SCIENCE FOR DEMOCRATIC ACTION

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1995 NPT Review and Extension Conference:

Outcomes and Implications

by Tessie Topol

"A Conference will be held in 25 years to decide whether the Treaty shall continue in force indefinitely, or shall be extended for an additional fixed period or periods. This decision will be taken by a majority of the parties to the Treaty."

— Article X.2 of the Nuclear Non-Proliferation Treaty, 1970.

From April 17–May 12, 1995, 174 of the 178 states parties to the Non-Proliferation Treaty (NPT) assembled at the United Nations to review the Treaty and to decide upon its permanence. On May 11, 1995 the body reached agreement by consensus that the Treaty should be extended indefinitely. In addition to the decision on extension, two other decisions on the "Principles and Objectives for Nuclear Non-Proliferation and Disarmament" and "Strengthening the Review Process for the Treaty" shaped the outcome of the 1995 NPT Review and Extension Conference.

The Debate Takes Shape

In the first few weeks of the conference, various sides of the extension debate emerged. One

See **Conference**, *page 13*

THE BETTMANN ARCHIVE

Crew of B-29 "Enola Gay" which dropped the atom bomb on Hiroshima on August 6, 1945.

"Always" the Target?[1]

by Arjun Makhijani

On 23 April 1945, Gen. Leslie R. Groves, director of the Manhattan Project, wrote a memo to Henry L. Stimson, Secretary of War. It contained a puzzling phrase, which I have italicized:

"Our previous hopes that an implosion type of bomb might be developed in the late spring of 1945 have now been dissipated by scientific difficulties . . .

"While our plan of operation is based on the more certain, more powerful, gun type bomb, it also provides for the use of the implosion type bombs as soon as they become available. *The target is and was always expected to be Japan.* A composite group of the 20th Air Force has been organized and

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[1] Based on an article in *The Bulletin of the Atomic Scientists*, May/June 1995.

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specially trained and equipped."[2]

By the time the memo was written, it was clear to everyone connected with the atomic bomb project that Germany would not be the target. The Third Reich would collapse long before the first bombs were ready for use. If the new weapon was to be used at all in World War II, it would be against Japan.

But had Japan "always" been the target, as Groves implied? If so, that fact suggests a terrible irony that has been little noted in the decades-long debate over the use of the bomb. From August 1939, when Albert Einstein alerted President Roosevelt to the possibility that atomic bombs could be built, to late 1944, when it became entirely apparent that Germany was not an atomic threat, the focus of U.S. bomb makers was Germany.

Émigré scientists from Europe — especially Leo Szilard, Enrico Fermi, Hans Bethe, Niels Bohr and the like — played pivotal roles in the Manhattan Project. To a man, they — along with their American and British colleagues — got involved for one overarching reason: Germany had first-rate scientists who presumably understood the destructive possibilities of nuclear fission. The United States had to develop an atomic bomb before the Germans did. Such weapons in the hands of Hitler would be the ultimate catastrophe for the world.

Joseph Rotblat, one of the European émigré scientists at Los Alamos, and the only one to quit when it became clear in late 1944 that Germany would not have the bomb before the war ended, said in an interview with me that "there was never any idea [among scientists] that it would be used against Japan. We never worried that the Japanese would have the bomb. We always worried about what [Werner] Heisenberg and other German scientists were doing. All of our concentration was on Germany."[3]

Surviving Manhattan Project scientists continue to believe that atomic bombs were used on Hiroshima and Nagasaki, rather than on German targets, because they were not ready in time. But that may not be the whole story.

Early Targeting Discussions

The first targeting discussion (insofar as can be determined from declassified documents and histories of the Manhattan Project) occurred during a meeting of the Military Policy Committee of the Manhattan Project on 5 May 1943, over two years before V-E day:

> The point of use of the first bomb was discussed and the general view appeared to be that its best point of use would be on a Japanese fleet concentration in the Harbor of Truk [an island in the Pacific Ocean]. General Styer suggested Tokio [*sic*] but it was pointed out that the bomb should be used where, if it failed to go off, it would land in water of sufficient depth to prevent easy salvage. The Japanese were selected as they would not be so

See **"Always?"** *page 3*

[2] L.R. Groves, Memorandum to the Secretary of War, "*Atomic Fission Bombs,*" 23 April 1945, Record Group 77, Records of the Manhattan Engineer District, 1942-1948, National Archives, Washington, D.C.

[3] Telephone interview with Joseph Rotblat, Pugwash, conducted by Arjun Makhijani on 15 February 1995.

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apt to secure knowledge from it as would the Germans.[4]

Of course, the bomb was far from ready, as the specific choice of Truk as a target was theoretical at this stage. But Manhattan Project scientists seem to have been unaware of this discussion or reasoning then or even in the decades that followed, though the document itself is not new and has been cited in historical works before.[5] For example, Hans Bethe, who headed the Theoretical Division at Los Alamos during the Manhattan Project, reacted with amazement when I brought this to his attention on 14 February 1945:

> This is completely new to me . . . I am amazed both by the conclusion not to use [the bomb] on Germany and secondly by their reasons [for targeting the Japanese fleet]. We [the scientists] had no idea of such a decision. We were under the impression that Germany was the first target until the German surrender. That was my belief. Obviously, it was wrong.[6]

Glenn Seaborg, who headed the team that first isolated plutonium, concurs. In an interview on 3 February 1995 he said:

> So far as I recall right up until the time the Germans surrendered in the spring of 1945, we thought that the Germans would be the target for the atomic bomb. As their demise became more and more predictable perhaps we somewhat drew away from that feeling, but certainly we thought in 1944 that Germany would be the target.[7]

David Hawkins was a special assistant to Robert Oppenheimer, the scientific director of the Los Alamos Laboratory where the first atom bombs were designed and built. Hawkins was also for a time the historian of the early Los Alamos effort. He also agreed that the scientists had no idea that Germany had been discussed and rejected as a potential target as early as May 1943.[8] Hawkins and others I interviewed do not recall discussions of targeting among the scientists until well into 1945, and especially after the war in Europe had ended on 8 May 1945.[9]

"We thought the Germans would be the target for the atomic bomb."
— Glen Seaborg, head of the team that first isolated plutonium

The Bomber of Choice

In contrast to a specific targeting of the Japanese fleet at Truk, the use of the bomb on Germany appears to have been considered only as a retaliatory measure in case of first German use of the bomb. A Military Policy Committee status report of 21 August 1943 makes a reference to the potential bombing of Germany, but the statement only discusses that possibility in case the war became "unduly" long and the Germans were be able to produce "a usable bomb" before the United States. In that event, the Committee concluded it might "be necessary for us to stand the first punishing blows [of German atom bombs] before we are in a position to destroy the enemy."[10] But the practical preparations continued to be for a bombing in the Pacific, not the European war.

An early decision to use the newly developed B-29 bomber also points to the choice of a Pacific war target as primary. The B-29 was selected as the bomber that the U.S. would use as early as the summer of 1943, provided the appropriate modifications could be made to it. Captain Parsons was put in charge of this project in June 1943. According to the official history of the Manhattan Project by Richard Hewlett and Oscar Anderson, Jr., the choice of the B-29 indicated that Japan was already the primary target. "Had Germany been the primary target, the choice would hardly have fallen on an aircraft never intended for the European theater."[11]

That conclusion is supported, at least indirectly, by the technical facts. British Lancasters could

See "Always?" page 4

4 L. R. Groves, Military Policy Committee Minutes, 5 May 1943, Record Group 77, Records of the Manhattan Engineer District, 1942-1948, National Archives, Washington, D.C.

5 For instance it is cited in a footnote in Martin Sherwin, *A World Destroyed: Hiroshima and the Origins of the Arms Race*: Vintage Books, New York, 1987, p. 209. According to Sherwin the document was declassified in 1976.

6 Telephone interview with Hans A. Bethe, Cornell University, conducted by Arjun Makhijani on 14 February 1995.

7 Telephone interview with Glenn Seaborg, Associate Director at Large, Lawrence Berkeley Laboratory, conducted by Arjun Makhijani on 3 February 1995.

8 Telephone interview with David Hawkins, conducted by Arjun Makhijani on 3 February 1995.

9 The first meeting of the Target Committee was on 27 April 1945 and that of the Interim Committee (which considered policy issues) was on 9 May 1945.

10 Military Policy Committee, "Report of *August 21, 1943* On Present Status and Future Program on Atomic Fission Bombs," Record Group 77, Records of the Manhattan Engineer District, 1942-1948, National Archives, Washington, D.C., p. 14.

