U.S. Nuclear Weapons and Nuclear Explosion Testing

Richard L. Garwin

Council on Foreign Relations
and
IBM Fellow Emeritus

Sidney D. Drell Lecturer
Stanford University

March 9, 2004

Outline

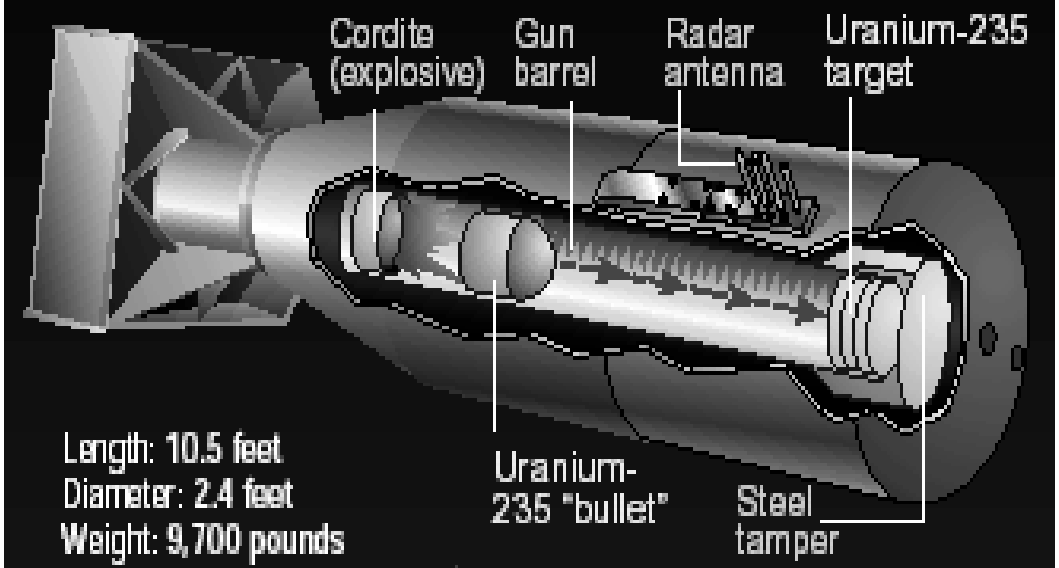
- **The nature of nuclear weapons**
- **The purposes of nuclear explosion testing**
- **A nuclear stockpile without nuclear explosion tests?**
- **The effectiveness of “bunker buster” and “agent defeat” weapons**
- **A path forward for nuclear weapons**
  - **Nonproliferation and counter proliferation**
  - **Reducing the threat from excess nuclear weapons and materials**
  - **Reducing nuclear weapon stockpiles.**

THE BOMB THEN AND NOW

A typical nuclear weapon today is more accurate and is nine times more destructive than the Hiroshima bomb.

"Little Boy"

The uranium-235 bomb that destroyed Hiroshima was flown there in a B-29 bomber and aimed with a bombsight.



