SCIENCE FOR DEMOCRATIC ACTION

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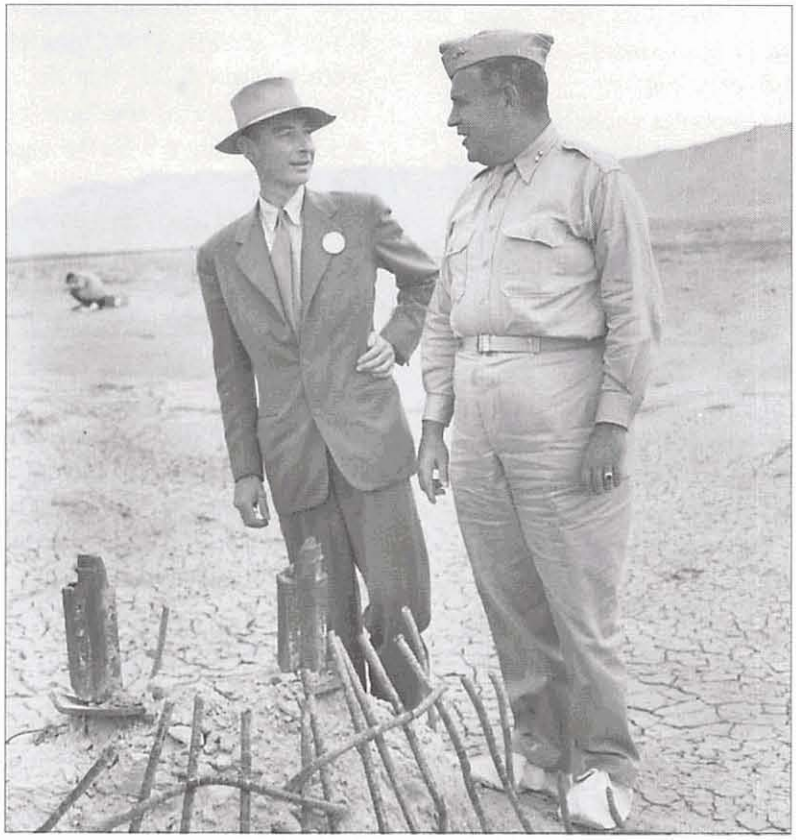
Nuclear Testing and Weapons Design[1]

by Arjun Makhijani

Over the decades the information provided by nuclear tests has enabled the development of an enormous battery of techniques for the design of nuclear weapons, including theoretical methods and calculations, computer codes, and diverse kinds and sizes of laboratory experiments. While full-scale testing of nuclear weapons is the one way in which all the relevant characteristics of a new warhead design can be definitively determined, new weapons can be designed without full-scale tests. The degree of confidence in the functioning of a new warhead that has been designed without full-scale tests depends on (i) the range and sophistication of the techniques that are used in the design process, (ii) the complexity of the design, and (iii) the relation of the new design to the designs of warheads that have already been tested.



Military director Leslie Groves and scientific operator J. Robert Oppenheimer revisit the site of the first nuclear test. This test, which took place in July 1945, is referred to as the "Trinity" test.

Techniques for Warhead Design

There are seven broad categories of techniques that can assist in the design of new warheads without full-scale testing:

1. Nuclear explosions ranging from a few tens of pounds to a few hundred tons of TNT equivalent or less that are not quite full-scale explosions, but which yield most of the crucial information about the functioning of the weapon, other than its exact explosive yield.
2. Small-scale nuclear explosions with a nuclear yield of a few tens of pounds or less (hydronuclear testing).
3. Tests of many of the properties of nuclear charges using materials that cannot sustain chain reactions (hydrodynamic testing).

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INSIDE

[1] I would like to thank Jacqueline Cabasso of the Western States Legal Foundation and John Stroud of the Los Alamos Study Group for the materials they sent me. John Stroud also provided a review of this article.