11 Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World: A History of the United States Atomic Energy Commission, Volume I 1939-1946*, University of California Press, Berkeley, CA 1990, p. 253. Vincent Jones, the U.S. Army's historian of the Manhattan Project concurs with Hewlett and Anderson, stating that the B-29 was chosen in September 1943 and that this "seemed to imply that the bomb was to be used against Japan." Vincent Jones, *Manhattan: The Army and the Atomic Bomb*, Center of Military History, United States Army, Government Printing Office, 1985, p. 510, footnote.

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have been modified for the atom bomb. The four-engine Lancaster had a normal payload of 14,000 pounds, but some had been modified to carry the "Grand Slam"—at 22,000 pounds, the heaviest bomb produced in the war. The chief technical advantage the B-29 had over the Lancaster was its great range: 3,000–4,000 miles. That made it the only bomber suitable in the Pacific.[12]

Nationalistic feeling may also have played a part in the choice of the B-29 over the Lancaster.[13] Manhattan Project officials wanted British collaboration in the scientific aspects of their work, but were reluctant to give up sole control of decisions regarding nuclear weapons. Germany as a target would not only have meant the probable use of a British bomber, but also that control over logistical aspects would have to be shared with the British.

It is noteworthy that the argument that American lives would be saved by bombing Japan does not seem to have been a factor in early targeting decisions. Indeed, the overall strategy of the war, including allocation of resources between the European theater and the Pacific theater, apparently did not figure in these nuclear targeting discussions, so far as we have been able to determine. Nuclear decisions seem to have taken place primarily within the context of the nuclear capabilities of Germany and Japan relative to the United States.

The other startling point is that the officials who made these early decisions did not see fit to communicate them to the scientists. Groves had set up the Manhattan Project on a "need to know basis"; it appears that he and his fellow members of the Military Policy Committee felt that the scientists and engineers who created the bomb under the assumption that the target was Germany had no need to know otherwise. During my interview with him on 3 February 1995, David Hawkins, Oppenheimer's special assistant at Los Alamos, speculated that Groves may have told Oppenheimer about the discussion of Truk as a target that occurred during the Military Policy Committee meeting 5 May 1943, but that if he did so Oppenheimer did not communicate this to other scientists.

Groves kept the bomb scientists isolated from any discussion of how their work would be used.

Targeting and the Schedule of Bomb Production

The Military Policy Committee targeting discussion of 5 May 1943, had nothing to do with an estimate of when the war against Germany might end. In the spring of 1943, no one knew when that might be. Moreover, the technical problems that eventually delayed bomb production into the summer of 1945 had not yet emerged. In fact, a report of the committee, dated 21 August 1943, suggested that a fission weapon might be available between the fall of 1944 and the spring of 1945.[14]

That schedule would have been compatible with the targeting of Germany. But the available documentation suggests that there were no specific discussions, much less plans, for use of the bomb against Germany. Given the fact that the losses of Allied troops were expected to be heavy during and after D-Day, one might expect to find evidence that contingency plans to use the bomb in the fall of 1944 had been made. But there is no evidence of that, either. Rather, what evidence there is — albeit sketchy — suggests that there was simply an automatic assumption at an early stage that Japanese forces would be the target.

That Japan would be the target of the first U.S. atomic bomb attack did not change when the Alsos mission came to the conclusion in late 1944 that there was no prospect that Germany would have an atomic weapon before the end of the war. Indeed, work on the project was speeded up. Alsos was the code name for the Manhattan Project's intelligence mission to find out the scientific and technological progress that Germany was making on its atom bomb project.

As historian Martin Sherwin has noted, by 1945 "the race for the bomb had already changed from a race against German scientists to a race against the war itself."[15] Oppenheimer recalled that the period of the most intense work

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[12] Technical data on the Lancaster and B-29 bombers provided by Robert S. Norris, Natural Resources Defense Council, Washington, D.C.

[13] Jones observes that the commanding general of the Army Air Forces H.H. Arnold "stated emphatically that an American-made airplane should carry the bombs . . . " Jones 1985, p. 520.

[14] Military Policy Committee, "Report of August 21."

[15] Sherwin 1987, p. 145.

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on the bombs was between the time of the German surrender and the use of the bombs against Japan.[16]

What began in the early years of the war due to fear of a German nuclear weapons program was completely transformed by the fall of 1944 to a project of using nuclear weapons as a tool of immense military superiority to be used to accomplish a variety of goals. In order to do that, successful use of the bomb as an instrument of power had, first of all, to be demonstrated.

Questions

Time has not stilled the controversies surrounding the decision to bomb Hiroshima and Nagasaki, even while Japanese diplomats were quietly exploring a face-saving way to surrender. In the past five decades, millions of words have been written to explain the bombings.

To most Americans — especially veterans — the use of the bombs was a cut-and-dry matter. They were dropped to end the war quickly and thus save American lives. Others have postulated that the bombs were used to send a signal to the Soviet Union about power in the post-war world or to study their effects on real cities as targets. The argument has also been made that the bombs were used to justify the huge expenditure of scarce wartime resources.

It seems clear that the 5 May 1943 memo suggests that a form of nuclear deterrence was at work. The Germans were thought to have an active nuclear bomb program; therefore, the Military Policy Committee was reluctant to use the first U.S. bomb against German forces. If it had been used against a German target, and if it had been a dud, the Germans might have been more likely to recover it and "to secure knowledge form it."

All such explanations, and more, find historical support in documents relating to the Manhattan Project. But nothing in the historical record can answer these questions: How many scientists, if any, would have left the project if they had known in 1943 that Japan might have been the target of first use? How many scientists simply would have quit in 1943 and 1944, Rotblat style, if they had known that the target "was always expected to be Japan"?

With the possible exception of Oppenheimer, the scientists, who were motivated mainly by the specter of a Nazi bomb, were not aware of the early targeting decisions. This throws a far harsher light on the ineffectiveness of dissenting scientists in affecting the political and military policy of the Manhattan Project. Until today, the central issue of debate on this score has been related to the failure of the group of scientists who wanted a demonstration shot or other warning before the use of the bomb to persuade the Interim Committee, a temporary body appointed by the Secretary of War to advise the President on targeting strategy and post-war nuclear weapons related issues. But if the scientists were not even aware of how the policy evolved, due to the secrecy and compartmentalization that was a hallmark of the Manhattan Project, how could they even have participated in the decision-making in an informed fashion?

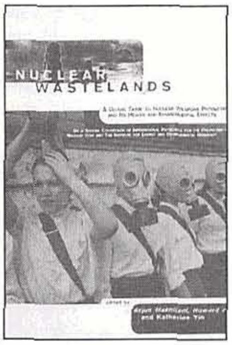
Fifty years later, such if-only-they-had-known speculation is merely an intellectual exercise dealing with a host of unknowable factors. But it does raise an essential philosophical and practical point regarding secrecy and the responsibility of scientists — an old question that is nonetheless as relevant today as it was 50 years ago: If scientists do not have the minimum information needed to participate openly and democratically in decision-making about the use of weapons of mass destruction, should they be involved in making them?

[16] Sherwin 1987, p. 145.

NEWS FLASH

A National Academy of Sciences panel has just issued a report entitled *Technical Bases for Yucca Mountain Standards.* It recommends a new method for calculating doses that, if adopted by the EPA, would essentially gut clean water standards. It could increase the amount of radioactive contamination allowed in drinking water by thousands of times. One panel member, Dr. Thomas H. Pigford, filed a dissent. The report is $39.00, plus shipping. To order a copy of the report, call 1-800-624-6242.

SELECTED PUBLICATIONS



Nuclear Wastelands

A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects

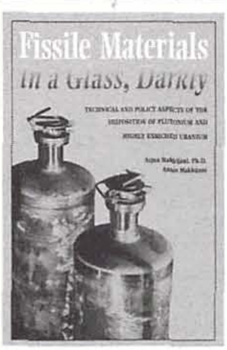
MIT Press, 1995

edited by Arjun Makhijani, Howard Hu, and Katherine Yih

A handbook for scholars, students, policy makers, journalists, and peace and environmental activists, *Nuclear Wastelands* provides concise histories of the development of nuclear weapons programs of every declared and de-facto nuclear weapons power, as well as detailed surveys of the health and environmental effects of this development both in the these countries and in non-nuclear nations involved in nuclear weapons testing and uranium mining. Its thorough documentation and analyses bring to light governmental secrecy and outright deception that have camouflaged the damage done to the very people and lands the weapons were meant to safeguard.