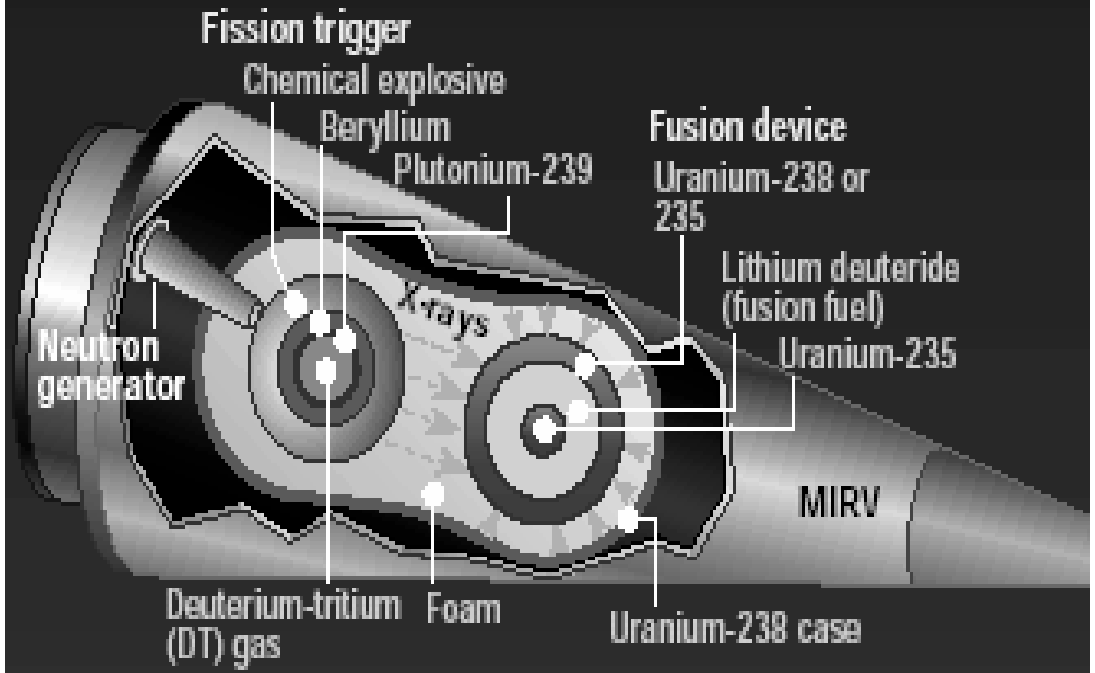
Length: 10.5 feet
Diameter: 2.4 feet
Weight: 9,700 pounds
Explosive power: 12,500 tons of TNT

Explosion process: When the bomb fell to 1,900 feet, a radar antenna set off a conventional explosive in the bomb chamber. This catapulted a uranium-235 wedge through the gun barrel into the U-235 target rings, producing a self-sustaining nuclear chain reaction.