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4. Experiments in nuclear fusion to develop understanding of the thermonuclear component of weapons as well of the deuterium-tritium boosters that make the fission components of warheads more efficient.
5. Computer modeling.
6. Theoretical models and calculations (other than computer models).
7. Other related experiments, field tests, theoretical work, and modeling exercises, for instance using nuclear reactors, conventional explosives, etc. to determine the properties of various components and subassemblies of warheads. This includes work on basic science in various disciplines such as nuclear physics and radiochemistry.

Nuclear weapons have been successfully designed without full-scale tests. In fact, the design of the bomb dropped over Hiroshima was not tested prior to its wartime use. That is because Manhattan Project scientists and engineers were very confident that the relative simplicity of the "gun-type" design combined with the various theoretical, laboratory, and non-nuclear field tests they conducted were sufficient to guarantee success. In contrast, they were far less sure of the implosion design that was needed for the plutonium weapon. One reason was that the timing of the firing of the conventional explosives was so critical that they could not predict the performance of the weapon based on theoretical considerations and laboratory experiments and non-nuclear field tests alone.

Hydronuclear and Hydrodynamic Testing

Nuclear weapons designers have been using hydrodynamic testing as well as full-scale testing for designing new weapons, which includes ensuring their safety. Since full-scale testing would be ended by a comprehensive test ban, some scientists claim that testing at some level, such as hydronuclear testing, is essential for determining the safety of nuclear weapons. In particular, such testing can be important for helping to determine what is called "one-point safety" or "single-point safety" of warheads in the absence of full-scale testing. One point safety means ensuring a nuclear explosion will not result if any point on the conventional explosive that surrounds the fissile material were accidentally detonated. The purpose of determining one-point safety is to help prevent accidental detonations of nuclear weapons. The United States has used nuclear tests extensively to determine one-point safety since 1955. During the 1958-1961 moratorium, Los Alamos put together a program for hydronuclear testing for studying one-point safety. The risks of a failure to determine one-point safety prior to putting a warhead into production have been recognized for well over three decades.

A recent report of the Natural Resources Defense Council set forth what can be learned about nuclear weapons design at various levels of nuclear explosive yield (expressed as equivalent weights

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Science for Democratic Action Acting Managing Editor: Tessie Topol

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of the conventional explosive TNT).[2]

- a yield of less than about one-tenth of a pound: information about one-point safety;
- a yield of less than about half-a-pound: information about the achievement of criticality (needed to initiate the nuclear explosion);
- a yield of under four pounds: criticality tests, measurements of temperature and pressure conditions as criticality is achieved, and other essential design information on the characteristics of the weapon at the very start of the nuclear explosion;
- a yield of a few pounds to several hundred pounds: data enabling estimation of the yield of the weapon, and all the other data from lower yield tests;
- a yield of a few tens of tons: development of advanced weapons consisting of fissile materials only (that is no thermonuclear component);
- a yield of a few hundred tons: most of the essential data about boosted fission as well as thermonuclear weapons.

The United States seeks a "comprehensive" test ban that would permit hydronuclear tests of up to four pounds; Russia would like to do tests of a few tens of tons; France would like several hundred tons. China would like to have a several-hundred-ton limit if any exceptions are allowed because it feels that lower limits would enable the superpowers to design new weapons more easily than states with less technologically sophisticated equipment.

The United States would carry out its hydronuclear testing program at the Nevada Test Site. This would be in addition to its extensive hydrodynamic testing program at Los Alamos and Lawrence Livermore National Laboratories. The main stated public official purpose of these facilities is to ensure "safety" and reliability" of the U.S. nuclear arsenal. The devices could also aid in designing new weapons. The U.S. is also building an advanced hydrodynamic testing facility called Dual-Axis Radiographic Hydrotest (DARHT) facility at Los Alamos. The term "dual axis" refers to two X-ray machines that would be built to photograph the interior of materials being compressed to represent a nuclear warhead pit. The materials tested in DARHT could be a dense non-radioactive element used to simulate the pit, depleted uranium, or perhaps even plutonium-242. (Photographs with X-rays are called radiographs.) The X-rays are generated by creating powerful electron beams in an accelerator and stopping the beam in a tungsten target.