No future research into nuclear weapons will be credible unless it refers to this study.
—Jonathan Steel, *The Guardian* (UK), August 9, 1995

LIST PRICE: $55.00. SDA readers can get discounted copies from IEER at $40.00 each, postage included.



Fissile Materials In a Glass, Darkly

IEER Press, 1995

by Arjun Makhijani and Annie Makhijani

IEER's report analyzes the options for disposition of plutonium and highly enriched uranium. It recommends policies designed to put these materials into non-weapons-usable forms as rapidly as possible. It urges that the U.S. adopt vitrification of plutonium as its disposition option (rather than using it in reactors) in order that the U.S. may persuade countries still separating plutonium from civilian spent fuel to stop doing so.

Fissile Materials In a Glass, Darkly *makes a compelling, highly readable case for disposing of plutonium as a waste and rejecting the dangerous notion that it is a valuable asset. The risks and options for disposing of nuclear-weapon material are explored thoroughly, and in a lucid style for the non-technical reader. This report should be required reading for those who insist that plutonium from warheads can only be disposed of by turning it into fuel for nuclear reactors. But the report's greatest value is as a primer for the public at large.* —Paul Leventhal, President, Nuclear Control Institute

PRICE: $12 including postage and handling.

COMING SEPT. '95

Mending the Ozone Hole

Science, Technology, and Policy

MIT Press, 1995

by Arjun Makhijani and Kevin Gurney

While CFC production has been reduced in many places, the ongoing emissions of chemicals and the production of other long-lived ozone-depleting substances mean a decade will pass before the levels of ozone-depleting chlorine in the earth's atmosphere begin to decline. This comprehensive overview details the most current knowledge about stratospheric ozone depletion. More than a review of the evolution of the ozone problem, *Mending the Ozone Hole* provides an objective and stimulating look at current debates surrounding the research, the technology development, and the policy-making aimed at eliminating ozone-depleting substances.

LIST PRICE: $35.00. SDA readers can get discounted copies from IEER at $27.50 each, postage included.

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Radiation Turns 100

by Hisham Zerriffi

Both X-rays and radioactivity were discovered by accident around 100 years ago. While studying the behavior of electrons in a vacuum tube in 1895, Wilhelm Roentgen noticed a glowing fluorescent screen in his laboratory. Roentgen deduced that the phenomenon was the result of invisible rays originating in the covered tube he was using to study the electrons. Since he did not understand the origin of the rays, he called them X-rays. The rays were given off by the slowing down of the electrons in the tube when striking a target. This kind of radiation is now called "braking" radiation, or more commonly by the German word for braking, "brehmstrahlung" radiation. It is high frequency electromagnetic radiation.

Antoine Henri Becquerel, a French scientist, first discovered radiation emanating from an element in 1896. He was examining X-rays by photographing uranium crystals. Becquerel believed that the uranium was absorbing energy from the sun and then emitting X-rays. However, the phenomenon could be observed even when the uranium was not exposed to sunlight. The photographs were not the result of X-rays, but rather the emission of gamma rays from the radioactivity of uranium.[1]

Gamma rays and X-rays are identical in nature. The different names simply have to do with the origin of X-rays from electron tubes and of gamma rays from disintegrating nuclei of radioactive elements. Later, it was observed that uranium emitted not only gamma radiation, but also particles. It was

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1 "Centennial Calendar: X Rays 1895-1995 Radioactivity 1896-1996." Health Physics Society.

Chronology *

November 8, 1895: Roentgen discovers X-rays.

March 1, 1896: Becquerel discovers radioactivity.

January 3, 1901: First report of death due to X-rays.

September 12, 1922: First radium-related dial painter death.

Late 1938: First detection of nuclear fission. Experimentally confirmed by Frisch on January 13, 1939.

February 25, 1941: Discovery of plutonium.

December 2, 1942: First controlled nuclear chain reaction.

July 16, 1945: First nuclear explosion (the Trinity Test) at the Alamogordo Bombing Range in New Mexico.

August 6, 1945: Bombing of Hiroshima.

August 9, 1945: Bombing of Nagasaki.

July 1946: First post-World War II nuclear weapons tests at Bikini.

August 29, 1949: Soviet Union detonates its first nuclear weapon.

December 8, 1953: Eisenhower announces the Atoms for Peace Program.

August 8, 1955: First UN Conference on peaceful uses of Atomic Energy.

1956: Calder Hall reactor, the world's first commercial electricity generating station begins operation, at Windscale site in northern England. It is also used for making plutonium for weapons.

October 10-11, 1957: Fire at a nuclear reactor at Windscale.

December 2, 1957: Shippingport (first US power reactor) begins operating.

1967: U.S. nuclear arsenal reaches its peak at 32,500.

March 28, 1979: Three Mile Island, Pennsylvania Accident.

1986: Russian nuclear arsenal reaches its peak at 45,000.

April 26, 1986: Chernobyl Accident spreads radioactive fallout over a large region.

1994: Active U.S. and Russian nuclear stockpiles at approximately one-third of their peak levels.

* Main source: for radiation-related information: "Centennial Calendar: X Rays 1895-1995 Radioactivity 1896-1996." Health Physics Society. Additional sources: Natural Resources Defense Councils "Nuclear Notebook" in *The Bulletin of the Atomic Scientists*, May 1993; Hewlett, Richard G. and Jack M. Holl. *Atoms for Peace and War: 1953-1961.* (Berkeley, CA: University of California Press, 1989); Hewlett, Richard G. and Oscar E. Anderson, Jr. *The New World: A History of the United States Atomic Energy Commission Volume 1 1939-1946.* (Berkeley, CA: University of California Press, 1990); May, John ed. *The Greenpeace Book of the Nuclear Age.* (New York: Pantheon Books, 1989)

Radiation, *from page 7*

found that uranium was mixed in with other elements called decay products; some emitted heavy particles (called alpha particles, later identified as helium nuclei) and others lighter particles (called beta particles, later identified as electrons).

After these discoveries at the end of the nineteenth century, scientists began to explore these phenomena and their applications, often in a cavalier manner, common at that time. At first, the dangerous effects of certain forms of radiation were unknown; highly radioactive substances were used in a variety of applications. But attempts to use X-rays in medical applications produced early evidence of cancers among medical practitioners caused by repeated exposure to X-rays. In another well-known example, World War I clock and instrument dials were painted with radium-226 to make them luminescent. The "dial painters" unfortunately ingested substantial quantities of radium by licking their brushes in order to make the most precise markings possible on the clocks. The link between the alpha-radiation from the radium that the dial painters were exposed to and the illnesses they contracted was established in the 1920s. The amount of radium-226 in the bones of the victims was a small fraction of a milligram (a milligram is a thousandth of a gram).

X-rays and radiation also have had some beneficial effects over the last century. As science has come to better understand its effects, modern medicine has made many uses of radiation in research and treatment. Radio-iodine has been used until recently as a diagnostic tool, especially in treating thyroid problems. X-rays continue to be used extensively in diagnostics. However, practices using X-rays, radium, and radon (a radioactive decay product of uranium-238) for supposed medical treatment which amounted to quackery and which flew in the face of the well-established

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Glossary

Absorbed Dose: The absorbed dose is the amount of energy deposited in a unit of biological tissue. The units of absorbed dose are the rad and gray. The biologically effective dose, measured in either rems or sieverts, accounts for the differing effects in tissue of different types of radiation. It is the absorbed dose multiplied by a Relative Biological Effectiveness (RBE) factor.

Alpha Radiation: Energetic helium nuclei (two protons and two neutrons) emitted from the nucleus of a heavier element in the process of radioactive decay of the element.

Beta Radiation: Energetic electrons or positrons (particles identical to electrons, but with a positive electrical charge) emitted from the nuclei of an element in the process of radioactive decay of the element.

Gamma Radiation: Electromagnetic waves, released during radioactive decay, that can ionize atoms and split chemical bonds. Gamma rays are similar to X-rays, the latter term being applied usually to electromagnetic waves emitted by electron accelerators, as for instance in medical equipment.