o

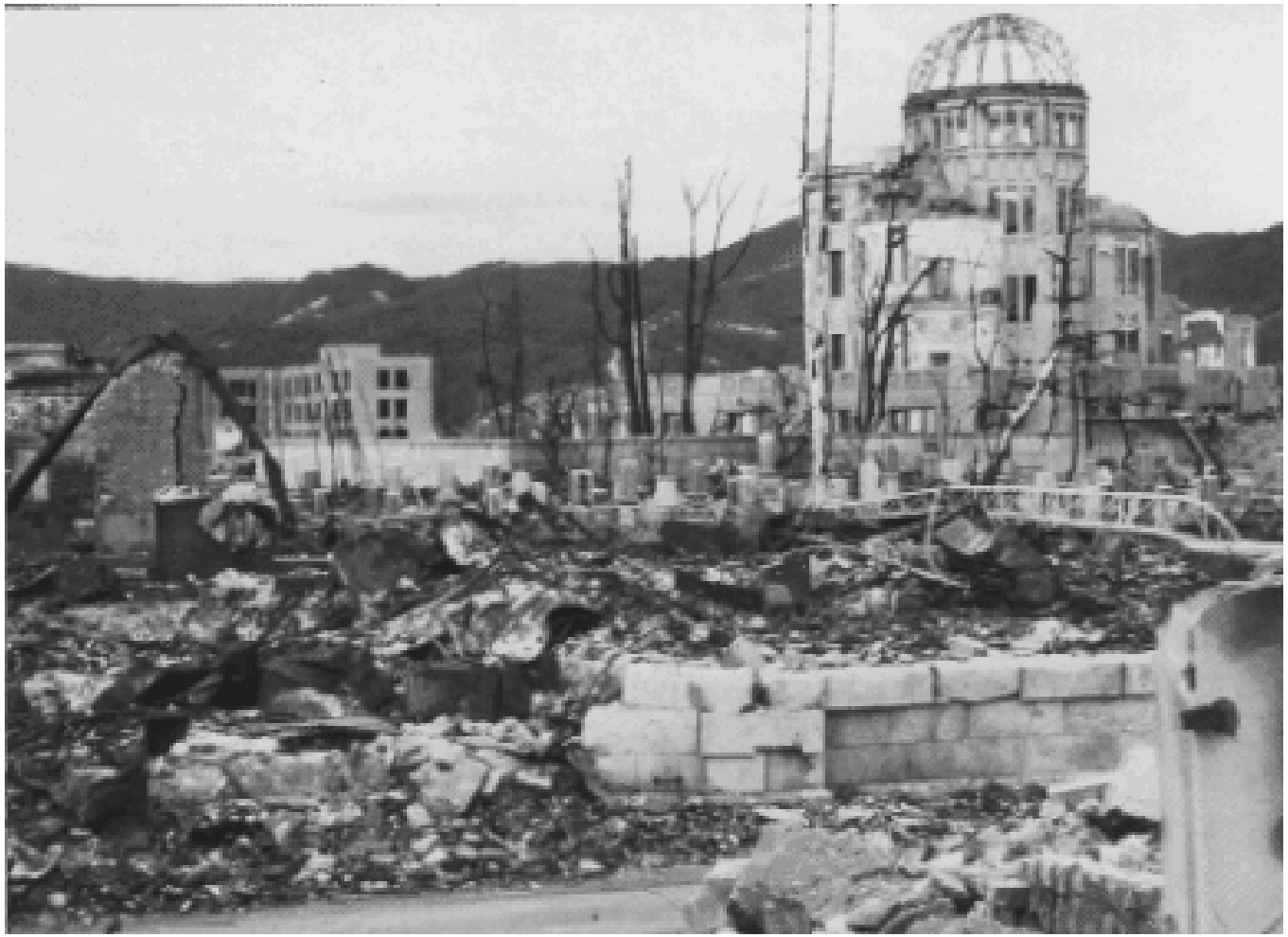
A modern thermonuclear

This W87 thermonuclear warhead is launched on an MX intercontinental missile. Packed into a multiple independently targeted re-entry vehicle (MIRV, shown below), it splits off from the missile to strike its target.



MIRV length: 5.7 feet MIRV base diameter: 1.8 feet
Explosive power: 300,000 tons of TNT