The proposed hydronuclear testing and laser fusion facilities will enable the United States to go on designing nuclear weapons.

DARHT is to be built in two stages, with one-X-ray machine being built by 1997 and a second to be added (if the first works well) by the year 2000. The two independent axes of observation will enable three-dimensional observation of the compression of materials simulating the pit of a warhead. This could possibly provide far more data for warhead design. Construction of DARHT began in 1994 without a full environmental impact statement. It was stopped in January 1995 by a court order pending completion of an environmental impact statement.

The utility of DARHT for its stated safety and reliability purposes is a matter of some dispute within the nuclear establishment. Los Alamos is, of course, convinced of the need for it. But a 1992 Sandia National Laboratory report stated that the aims of the first part of DARHT could be accomplished by an $8 million upgrade to the FXR machine at Lawrence Livermore National Laboratory (compared to the $85.6 million cost of the first part of DARHT) and that for reasons dealing with uncertainty of performance and other factors, the second arm of DARHT should be postponed.[3] The total estimated cost of DARHT is $123.8 million. The labs also want an even more advanced hydrotest facility (AHF), with four to six X-ray beams, currently estimated to cost $422 million.

See **Nuclear Testing**, *page 4*

[2] Cochran, Thomas B., and Christopher E. Paine, *The Role of Hydronuclear Tests and Other Low-Yield Nuclear Explosions and Their Status Under a Comprehensive Test Ban.* Washington, D.C.: Natural Resources Defense Council, March 1995, pp. iv-v.

[3] Ramirez, Juan J., T.F. Godlove, W. B. Herrmannsfeldt, D.J. Nagel, and P. Sprangle, "DARHT Feasibility Assessment Independent Consultants DFAIC Panel," Sandia Report SAN92-2060. UC-700. Albuquerque, New Mexico: Sandia National Laboratories, September 1992, p. 14 and DARHT project October 1994 fact sheet from Los Alamos.