Numbers

Average Annual Radiation Dose, USA
(Source: Health Physics Society Calendar)

Natural background radiation: ~90 mrem at sea level

Indoor radon: ~200 mrem (with high variation from one region to the next, even one house to the next)

Other man-made sources, mostly medical: ~60 mrem

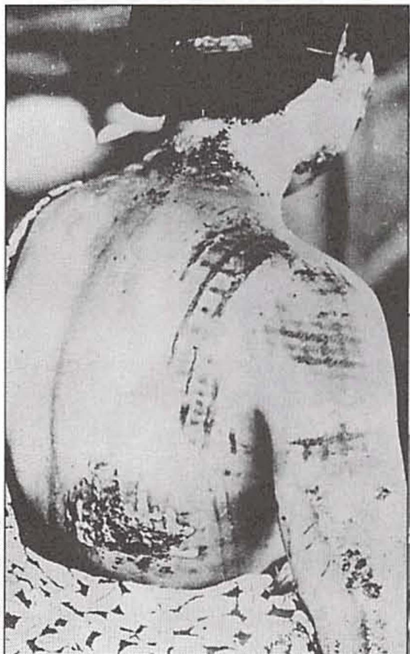
Fallout from atmospheric testing: ~4 mrem

Notes:

1. Effective whole body dose from a single chest X-ray: approximately 10 mrem (0.15 mSv).
2. Estimate of medical X-ray procedures in 1990: between 260 and 330 million
3. Number of medical tests and studies using radioactive materials in 1987: 7,690,000
4. These figures do not reflect the large doses obtained by certain groups of people such as radiation workers in nuclear weapons plants. Of particular note also should be the high exposures received from various sources during the 1940s and 1950s by needless X-rays from machines of poor quality. Prominent among these were chest X-rays given to children from mobile machines. Most of the carcinogenic consequences of such exposures would have begun manifesting themselves only from the 1970s onward.

RETROSPECTIVE ON THE NUCLEAR AGE

This SDA Centerfold is a retrospective on the fifty years of the nuclear age through photos, graphs, charts, and quotations. From the first nuclear test at Alamagordo, New Mexico and the bombings of Hiroshima and Nagasaki to the thousands of nuclear tests that have been conducted worldwide, nuclear weapons have caused enormous harm to human life and health, as well as environmental devastation. Safeguarding weapons-usable fissile materials and containing the environmental hazards from nuclear waste will remain formidable challenges for generations to come. On a more positive note, the Centerfold shows the dismantlement of nuclear weapons and the continuing vigilance and activism of citizens around the world who are seeking a nuclear weapons free world. The Centerfold illustrates how individuals around the world have been affected by the age of nuclear weapons, how some have propelled its growth, and how others have tried to come to grips and contain the power and dangers of the atom.



NATIONAL ARCHIVES

▲ *The patient's skin is burned in a pattern corresponding to the dark portions of the kimono worn at the time of the explosion. Japan 1945.*

They held their arms bent [forward] . . . and their skin — not only on their hands but on their faces and bodies, too — hung down . . . Many of them died along the road. I can still picture them in my mind — like walking ghosts. They didn't look like people of this world.

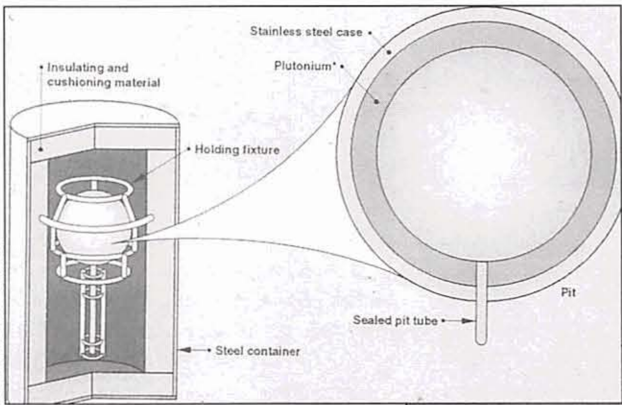
— Interview with a Hiroshima survivor by Robert Jay Lifton, reprinted in Donna Gregory, *The Nuclear Predicament: A Sourcebook,* (New York: St. Martin's Press, 1986), p. 6.

PEACE ACTION

▲ *Demonstration for nuclear disarmament, Hiroshima Japan, August 1994.*

We scientists recognize our inescapable responsibility to carry to our fellow citizens an understanding of the simple facts of atomic energy and its implications for society. In this lies our only security and our only hope — we believe that an informed citizenry will act for life and not death.

— Albert Einstein 1947, reprinted in Harvey Wasserman and Norman Soloman, *Killing Our Own: The Disaster of America's Experience With Atomic Radiation,* (New York: Delacorte Press, 1982).

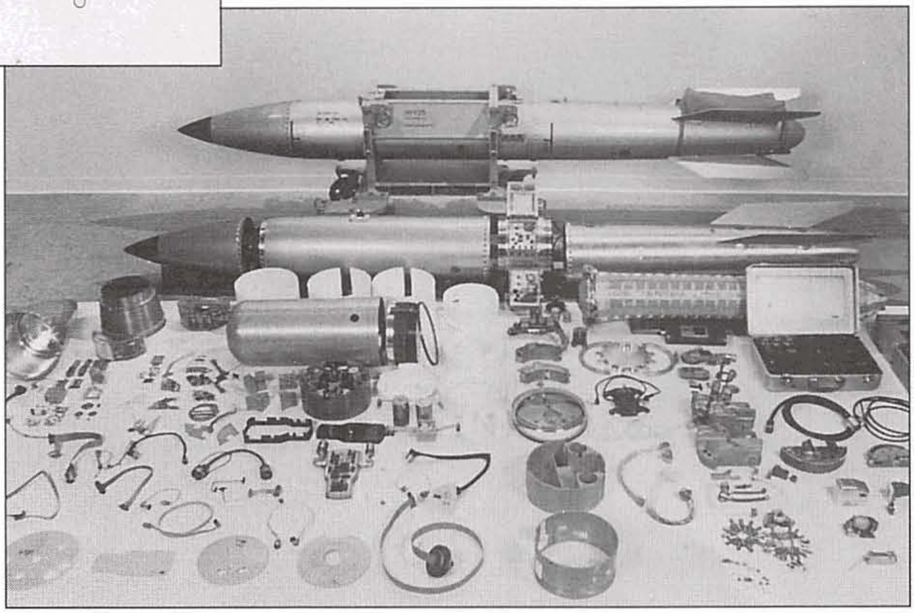


DEPARTMENT OF ENERGY

Plutonium pit storage barrel.

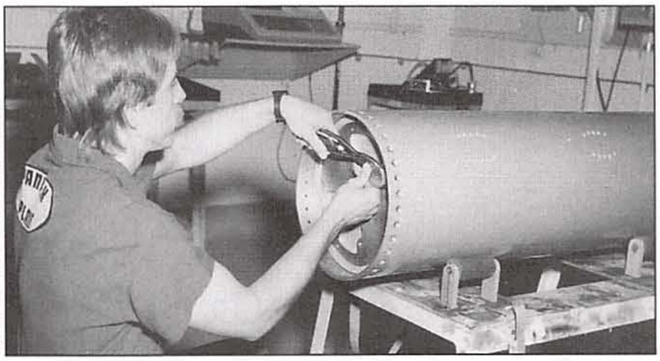
Where science fiction goes, can the atom be far behind? My only fear is that I may be underestimating the possibilities.

— Glenn T. Seaborg, AEC Chairman (1971) in Stewart L. Udall, *The Myths of August*, (New York: Pantheon Books, 1994), p. 250.



OFFICE OF TECHNOLOGY ASSESSMENT

Some 6,000 parts of a B-61 nuclear bomb, along with an intact weapon and its 4 major subassemblies.



OFFICE OF TECHNOLOGY ASSESSMENT

Pantex worker begins warhead disassembly.

There is a film that tells how a war almost broke out between America and the Soviet Union, and after that I didn't sleep for several nights thinking about this, about how war almost broke out and how our existence is hanging on a thread.

— Oleg (Ukraine, age 15) in International Physicians for the Prevention of Nuclear War, "What Soviet Children are Saying about Nuclear War," reprinted in Donna Gregory, *The Nuclear Predicament*, (New York: St. Martin's Press, 1986), p. 183.