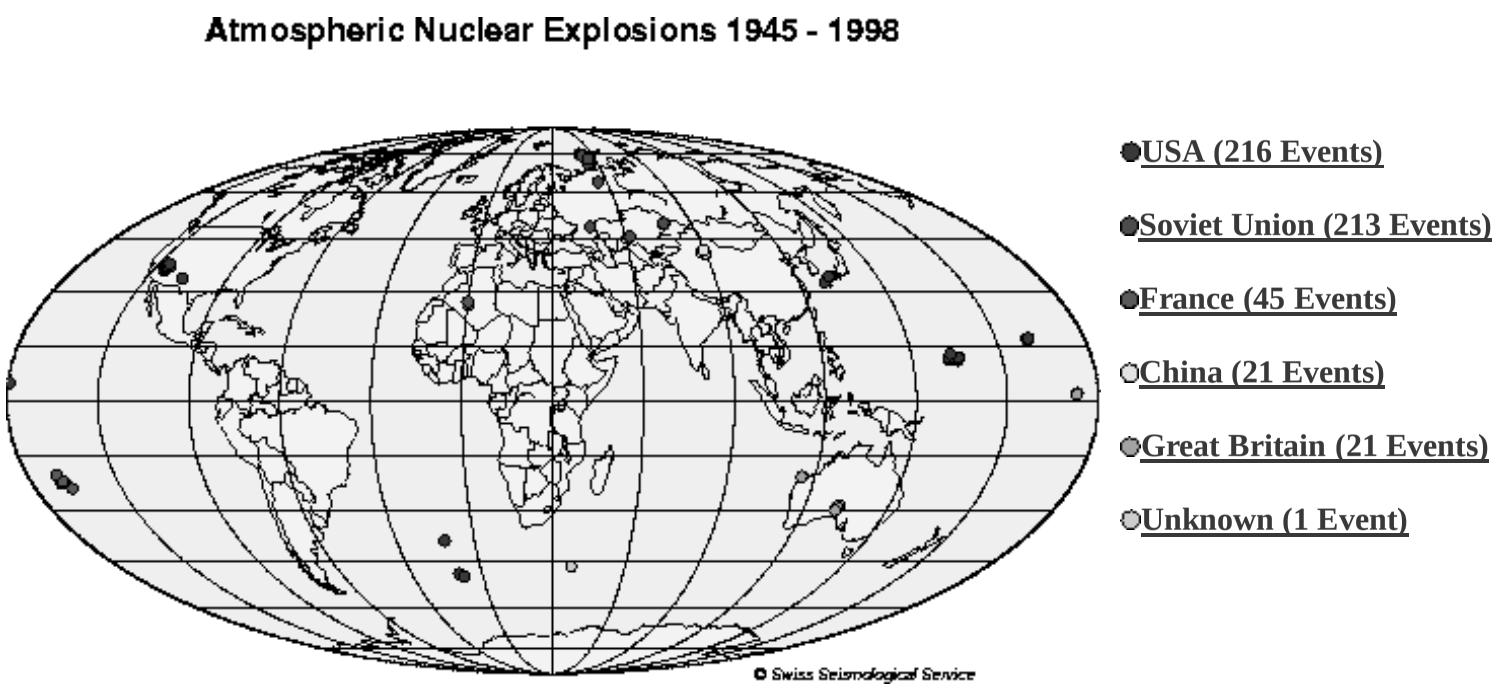
Explosion process: The compression of plutonium with a chemical explosive (above, left) starts a fission explosion that, in turn, is boosted by the fusion of DT gas. X-rays then compress the second component, causing a larger fission/fusion.