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Laser Fusion

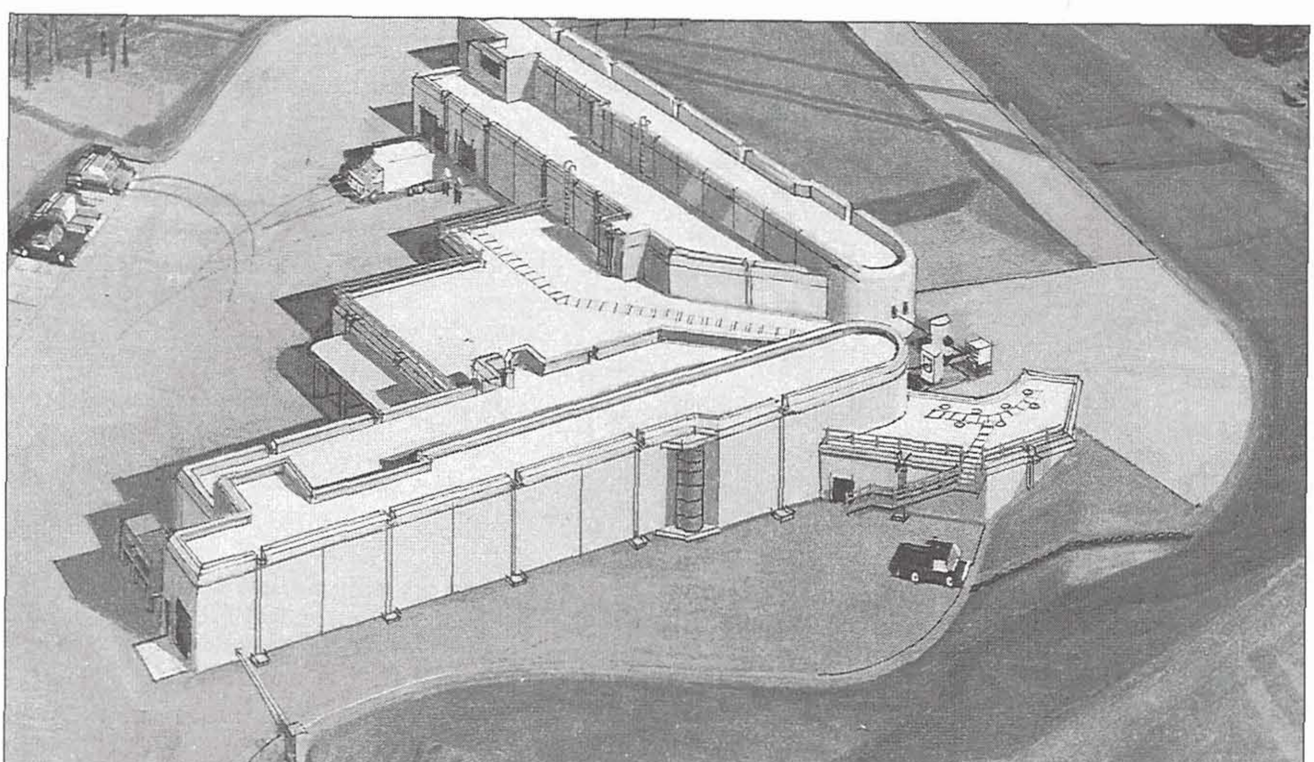
Another new facility, called the National Ignition Facility (NIF) is proposed to be built at Lawrence Livermore National Laboratory. This has not yet obtained final approval, pending the outcome of a technical study. NIF is a larger version of a laser fusion machine that already exists at Livermore.

Laser fusion is a process in which powerful lasers are simultaneously focused on a minute pellet of tritium and deuterium, raising temperatures to levels comparable to those in the interior of the sun. This initiates a tiny thermonuclear reaction, which is essentially a very small scale version of a thermonuclear bomb. The process is also called inertial confinement fusion (ICF). The often-stated purpose of such experiments for over two decades has been to develop a device for generating electricity from fusion. But, while the scientific and commercial feasibility of this or any other method of generating electricity from fusion is decades away at best, the more immediate weapons applications of inertial confinement fusion have been officially acknowledged.

According to a Livermore document about NIF, the inertial confinement fusion program has, besides its potential application to laser fusion power generation, "an essential role in accessing physics regimes of interest to nuclear weapons design and to provide nuclear weapon related physics data, particularly in the area of secondary design." It would also "provide an aboveground simulation capacity for nuclear weapons effects on strategic, tactical, and space assets (including sensors and command and control)...."[4]

In sum, the new hydrotest facility, DARHT, and the new laser fusion machine, NIF, as well as various other preparations and existing facilities, will enable the United States to design new nuclear weapons and to maintain the capacity to do so for the long term, despite its Non-Proliferation Treaty obligations to pursue nuclear disarmament in good faith and despite the end of the Cold War.

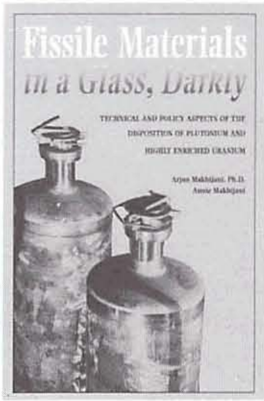
[4] Lawrence Livermore National Laboratory 1994 document (UCRL-AR-110100-94) as quoted in Andrew Lichterman, Jacqueline Cabasso, and John Burroughs, "Comment of the Western States Legal Foundation on the Scope of the Proposed Proliferation Impact Review for the National Ignition Facility." Oakland California: Western States Legal Foundation, March 9, 1995. p. 7.