Chronology of Arms Control

1945 *Atomic weapons used on Hiroshima and Nagasaki*

1946 *Baruch plan for international control of nuclear weapons fails at UN*

1958 *U.S.-Soviet nuclear testing moratorium begins*

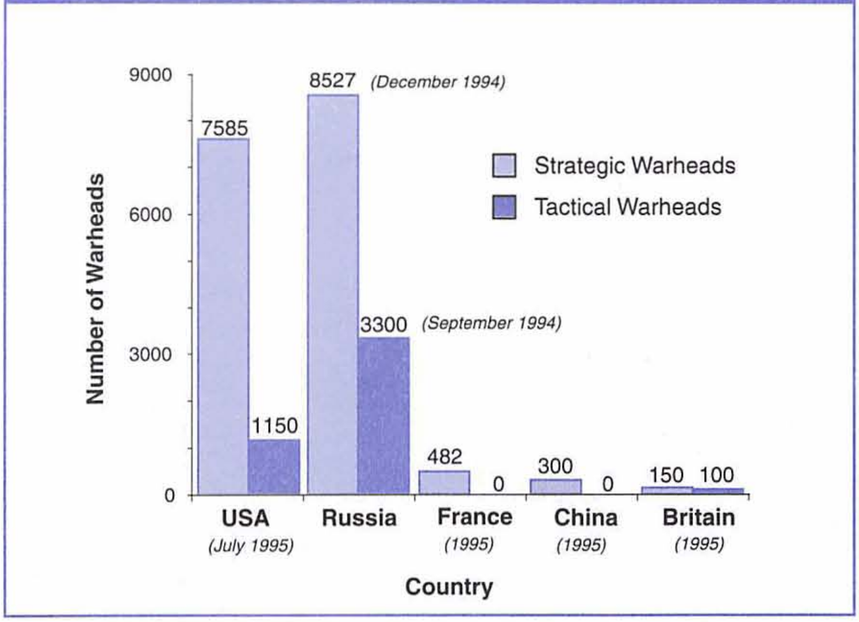
1961 *U.S.-Soviet nuclear testing mortatorium ends*

1963 *Limited Test Ban Treaty signed, bans atmospheric nuclear tests*

1968 *Non-Proliferation Treaty signed*

1945 1950 1955 1960 1965

Estimated Total Nuclear Stockpiles



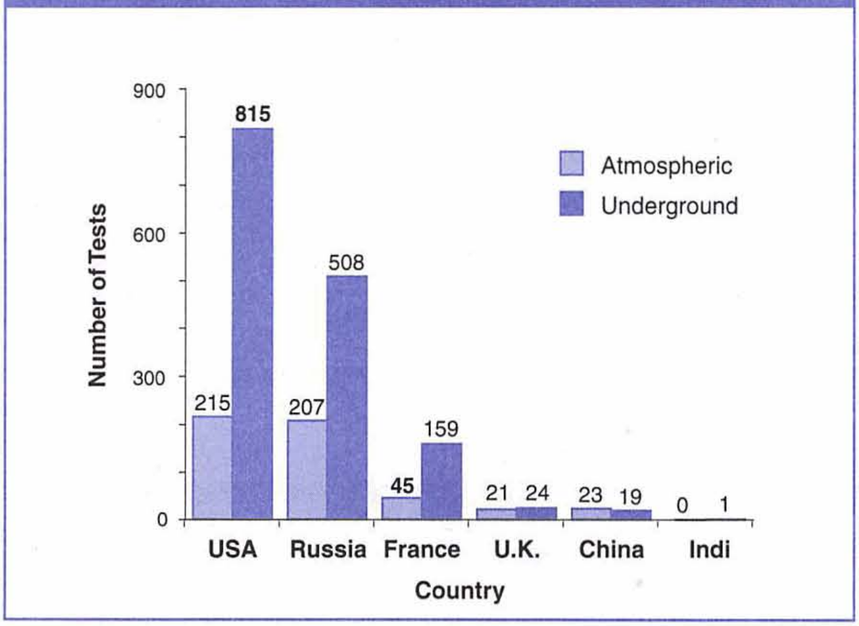
Source: Natural Resources Defense Council

Notes:

1 Totals do not include warheads awaiting disassembly. The U.S. and Russia together have over 20,000 warheads awaiting disassembly.

2 After START II is implemented, the U.S. will retain 3,500 startegic warheads, 950 tactical warheads and a "hedge" of 2,500 warheads. Russia's arsenal after START II will consist of 3,500 strategic warheads and presumably an unknown number of tactical warheads. It is not known if Russia will retain a "hedge."

Known Nuclear Tests Through 1994



Source: Natural Resources Defense Council

Is it possible for a scientific society to continue to exist, or must such a society inevitably bring itself into destruction? It is a simple question but a very vital one. I do not think it is possible to exaggerate the gravity of the possibilities of evil that lie in the utilization of atomic energy.

— Bertrand Russel, English Philosopher, November 1945, reprinted in Jonathan Schell, *The Fate of the Earth*, (New York: Knopf, 1982).

1970 *Non-Proliferation Treaty enters into force*

1972 *Anti-Ballistic Missile Treaty enters into force*

1974 *Threshold Test Ban Treaty signed, bans nuclear tests above 150 kilotons*

1979 *SALT II agreement signed, never entered into force*

1987 *Intermediate-Range Nuclear Forces (INF) Treaty ratified*

1991 *START I treaty signed*

1993 *START II treaty signed; START I Treaty enters into force*

1995 *Non-Proliferation Treaty extended indefinitely, parties pledge to achieve Comprehensive Test Ban no later than 1996*

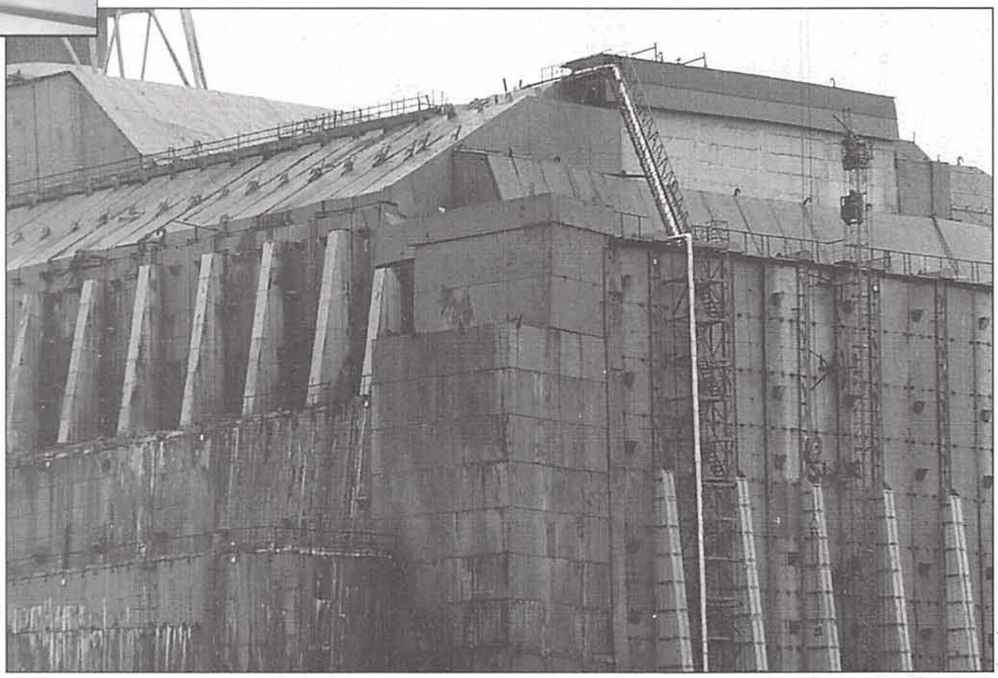
1975 1980 1985 1990 1995

DEPARTMENT OF ENERGY

First light from a nuclear power reactor, 1951.

In some sort of crude sense which no vulgarity, no humor, no overstatement can quite extinguish, the physicists have known sin; and this is a knowledge which they cannot lose.

— J. Robert Oppenheimer, Scientific Director of Los Alamos Laboratory where the first atom bombs were designed and built, "Physics in the Contemporary World," *Bulletin of the Atomic Scientists,* Vol. IV, No. 3, March 1948, p.66.



JAMES LERAGER (1991)

Sarcophagus of the Chernobyl reactor that was destroyed in a catastrophic fire on April 26, 1986. As a result of the Chernobyl accident, thousands of square kilometers of agricultural land were highly contaminated and vast areas beyond the former Soviet Union experienced radioactive fallout.

DEPARTMENT OF ENERGY

View of Oak Ridge National Laboratory low-level solid waste burial ground.