Nuclear Explosions

Verification

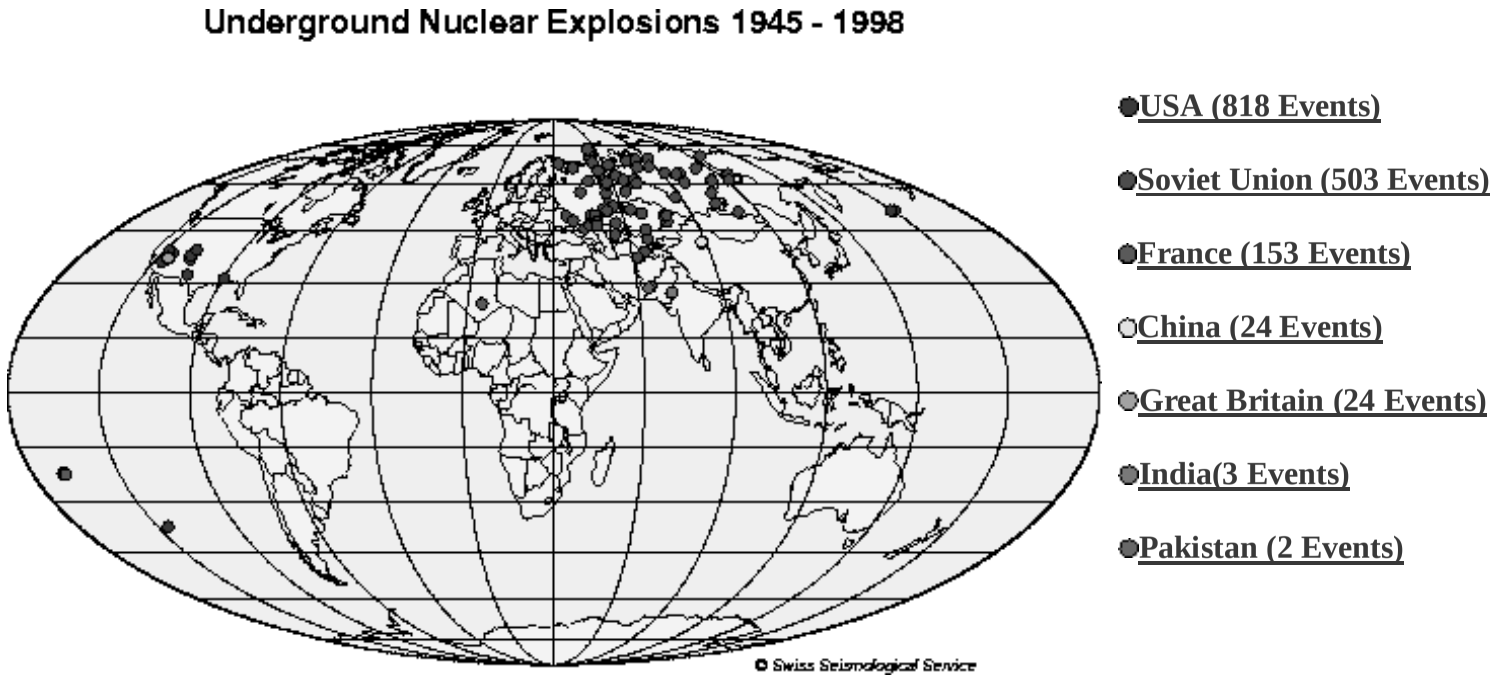
- Home
- Introduction
- Swiss Activities
- Chronicle
- Nuclear Explosions
  - Underground
  - Atmospheric
  - Underwater
- DAVOX
- CTBT
- Links