LOS ALAMOS NATIONAL LABORATORY

Artist rendition of the completed DARHT Hydrotest Firing Site.

SELECTED PUBLICATIONS



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.

Nuclear Wastelands

COMING JULY 1995

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.

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

Mending the Ozone Hole

COMING SEPT. 1995

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.

NEW FACT SHEETS AVAILABLE FREE

IEER and Physicians for Social Responsibility (PSR) have joined together to produce a series of fact sheets dealing with fissile materials. Each fact sheet is approximately 2 pages long and written in clear, understandable language. The first two fact sheets in the series are:

Fissile Material Basics

This fact sheet describes what fissile materials are, how they are made, and what they are used for.

Fissile Material Health and Environmental Dangers

This fact sheet outlines the health and environmental dangers of plutonium and uranium and their production processes.

Other free fact sheets still available from IEER:

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"Dear Arjun"

Dear Arjun,

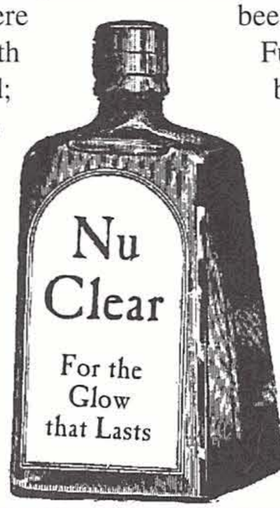
What is a nuclear test and why?

—At-a-loss in Los Alamos

Dear At-a-loss,

In the nineteenth century a new company, called the Wax'N John Company, had invented a new coating that would make all furniture and toilets gleam forever. It was called Nu Clear. (It was the forerunner of Lemon Pledge, without the lemon.) During the testing program of Nu Clear, it was plain that this product was so good that it would drive the company out of business, since no one would ever need cleaning products anymore. So the company stopped Nu Clear testing. But the Nu Clear scientists were very unhappy and wanted to resume it.

They got their chance generations later when new glowing and gleaming substances were discovered in the twentieth century. Cobalt-60 glowed; cesium-137 glowed. These substances gave rise to hopes of eternal cleanup jobs. So the nuclear establishment decided to make these products and to make a mess by testing them. Nuclear testing began in this new form in 1945. Du Pont and Union Carbide and General Electric and Westinghouse took over the nuclear business from the long-since defunct Wax'N John Company.



Seriously though, a nuclear weapons test has never been officially defined. While the nuclear disarmament movement has sought a complete and total halt to all nuclear weapons testing, the nuclear weapons establishment has sought to create as many loopholes, exceptions, and escape clauses to any treaty that might stop nuclear testing. For many years, the argument was that tests of nuclear explosives of up to one kiloton (one thousand tons of TNT equivalent) should be allowed, since they could not be detected remotely, making verification of a test ban difficult. As comprehensive test ban negotiations made progress, new arguments against a CTB have been brought to the fore. Further, ever since the test ban movement of the 1950s, nuclear weapons scientists have been trying to perfect ways to design new weapons without full-scale testing of the actual warhead. (Remember that the very first nuclear weapon used in war, the Hiroshima bomb, was of a gun-type design that had not been tested prior to its wartime use.)