Rough Estimates of Cumulative Global Plutonium Production

in metric tons

Arjun Makhijani, Institute for Energy and Environmental Research

Type	1945	1950	1960	1970	1980	1990	1994 year end
Subtotal Military	0.1	2	45	130	210	265	270
Unseparated Commercial	0	0	0	1	145	530	750
Separated Commercial	0	0	0	5	40	120	180
Subtotal Commercial	0	0	0	6	185	650	930
Total	0.1	2	45	136	395	915	1,200

Conference, *from page 1*

voice in the debate, made up of mostly western nations, and led by the five nuclear weapon states, advocated an indefinite and unconditional extension of the NPT. Russian Foreign Minister Andrey Kozyrev, a strong supporter of indefinite extension, told the conference body that the Treaty was fulfilling its role of preventing the spread of nuclear weapons and has created a "favorable climate for a continuously broadened international cooperation in the use of the atom for peaceful purposes." U.S. Vice President Al Gore, the highest ranking official at the conference, also pushed for unconditional indefinite extension, stating that the nuclear weapon states are on track in fulfilling their NPT obligations. He drew the signatories' attention to such U.S. policy successes as the Intermediate-Range Nuclear Forces (INF) Treaty and the Strategic Arms Reduction Talks (START). Indefinite extension proponents also expressed that a world without the NPT would be extremely unsafe, as it is the cornerstone of the global non-proliferation regime. Gore likened a vote in favor of rolling extension to, "a decision right now to terminate the Treaty," which would cause the NPT regime to fall apart. By the end of the first week of the conference, 92 states were on record as supporting indefinite NPT extension.

"If all countries of the conference had the opportunity to express their views freely, indefinite extension would never have won."
— Adolfo Taylhardat, then Venezuelan Ambassador

Several countries within the Non-Aligned Movement (NAM), a group of over 100 developing nations, presented another side of the debate by speaking out against unconditional indefinite extension. One of the main objections lodged against indefinite extension was that it made permanent the inequality inherent in the Treaty between the nuclear weapon states and the non-nuclear weapon states. Ambassador Izhar Ibrahim of Indonesia advanced this view in stating that "indefinite extension would mean the permanent legitimization of nuclear weapons and the five privileged powers ..." Many non-nuclear weapon states assumed that if the status-quo was maintained indefinitely, they would lose whatever leverage they had to keep the nuclear powers in check.

The many voices against indefinite extension did not translate into a united front for any particular extension option. Within the anti-indefinite camp, there emerged several proposals. For example, Indonesia and Myanmar called for a "rolling extension of successive fixed periods," without a specific period duration. Nigeria proposed a "single fixed period" option, not specifying duration and suggesting the possibility of renewal. There was also the offering by Egypt and Syria for conference suspension, so that the extension decision could be taken after certain conditions had been met. One of the main conditions for Egypt was that Israel, considered a de-facto nuclear weapon state, join the Treaty as a non-nuclear weapon state before it was extended indefinitely.

U.S. Lobbying Effort

There were several factors that contributed to the outcome of the conference. The United States and several other western nations launched an intense lobbying effort in the weeks prior to the NPT Review and Extension Conference, with the goal of convincing as many nations as possible to support unconditional indefinite extension. In meetings with foreign officials, U.S. representatives spread the word that a vote against indefinite extension could mean soured relations with the United States. In some instances, as was the case with Egypt, the vote was linked to more tangible items such as foreign aid. Venezuelan Ambassador Adolfo Taylhardat told the *New York Times* on May 14 that, "Many countries have been submitted to these pressures. If all the countries of the conference had the opportunity to express their views freely, indefinite extension would never have won."

In line with what some NPT delegates have referred to as its' "strong-arm" strategy, the United States showed support for a roll-call vote in regards to the extension decision, arguing that an open ballot was essential for accountability. Many Non-Aligned members wanted the vote to be secret, so that states opposing indefinite extension would not feel pressured into changing their vote in order to avoid a backlash by certain countries, notably the United States.

See **Conference,** *page 14*

The Nuclear Weapon Haves and the Have-Nots

Declared Nuclear Weapon States

(The "Big Five")

United States	France
Russia	Britain
China	

Heirs of the Soviet Breakup

Ukraine	Belarus	Kazakhstan#

De-Facto Nuclear Weapon States

(states that are believed to possess or have tested nuclear weapons)

India*	Israel*	Pakistan*

Suspected Secret Bomb Programs

Iraq	North Korea

Believed to Have Abandoned Bomb Programs

South Africa	Brazil*	Argentina

States Possessing Separated Plutonium

Germany	Italy	Japan
Switzerland	Belgium	Netherlands

All nuclear warheads have been removed from Kazakhstan and transferred to Russia.

* States that are *not* NPT signatories as of August 1994.

Note: Many U.S. analysts believe the list of countries attempting to acquire weapons may be larger. See Gray 1994 as an example.

Sources: "Factfile." *Arms Control Today*, July/August 1994, p. 28; Gray, P. *Briefing Book on the Nonproliferation of Nuclear Weapons*. Council for a Livable World, December 1993 , pp. 7-10; Posey, C. "Nuclear World Order." *Omni*, February 1993, p. 43.

Conference, *from page 13*

Though the final decision was made by consensus, the "open versus closed" vote debate was highly symbolic of the dynamic that had developed between the different factions.

Indefinite Extension Proponents Fail to Reach Agreement

The inability of indefinite extension opponents to speak with a unified voice also influenced the conference results. This lack of consistency was clearly illustrated when Foreign Ministers within the Non-Aligned Movement, meeting in Bandung for the Foreign Ministers' Conference on April 27, 1995 — seen as the last hope for this movement to join forces — failed to unite around one extension plan. Realizing they could not agree and in the hopes of achieving as much commitment for future implementation as possible, the Non-Aligned Movement began to focus their energies on the NPT review process rather than the extension decision. Many non-nuclear weapon states concluded that if debate over one extension option or another continued, insufficient attention would be paid to other important issues, most importantly the Treaty review process and future accountability. As the west had less to gain from a shift in the status-quo, the non-nuclear weapon states knew that if they did not make a case for accountability, it would probably go unaddressed. Specifically, the majority of indefinite extension opponents wanted to ensure that the nuclear weapon states would fulfill their Article VI disarmament obligations, that a Comprehensive Test Ban Treaty (CTBT) would be reached by a specified date, and that a global fissile material cutoff would be achieved. Without the leverage they perceived would be gained from a strengthened review process, several non-nuclear weapon states believed they would eventually lose on these issues, in addition to the extension decision.

South Africa Toes the Line

This shift in priorities found a voice in South Africa's proposal to the conference body. By coming out in support of indefinite extension, while proposing concrete points to strengthen the review process, South Africa acted as the bridge between the two sides of the extension debate. Several factors contributed to South Africa's unique position within the Review and Extension Conference. On the nuclear front, it is one of the few nations to have dismantled its own nuclear weapons program. In regards to its place in the global community, it maintains strong ties with several Non-Aligned countries, but also seeks financial

See **Conference**, *page 15*

Conference, *from page 14*
assistance from the west. Because of its unique status, states on all sides of the debate were carefully watching South Africa's positioning.

South Africa proposed several concrete steps for strengthening the review process that took the form of two documents: "Strengthening the Review Process for the Treaty" and "Principles and Objectives for Nuclear Non-Proliferation and Disarmament." Both were fleshed out by a group of delegates organized by conference President Jayantha Dhanapala of Sri Lanka and agreed upon by the conference body. The "Review" document continues the practice of holding review conferences every five years, with preparatory committees being held every year in the three years leading up to the conference.[1] The purpose of these meetings is to ensure the full implementation of the Treaty, particularly those points laid out in "Principles and Objectives for Nuclear Non-Proliferation and Disarmament." "Principles" commits all parties to a "programme of action" including: the completion of a CTBT by 1996; the "early conclusion" of a cutoff of the production of fissile materials for weapons purposes; and "the determined pursuit by the nuclear weapon states of systemic and progressive efforts to reduce nuclear weapons globally, with the ultimate goal of eliminating those weapons." Though the actions called for in "Principles" are not legally binding, they were viewed as a way for the non-nuclear weapon states to maintain some leverage over the nuclear weapon states. The nuclear weapon states accepted them because they allowed for a compromise to be made, which led to a consensus on indefinite extension. Their success in weakening the language of the original "Principles" also made the nuclear weapon states more willing to accept this document. For example, "clear-cut language to complete CTBT negotiations this year and have the treaty signed in 1996 was modified to read: 'a universal and internationally and effectively verifiable' treaty 'no later than 1996.' This language pushed back the negotiation deadline a year and inserted difficult to achieve modifiers, such as 'universal.'"[2]

Looking Ahead: Promises Unfulfilled?

Will the commitments laid out in "Principles and Objectives for Nuclear Non-Proliferation and Disarmament" be fulfilled by the Treaty signatories, particularly the nuclear weapon states? Was the shift in priorities from extension to review on the part of several Non-Aligned states wise? If nuclear arms related events in the months since the conference are any indication of the nuclear weapon states' true intentions concerning their disarmament commitments, the Non-Aligned Movement may have paid a higher price than they originally suspected.

