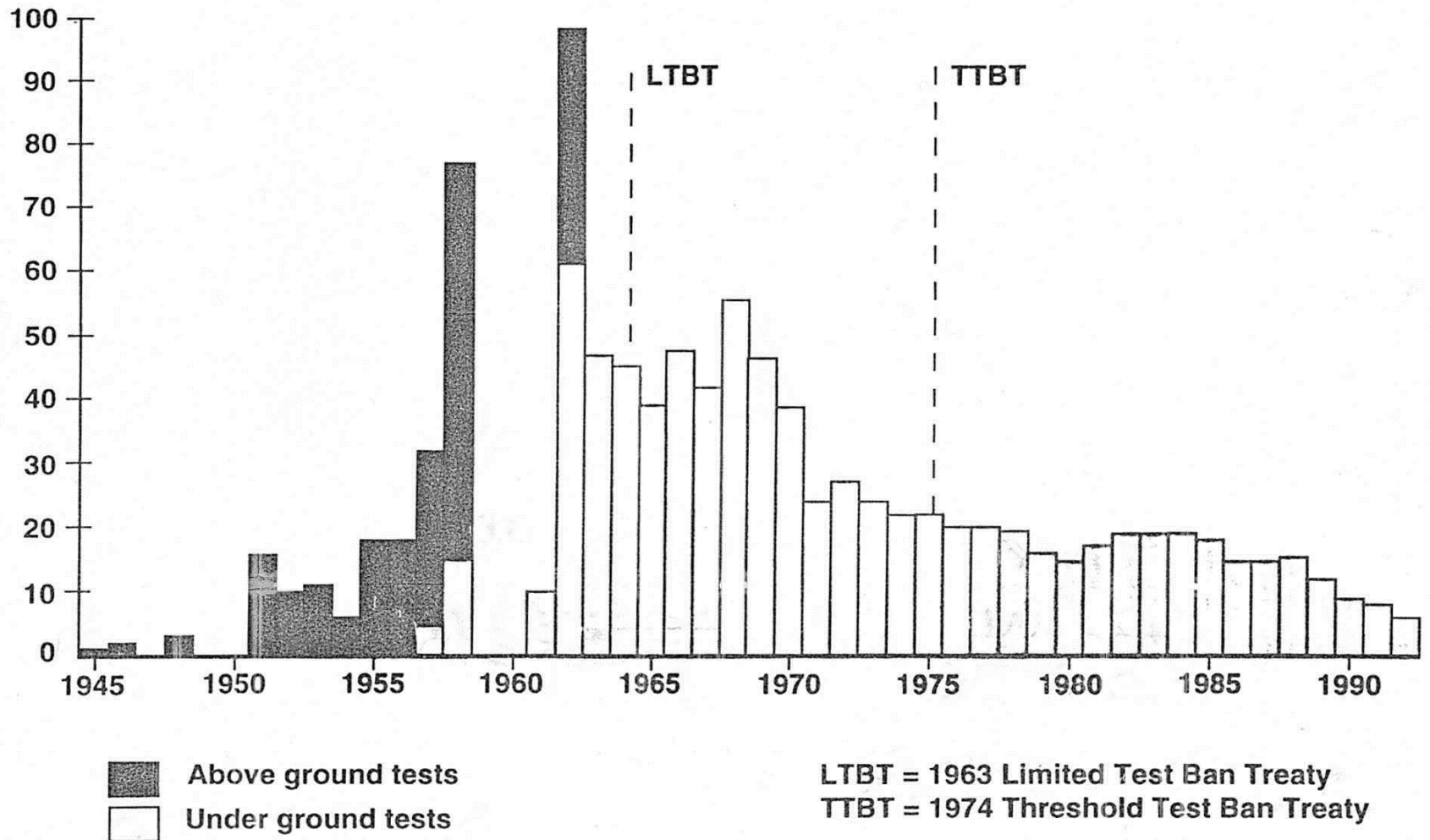
- Many of their tests were at yields much higher than our biggest. (Bravo).
- Many of us believed that there were not practical uses of really high yields. We were just not that angry at the world.

# *Operations and Numbers of Tests*



• Trinity	1	• Wigwam	1
• Crossroads	2	• Project 56	4
• Sandstone	3	• Redwing	17
• Ranger	5	• Project 57	1
• Greenhouse	4	• Plumbbob	30 (5 Underground")
• Buster	5	• Project 58	3 (2 Underground)
• Jangle	2	• Hardtack I	35 (2 Underwater)
• Tumbler/Snapper	8	• Argus	3
• Ivy	2	• Hardtack II	37 (13 Underground)
• Upshot/Knothole	11	• Nougat	32 (All"Underground")
• Castle	6	• Dominic	37
• Teapot	14		

# US Nuclear Testing



Data Source:  
United States Underground Nuclear Tests - July 1945 through September 1992  
DOE/NV-209 (Rev. 14)

*Throughout our Atmospheric Test  
Program There Was One Constant*




Perpetual Change  
Daily, even Hourly

## *An Aside--*



- In those (golden) days, the chain of command was like this.
- The President of the U.S.
- To the Chairman of the AEC.
- To the Laboratory Director.
- To the Division Leader.
- **To us!**



Is It Any Wonder  
that we got things  
done?

# *Now, Let's Consider Certain Concerns!*




- We know WHY we have nuclear weapons.
- We have believed that deterrence can be made to work.

# *So, We Have a Nuclear Stockpile*



- We have been reducing the number of nuclear weapons for many years.
- We should be increasingly uncomfortable about what is left.



*In Today's World, Would You Be  
in Favor of Unilaterally Giving  
up Our Nuclear Stockpile?*

# *The Existence Of A Stockpile Is Profound*



- The Nuclear Stockpile
  - Involves Many Hundreds of Thousands of Components
  - Each Wanes Differently Each Day
  - Brings About Nasty Problems

!

# *Nuclear Stockpile Is a Hard Master*



- It existence constantly raises questions about its integrity.
- It has the capacity to outwit the biggest and fastest computers.
- It is unforgiving.
- It requires EXPERTS to care for it. (This is a HUGE demand).

# *Knowledgeable People a Rare Asset*



- At least 5 years are required to educate real experts.
- An astonishing number of things have NOT been written down.
- Most needed: “new” experts mentored by “old” experts.

Must be achieved at any cost.

# *Remember*



- Your Nuclear Stockpile  
DICTATES Behavior
- Do What It Demands, Or  
You'll Pay, BIG TIME

# *Probably Not Every Nuclear Country Understands This*



- Most are eager to have nuclear devices, but are not really prepared to be responsible custodians.

# *Stockpile's Cadre of Experts Must Include*



- Theoreticians
- Experimenters
- Visionaries
- Pragmatists
- World's best educators

# *Nuclear Stockpile Will Eventually Require Testing*



- Places to test are disappearing before our eyes!
- NTS still has capability and capacity, but perhaps not much longer.
- **Testing in Space is the way to go.**

# *Nuclear Energy in Space?*

- That's where it all is— already!
- Mankind's future is there
- Interplanetary travel needs nuclear energy
- So do we
- Reactors in space have enormous potential
- NASA currently of little help

# *“When the Soviet Union Collapsed----”*

( I try to work this into my conversation every day).

- There was a price we also had to pay, or should have paid.
- The Soviets abandoned salaries, bookkeeping, responsibilities, control, common sense.
- We responded with salaries, bookkeeping, irresponsibility, bureaucratic boredom, odd controls,
- and little common sense.

*Was This Behavior a Surprise?*



Of Course Not.

(All bureaucracies become mindless)