Several methods have been developed to obviate the requirement to test an actual warhead. The initiation of fission reactions in such a way that the reaction stops shortly before or shortly after achieving criticality can be used to mimic the start of a full scale nuclear explosion. Such tests can also be used to produce a slightly supercritical mass — a growing chain reaction — for a very short time. This produces small explosive yields (a few pounds of TNT equivalent) that can be contained within an engineered structure (unlike a full-scale explosion of a nuclear warhead). These laboratory events (shall we say) are called hydronuclear tests. They were first developed and used at Los Alamos during the 1958 to 1961 moratorium on nuclear weapons tests that was being observed by both the US and the Soviet Union. Los Alamos conducted the first laboratory hydronuclear test on January 12, 1960.[1]

Hydronuclear tests are tests of nuclear weapons in that they allow

See **Dear Arjun**, *page 14*

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

A CENTERFOLD FOR TECHNO-WEENIES

Estimated Doses and Fatal Cancers from Nuclear Testing

The accompanying tables show fallout data and estimated doses from the testing of nuclear weapons in the atmosphere. The fallout data for various radionuclides and resulting doses estimates were published by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). IEER calculated the fatal cancers that would result from these doses to the global population based on fatal cancer risk estimates published by the fifth report of the committee on the Biological Effects of Ionizing Radiation (BEIR V) of the U.S. National Academy of Sciences.

The centerfold table shows fatal cancers as they would be calculated directly from the risk estimates as published in BEIR V, without any adjustments. It is common regulatory practice to adjust the fatal cancer risk estimates downward by about a factor of two for doses that are delivered slowly over long periods of time (as is the case with global population doses from fallout). The reduction is based on the hypothesis that low doses and low dose rates are less effective in producing cancer *per unit of dose* than high dose rates. Except for leukemia, this assumption is based mainly on animal data. These data could justify the use of various dose rate effectiveness factors (DREF) and BEIR V does not explicitly recommend a specific one to use. The U.S. Environmental Protection Agency had the Nuclear Regulatory Commission use a factor of 2, noted above. This hypothesis is not universally accepted, however. Many believe that doses delivered at low dose rates are at least as effective if not far more effective in producing cancer as higher dose rates (per unit of dose). Fatal cancers estimated using such methods would be far higher than those presented in the centerfold.

Since there are considerable uncertainties in the area of low dose estimation, it is IEER practice to use unadjusted BEIR V risk coefficients for fatal cancers, which are the most authoritative published ones (though how they will compare to the ones that will eventually be considered precise is unknown at this time). We also normally describe the effect of using a DREF of 2. Note that the official estimates of the cancer risk of low-dose radiation have generally tended to increase over time.

The use of a DREF of 2 would reduce all cancer estimates in the centerfold by a factor of 2. The total estimate for all fatal cancers through the next century from doses committed through the year 2000 would be about 215,000 (compared to 430,000 in the Table). There are considerable uncertainties in both of these figures (several-fold on either side).

The centerfold also shows fatal cancer estimates extending out to all time — that is it includes all doses for all radionuclides until they are completely decayed away. These long-term doses come mainly from carbon-14, which was created in the atmosphere from neutron bombardment of nitrogen during atmospheric nuclear explosions. This carbon-14 exists as radioactive carbon dioxide gas in the atmosphere; it is mixed with naturally occurring carbon-14. It enters our food chain through the photosynthesis process and due to its long half-life (5,730 years) dominates the dose over the long term. The total, rounded to one significant figure, using unadjusted BEIR V risk coefficients is about 2.4 million fatal cancers. With a DREF of 2, the total would be about 1.2 million fatal cancers.

Note that even with such very large numbers of cancers, it is essentially impossible to attribute any specific person's cancer to testing because there are so many more cancers from other causes, and because the increased risk to any one individual from fallout is comparatively low. (This does not apply to certain groups that were more highly exposed, such as many workers in nuclear weapons plants

See **Techno-Weenie**, *page 10*

Estimated Global Collective Dose Equivalent Commitment and Associated Cancer Deaths Due to Fallout from Atmospheric Nuclear Tests, by Radionuclide

Dose integration time until the year 2000

(All doses in million person-rems = 10^4 person-seiverts)