World map with known atmospheric nuclear explosions, subdivided by countries.

Nuclear Explosions

Verification

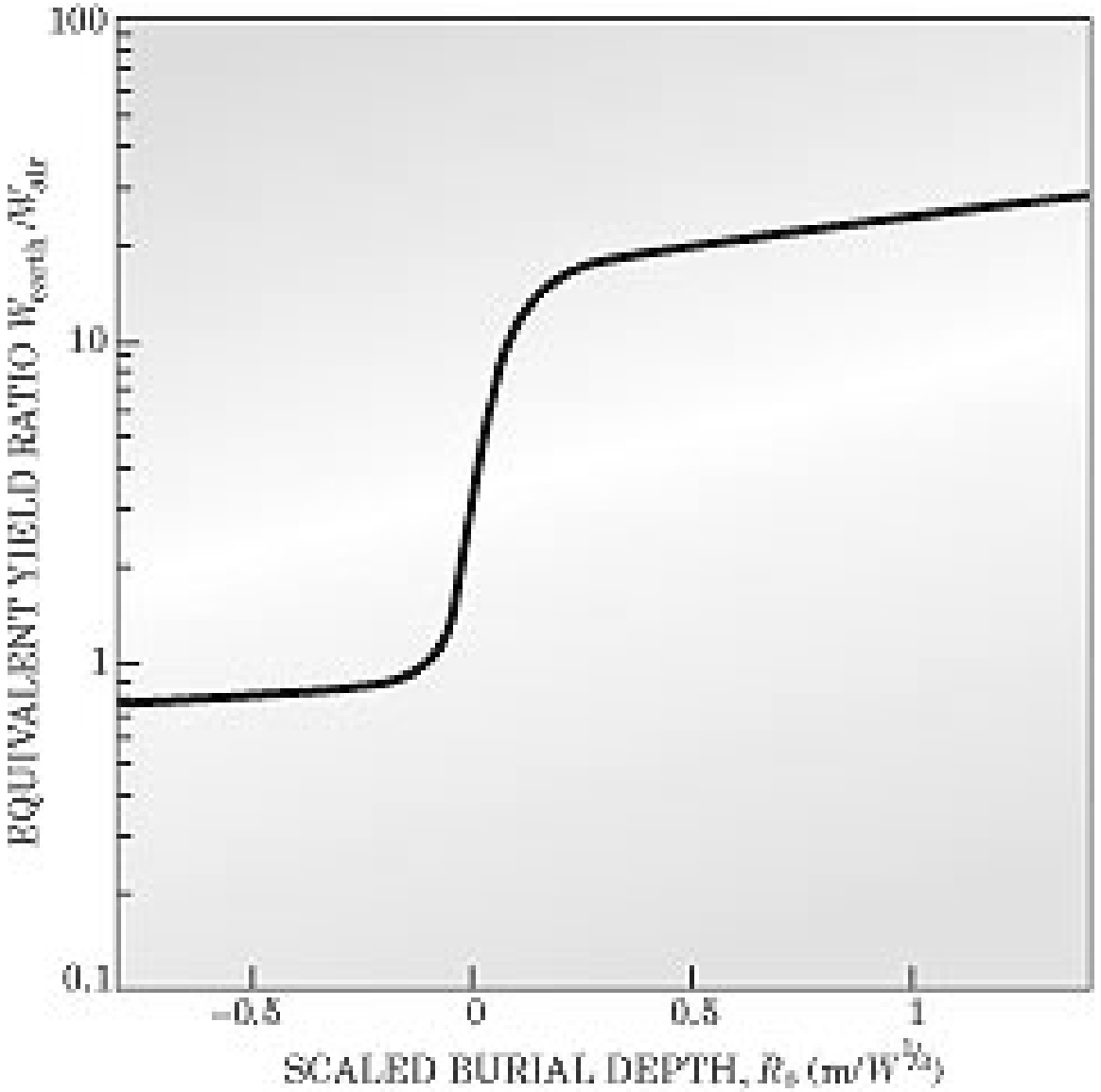


World map with known underground nuclear explosions, subdivided by countries.

1. Nordyke: http://www.osti.gov/servlets/purl/514386-g3aMbc/webviewable/514386.pdf

B. Contained Applications

Chronological Number	Ministry of Atomic Energy (MAE) Name	Date	Geographic Vicinity	MAE Yield (kt)	MAE Depth of Burial (m)	Geology	Name/Comments	Sponsor of test
B.1. Stimulation of Oil Production and Increasing the Efficiency of Oil Recovery								
2	Butane	03-30-65	15 km nw of Meleyz, Bashkir, ASSR	2x2.3	1341& 1375	Limestone	"Grachevka 1"; Holes 617 and 618	Oil Prod. Ministry
3	Butane	06-10-65	Same as above	7.6	1350	Limestone	"Grachevka 2";Hole 622	Oil Prod. Ministry
12	Grifon	09-02-69	10 km s from Osa, Perm Ob.	7.6	1212	Limestone	Osa oil field; Hole 1001	Oil Prod. Ministry
13	Grifon	09-08-69	Same as above	7.6	1208	Limestone	Osa oil field: Hole 1002	Oil Prod. Ministry
14	Stavropol'	09-26-69	100 km nne of Stavropol', Stav. Kr.	10	712	Clay	Takhta-Kagulta Gas Field	Oil Prod. Ministry
49	Oka (Neva)	11-05-76	90-120 km ssw of Mirnyy, Yakut ASSR	15	1522	Dolomite	Also listed as DSS by Benz[5]	Geology Minstry
61	Vyatka (Neva)	10-07-78	90-120 km ssw of Mirnyy, Yakut ASSR	13	1530	Dolomite		Geology Ministry
73	Sheksna (Neva)	10-07-79	Same as above	15	1545	Dolomite	Hole 47	Oil Prod. Ministry
75	Butane	06-16-80	15 km nw of Meleyz, BAshkir, ASSR	3.0	1400	Limestone		Oil Prod. Ministry
76	Butane	06-25-80	Same as above	3.0	1390	Limestone		Oil Prod. Ministry
79	Angara	12-10-80	140 km nw of Khanti-Mansiysk, Kh. Ms.AO.	15	2485	Sandstone.		Geology Minstry



http://physicstoday.org/vol-56/iss-11/p32.html (Rob Nelson)

Nuclear Explosion Testing ("Nuclear Testing")