- Within two days of the extension decision, China conducted a nuclear test;
- within a month of the extension decision, France announced that in September it would resume underground nuclear testing;
- the Department of Energy is seeking to restart tritium production activities.[3]

Steps that allow for weapons design and modification purposes — such as the Chinese test and France's decision to resume testing — are contrary to the spirit of the NPT, as is U.S. construction of its Dual-Axis Radiographic Hydrotest (DARHT) facility, an advanced hydrodynamic testing facility currently under construction at Los Alamos.[4] The capabilities provided by DARHT could possibly provide far more data for warhead design.

Though we cannot discount steps nuclear weapon states have taken to fulfill their Article VI obligations — START I and II, Russia's agreement to shut down its plutonium production reactors by 2000 . . . — a path to global nuclear disarmament has yet to emerge. Actions by the nuclear weapon states, not only over the last few months, but over the last few decades, remind us that it is the determination of the non nuclear weapon states and the NGO community that will create such a path. The five year review meetings called for under the "Strengthening the Review Process for the Treaty," will also be critical to this success.

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1. Jim Wurst, "NPT Extended Indefinitely with Greater Accountability," *Dis-armament Times,* Vol. XVIII, No. 4 - Special Issue 4, New York: NGO Committee on Disarmament, Inc., May 18, 1995.
2. Tom Zamora Collina, "ISIS Trip Report from the NPT Extension Conference: Permanent NPT Wins Widespread Support with a little Help from South Africa," Washington, DC: Institute for Science and International Security, May 30, 1995.
3. Tritium is a gaseous material used to boost the explosive yield of nuclear weapons.
4. See *Science for Democratic Action*, Vol. 4, No. 2 for more information about DARHT and other testing related activities.

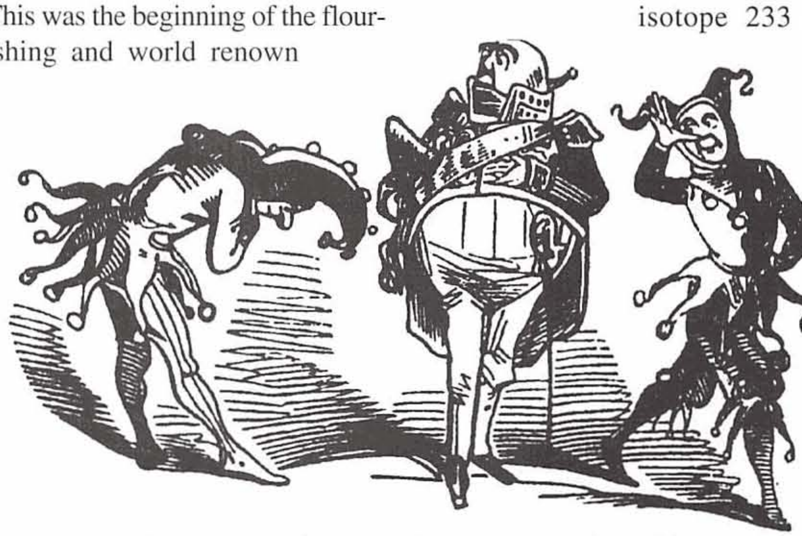
"Dear Arjun"

Dear Arjun:

What are clean-up standards and why don't we have them yet?*

Clean-up standards are very old and diverse, having evolved through the ages. Often progress in technology and increase of resources has resulted in improved standards for cleanliness, but not always. Take for example corporal cleanliness standards at the court of Louis the XIV in France. They were dismal and resulted in rather unpleasant aromas. Rather than being distracted from the pursuit of pleasure by taking a bath, the aristocracy created an agency called the NRC agency, (New Regulatory Cleanliness Agency) and charged it with finding a solution to the persistent foul emanations. This was the beginning of the flourishing and world renown French perfumery industry which took care of the odors but left the dirt behind. After the French Revolution, which really cleaned up the royalty, the NRC moved to the United States where it did not do much for almost 200 years. It was reincarnated in 1974 as the Nuclear Regulatory Commission.

Today the NRC is faced with a clean-up problem far more challenging than royal body odors. It is responsible for overseeing the decommissioning of the facilities of its licensees. This includes clean-up of residual radioactive contamination at sites which have processed source material (such as natural uranium, natural thoriun, depleted uranium), byproduct material (fission products and uranium tailings) and special nuclear material (uranium-233, enriched uranium in the isotope 233 or 235, and plutonium) during their operation. It is required to leave behind the attitude that what does not smell cannot hurt because the mandate of the NRC is to ensure "protection of health and safety and the environment related to the possession and use of source, byproduct, and special nuclear material."



Bathe, sir? Why not just wear perfume??

So far the NRC had regulations only for the cleaning up of uranium mill tailings which are spelled out in Appendix A of 10 CFR part 40 and in 40 CFR part 192 (the EPA — Environmental Protection Agency — standards) and until now decommissioning for other facilities has been governed by a patchwork of guidelines and standards.[1] We don't have clean-up standards yet because they have been a low official priority.

To remedy this problem, the Nuclear Regulatory Commission has come up with a set of proposed generic radiological criteria for decommissioning to which the companies that own the sites will have to comply in order to see their licenses terminated. Since the NRC is working in cooperation with the EPA, it is likely that the

See **Dear Arjun**, *page 17*

* (written by not-so-ghost-writer, Annie Makhijani)

[1] Thorn, Robert N. and Donald R. Westervelt, "Hydronuclear Experiments," LA-10902-MS UC-2, Los Alamos National Laboratory, Los Alamos, February 1987.

Dear Arjun, *from page 16*

rules applying to NRC licensees will also apply to other sites to be covered by the EPA rules to be issued later. These EPA rules will apply to the clean-up of the Department of Energy nuclear weapons complex.

The stated goal of the NRC is to: "reduce the residual radioactivity at the site so that it is indistinguishable from the background." If this goal could be met consistently, by the rules, it would be acceptable. But, in reality such a goal can only be achieved in some cases and the proposed rules allow considerable residual contamination. The rules contain a number of weaknesses, omissions, and loopholes which have the potential to undermine the improvement of these new proposed regulations.

The proposed rules

■ *Exposure limit*

The maximum dose to the average member of the critical group for release of a site to the public for unrestricted use is 15 millirem per year. For comparison the natural background dose at sea level in the United States excluding indoor radon is about 90 millirem per year.[2]

■ *ALARA requirement*

The licensee is expected to clean up the site to a level "As Low As is Reasonably Achievable" (ALARA) below the dose limit of 15 millirem per year. The suggested ALARA dose is 3 millirem per year, but this suggestion is not a part of the proposed rules, and thus not enforceable.

■ *Future remedial actions*

The NRC allows for additional remediation if it is found that the technical basis on which the criteria protecting health, safety and the environment are found to be not adequate anymore and/or additional significant contamination is found which would have the potential to put the public at substantial radiological risks.

■ *Community involvement*

The public affected by the decommissioning of a site will be notified through various channels such as local and state governments, newspapers, and federal register of the status of the decommissioning. For the case of termination of license with restricted land use (see below), the licensee will convene a Site Specific Advisory Board (SSAB) composed of the affected parties which will advise the licensee regarding decommissioning.

Loophole in the proposed rules

■ *Termination of licenses for sites which are released for restricted use*

The NRC will consider termination of a license for a site where residual radioactivity implies doses higher than 15 millirem per year if the licensee will demonstrate that complying with the 15 millirem per year unrestricted use limit is not feasible or "prohibitively expensive" and if site use restrictions and controls will reduce the dose to the average member of the critical group to 15 millirem per year. The NRC would allow residual radioactivity that could result in doses up to 100 millirem per year "even if restrictions applied in the termination were no longer effective in limiting the possible scenarios or pathways of exposure." This exemption would apply for sites where the licensee can show that doing a better job would be too expensive, technologically impossible, or result in net public and environmental harm. The licensee will need to provide "sufficient financial assurance to enable a third party to assume and carry out responsibilities for any necessary control and maintenance of the site". The "third party" would be, for example, the State, the Federal government, the EPA, or the DOE; in other words, the taxpayer. No criteria are set forth in what "sufficient" financial assurance would be.

The omissions and weaknesses in the proposed rules

■ *Risk minimization*

The NRC excludes non-radioactive hazardous materials from its regulations on the basis that these will be regulated by the EPA. However this leaves the possibility for the NRC to allow a company to walk away from a site leaving extensive chemical contamination. This also ignores the fact that often the migration of radionuclides can be enhanced or hindered by chemical contamination which can be both hazardous as well as non-hazardous. For these reasons the clean-up of radioactive as well as non-radioactive hazardous materials should occur at the same time.