Radionuclide	External Dose	Inhalation Dose	Ingestion Dose	Total Dose	Dose in %	Number of fatal cancers Unadjusted Estimate*
Carbon-14	-	0.3	100	100	18.45%	7.9x10^4
Cesium-137	150	0.1	69	219	40.30%	1.7x10^5
Zirconium-95	64	-	-	64	11.77%	5.1x10^4
Strontium-90	-	3	44	47	8.64%	3.7x10^4
Ruthenium-106	17	10	-	27	4.97%	2.1x10^4
Hydrogen-3	-	1	18	19	3.49%	1.5x10^4
Cerium-144	5	12	-	17	3.13%	1.3x10^4
Iodine-131	-	-	11	11	2.02%	8.7x10^3
Plutonium-239	-	8	2	10	1.84%	7.9x10^3
Barium-140	8	0.07	0.05	8	1.49%	6.4x10^3
Other				22	3.90%	1.7x10^4
Total				544		4.3x10^5

* Based on BEIR V coefficients unadjusted for dose rate effectiveness factor (DREF). Fatal cancer estimates would be reduced by a factor of 2, if a DREF of 2 is used, as is common regulatory practice.

U.S. DEPT. OF ENERGY PHOTO BY JOHNSON CONTROLS WORLD SERVICES

Shot "Mike" was fired on Enewetak on October 31, 1952, as part of Operation Ivy. It was an experimental thermonuclear device.

Estimated Global Collective Dose Equivalent Commitment and Associated Cancer Deaths Due to Fallout from Atmospheric Nuclear Tests, by Radionuclide

Dose integration time until infinity

(All doses in million person-rems = 10^4 person-seiverts)

Radionuclide	External Dose	Inhalation Dose	Ingestion Dose	Total Dose	Dose in %	Number of fatal cancers Unadjusted Estimate*
Carbon-14	-	0.3	2600	2600	85.43%	$2.1x10^6$
Cesium-137	150	0.1	69	219	7.20%	$1.7x10^5$
Zirconium-95	64	-	-	64	2.10%	$5.1x10^4$
Strontium-90	-	3	44	47	1.54%	$3.7x10^4$
Ruthenium-106	17	10	-	27	0.89%	$2.1x10^4$
Hydrogen-3	-	1	18	19	0.62%	$1.5x10^4$
Cerium-144	5	12	-	17	0.56%	$1.3x10^4$
Iodine-131	-	-	11	11	0.36%	$8.7x10^3$
Plutonium-239	-	8	2	10	0.33%	$7.9x10^3$
Barium-140	8	0.07	0.05	8	0.27%	$6.4x10^3$
Other				22	0.69%	$1.7x10^4$
Total				3044		$2.4x10^6$

Underground Radioactivity Due to the Testing Activity of Each Nuclear Weapons State, in Curies

Decay-corrected and Rounded to Two Significant Figures

Country	Strontium-90	Cesium-137	Plutonium-239	Principal Locations
U.S.A.	3,200,000	5,000,000	140,000	Nevada Test Site
U.S.S.R.	2,100,000	3,300,000	75,000	Kazakh Test Site Novaya Zemlya
Britain				Nevada, see U.S. total
France	170,000	270,000	18,000	Moruroa, Fangataufa
China	?	?	1,800	Lop Nor
Total	5,500,000	8,600,000	230,000	Totals are Rounded, cesium and strontium totals exclude China.

Notes:

1. The decay-uncorrected figures assume 0.1 megacuries per megaton for strontium-90, 0.16 megacuries per megaton for cesium-137, and 150 curies of unfissioned plutonium per nuclear explosion.
2. We assume that one-third of the strontium-90 and cesium-137 have decayed away since the tests. No decay correction has been made for plutonium due to the very long half-life of the principal isotopes plutonium-239 and plutonium-240.

Techno-Weenie, *from page 7*

or downwinders).

The centerfold also shows IEER's estimates of radioactivity left underground due to underground nuclear weapons testing. These figures are for decay-corrected radioactivity. This means that we have adjusted for the decay of radionuclides. While plutonium-239 (half-life over 24,000 years) and carbon-14 have not yet decayed significantly, cesium-137 and strontium-90, both with half-lives of about 30 years have decayed substantially.