- **Four environments: atmosphere, underwater, underground, space.**
- **Purposes**
  - **Nuclear-weapon-related**
    - **Exploration of principles—boosting, radiation implosion**
    - **Development of a stockpile weapon**
    - **Production verification**
    - **Stockpile verification (absence of aging effects)**
    - **Weapons effects (on military and civil targets, on nuclear weapons, on the environment—e.g., space)**
  - **Basic research—e.g., super heavy nuclei, neutrinos, equation of state**
  - **Peaceful nuclear explosions (PNE)—stimulation of oil and gas, earth moving, storage cavities, rock crushing, seismic sounding**
  - **To provide "ground truth" for weapon designers and to maintain skill in testing.**

The National Academies Report on "Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty"

- **Whether U.S. weapons could be maintained safe and reliable under a CTBT.**
- **Whether the International Monitoring System, supplemented by U.S. national technical means, could detect significant tests-- say, those above 1 kt.**
- **And whether activities harmful to U.S. security could be conducted by nuclear test explosions below the detectable level.**

Conclusion on the impact of a CTBT on US weapons

"that the United States has the technical capabilities to maintain confidence in the safety and reliability of its existing nuclear-weapon stockpile under the CTBT, provided that adequate resources are made available to the Department of Energy's (DOE) nuclear-weapon complex and are properly focused on this task…" **and**

"Some have asserted, in the CTBT debate, that confidence in the enduring stockpile will inevitably degrade over time in the absence of nuclear testing."

It responds that such a view

"... underestimates the current capabilities for stockpile stewardship, underestimates the effects of current and likely future rates of progress in improving these capabilities, and overestimates the role that nuclear testing ever played (or would ever be likely to play) in ensuring stockpile reliability."

NUCLEAR AND BIOLOGICAL MEGATERRORISM[1]

Table-- Summary of ranges for significant effects (in meters).				
Yield (kt)	**(a)***	**(b)***	**(c)***	**(d)***
1	**275**	**610**	**790**	**5500**
10	**590**	**1800**	**1200**	**9600**

a* Range for 50% mortality from air blast (m)
b* Range for 50% mortality from thermal burns (m)
c* Range for 4 Gy initial nuclear radiation (m)
d* Range for 4 Gy fallout in first hour after blast (m)

*****A detonation at ground level in Manhattan timed for maximum working population density would kill some 200,000 people (1 kt) within a week—mostly from prompt radiation exposure.**

Hence the urgency to dry up the source of highly enriched uranium and plutonium.

[1] See R.L. Garwin, www.fas.org/RLG

WHAT TO DO?

President Bush's Proliferation Security Initiative (PSI) of February, 2004 does not go far enough—words but no significant money. Perhaps it can be a real program. Nuclear fuel cycles…

Re weapon-usable materials, need to:

- **Consolidate plutonium and highly enriched uranium at fewer sites**
- **Rapidly provide security for it with sufficient mechanisms and force to prevent robbery by concerted terrorists**
- **Expand systems for detecting smuggled HEU and Pu (not an easy task)**
- **Compare < $1 billion/yr for Nunn-Lugar Cooperative Threat Reduction program with $87 billion for less than a year in Iraq.**
- **Rapidly and seriously cut Russian and U.S. nuclear weapon inventories to 2000 and then to 1000 from the > 10,000 now.**