■ *Exposure limits*

The exposure limit of 15 millirem per year with a suggested ALARA of 3 millirem per year are still 50% higher than the cor-

See **Dear Arjun**, *page 18*

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[2] SDA, volume 4, Number 1, centerfold table entitled: "Typical Estimated Annual Effective Dose Equivalent from Natural Sources.

Arjun, *from page 17*
responding British limits of 10 millirem and 2 millirem.

■ *SDMP (Site Decommissioning Management Plan) sites*

Those sites whose decommissioning plans have been approved or are pending approval will not be bound by the new rules.

■ *Release of documents*

The proposed rules do not require the owner of a facility to make public all documents which would pertain to contamination, and exposures accidental as well as non-accidental, which occurred during the operation of a plant.

■ *Integration of risks*

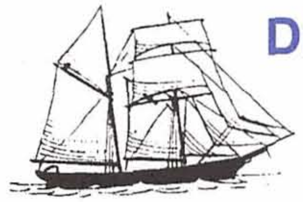
The rules do not integrate risks from past operations or waste disposal with risks from residual contamination.

■ *Community funds*

The proposed rules do not require funds to be made available to communities to monitor residual radioactivity make the findings known to the public.

■ *Compliance with drinking water standards*

The proposed rules do not require strict compliance with the EPA's "National Primary Drinking Water Standards" (40 CFR part 141). Compliance with these standards would require the maximum levels of contamination for radionuclides in ground and surface water to be the same as those for drinking water.



Dr. Polly C. Wonk still travelling in France

Dr. Wonk is having such a grand old time in 18th century France interviewing philosopher J.J. that she has decided to stay for *another* issue. Her report will appear in your next *SDA*.

Dr. Wonk is IEER's esteemed consultant who regularly writes a column of advice to Washington officialdom. She welcomes short letters from those in the government concerned with nuclear-weapons related issues. Letters should discuss good, bad, or ugly aspects of current policy and what ought to be done to improve the latter two. Dr. Wonk may publish some of these letters. She reserves the right to abbreviate them.

Radiation, *from page 8*
evidence of the dangers of radiation, persisted well into the twentieth century. Radio-iodine was also discharged as a result of military plutonium production and of atmospheric nuclear testing, increasing cancer and other risks to exposed people.

Since the 1940s, the history of radiation has been linked to both nuclear power and nuclear weapons. Nuclear power, while generating electricity, also creates radioactive waste. There is also a finite probability of catastrophic accidents, as demonstrated by the Chernobyl accident. Nuclear reactors operate by splitting heavy elements like uranium into lighter elements and releasing energy in the process (fission). Many of the products of fission are highly radioactive. Nuclear weapons testing has released a large amount of radioactive material into the air, water, and land. The nuclear weapons industry has also created radioactive wastes. There is as yet no generally accepted method of disposing of long-lived highly radioactive wastes.

Answers to the Last Atomic Puzzler
(Vol. 4, No. 2)

ACROSS	DOWN
2. hydronuclear	1. supercritical
4. Trinity	3. criticalmass
5. one point safe	6. United States
6. UNSCEAR	7. Yield
8. zeroyield	10. TNT
9. radionuclide	
11. laser fusion	

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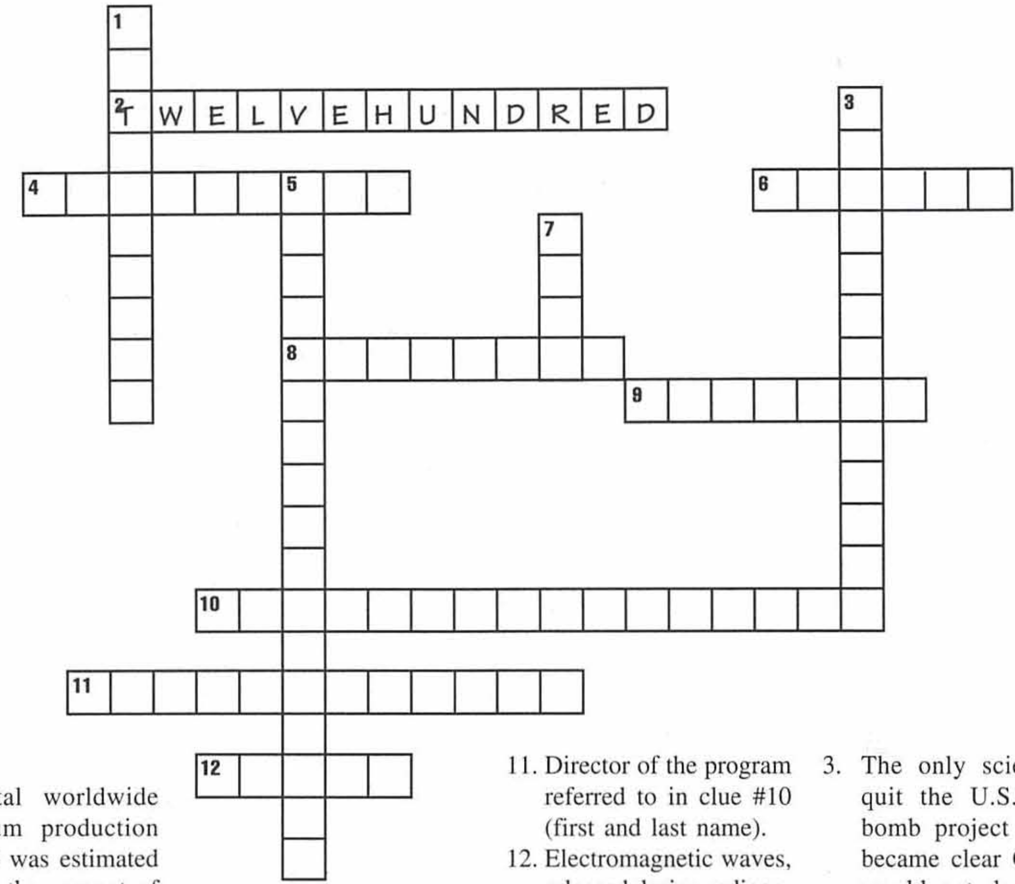
Atomic Puzzler

Once again, it's the Atomic Puzzler—**Crossword Edition.** Yes, that's right! It's time to challenge your word power and give your arithmetic abilities a calculated rest. Look at the clues and fill in the blocks with the appropriate words. *All words are described somewhere in this issue of the newsletter.* The first clue has been filled in for you. And remember, **you could win $25!!**



ACROSS

2. The total worldwide plutonium production by 1994 was estimated to be in the amount of _____ metric tons.
4. His "X-ray" studies were actually of the natural radioactivity of uranium (last name only).
6. The joining together of two or more nuclei resulting in the release of energy.
8. He discovered X-rays in 1895 while studying electrons (last name only).
9. The splitting of a nucleus, which results in a release of energy.
10. The top secret program to develop the first atomic weapon.
11. Director of the program referred to in clue #10 (first and last name).
12. Electromagnetic waves, released during radioactive decay, that can ionize atoms and split chemical bonds.

DOWN

1. The section of the Non-Proliferation Treaty that requires progress towards disarmament.
3. The only scientist to quit the U.S. atomic bomb project when it became clear Germany would not develop an atomic weapon (first and last name).
5. The scientific director of Los Alamos Laboratory during the first U.S. atomic bomb project (first and last name).
7. The number of declared nuclear weapon states.

The **Atomic Puzzler** is a regular *Science for Democratic Action* feature. We offer 25 prizes of $10 to people who send in solutions to all parts of the puzzle, right or wrong. There is one $25 prize for a correct entry. Fill in the puzzle and submit the answer (either a photocopy of the solved puzzle or the answers written out) to Tessie Topol, IEER, 6935 Laurel Avenue, Takoma Park, MD 20912. If more than 25 people enter and there is more than one correct entry, the winners will be chosen at random. The deadline for submission of entries is **September 20, 1995**.

The Institute for Energy and Environmental Research (IEER) provides the public and policy-makers with thoughtful, clear, and sound scientific and technical studies on a wide range of issues. IEER's aim is to bring scientific excellence to public policy issues to promote the democratization of science and a healthier environment.

We gratefully acknowledge the generous support of the W. Alton Jones Foundation, Ploughshares Fund, the Unitarian Universalist Veatch Program at Shelter Rock, the John D. and Catherine T. MacArthur Foundation, Public Welfare Foundation, the Rockefeller Financial Services, the John Merck Fund and the C.S. Fund, whose funding has made possible our project to provide technical support to grassroots groups working on Department of Energy issues and our plutonium outreach project.

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