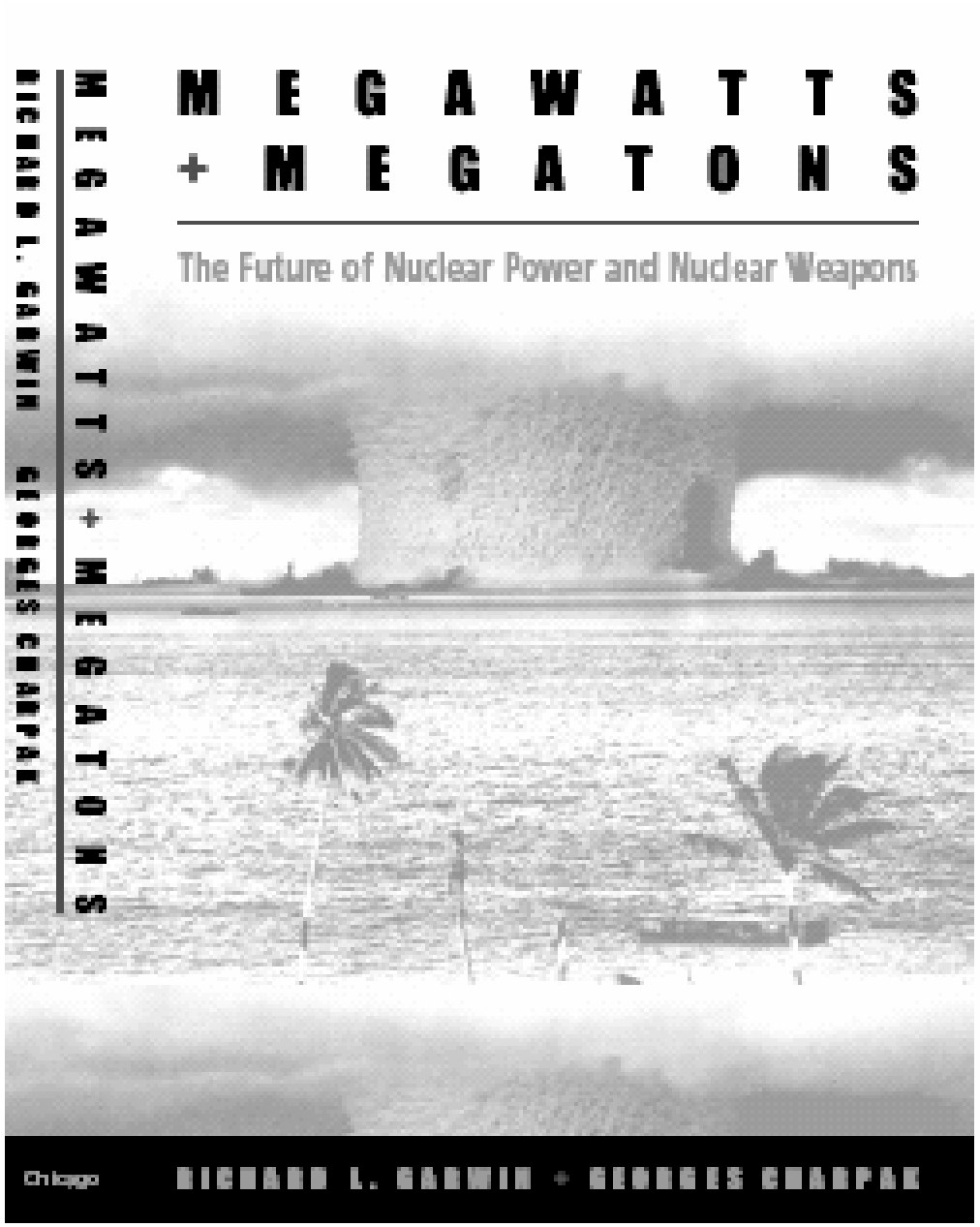
To read further:
Nuclear Threat Initiative and the Managing the Atom project: ***Preventing Nuclear Terrorism,*** **Matthew Bunn, October 2003**

The Garwin Archive, **www.fas.org/RLG E.g., see 1995 JASON report on nuclear testing.**

Effectiveness of Nuclear Weapons against Buried Biological Agents Targets, **Michael May and Zachary Haldeman, March 2003**

http://www.osti.gov/opennet/rdd-7.pdf
RESTRICTED DATA DECLASSIFICATION DECISIONS, 1946 TO THE PRESENT **(RDD-7), January 1, 2001**

The Gravest Danger: Nuclear Weapons **by Sidney D. Drell and James E. Goodby, ISBN: 08179-4472-9 $15.00, paperback 134 pages October 2003**



Univ. of Chicago Press 01/2003