It was claimed by the nuclear establishment that the contamination from underground testing would be neatly contained in glassy material created out of the molten rock resulting from the intense heat of the underground nuclear explosion. There is, however, no basis in measurements to claim that essentially all the radioactivity has been contained in this way; in fact there is some clear evidence to the contrary. In any case, it is noteworthy that the DOE does not believe it can even begin to address the clean-up of the severely contaminated underground environment of the Nevada Test Site. In its recent report on "baseline" costs of clean-up of the weapons complex, the DOE did not even attempt to put a figure to what it might cost to clean-up after the underground testing program. Thus, in practice it is clear that the DOE is admitting that the contamination is not sitting there in a neat glassy blob for someone to retrieve at low or even moderate cost. It does not even know how to begin to address the problem of this contamination, so far as one can tell from its cost assessment.

In sum, the shift of testing underground in 1963 after the U.S.-Soviet-British treaty banning atmospheric tests, drove the problem out of sight (for the most part) but did not eliminate it.

The centerfold is derived from the book on nuclear weapons testing prepared by the International Physicians for Prevention of Nuclear War and IEER, entitled *Radioactive Heaven and Earth*, published by Apex Press, New York, 1991. Copies are available from IEER for $17, inclusive of postage.

CYBER-FLASH

As a service to NGOs and other interested parties during the 1995 NPT Review and Extension Conference, the ACRONYM Consortium and Disarmament Times put out a series of updates on the NPT conference proceedings. These updates, which are clear and concise, track key events over the course of the conference. They are an invaluable information source for those who are interested in what ***really*** took place at the UN from April 17-May 12, 1995.

To obtain these updates, just use the following Internet address: http:/www.igc.apc.org/basic/ or try: gopher://gopher.igc.apc.org:70/11/orgs/basic/ If you do not have access to Internet, please call Roger Smith at the NGO Committee on Disarmament at 212-687-5340 for further information on how to obtain the NPT updates.

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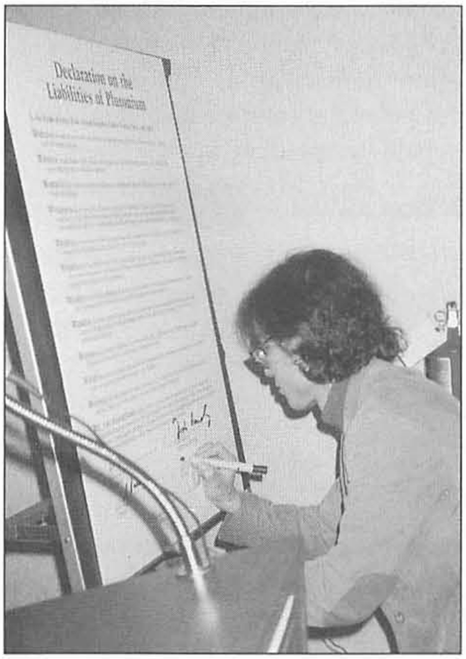
Report on IEER's International Symposium on Weapons-Usable Fissile Materials

By Noah Sachs

On January 20th and 21st, 1995, over seventy participants from fourteen countries assembled in New York to discuss plutonium and highly enriched uranium (HEU) at a symposium hosted by the Institute for Energy and Environmental Research. The participants represented citizens' groups, research centers, universities, foundations, and the media. Three main topics were discussed:

Fissile Materials and the Non-Proliferation Treaty

There was agreement among participants that Article IV of the NPT, which encourages the sharing of nuclear technology, including the technology to separate plutonium, is incompatible with the goal of preventing nuclear proliferation. Participants also criticized the failure of nuclear weapon states to meet their obligations under Article VI of the Treaty, and especially their failure to achieve a cut-off of fissile material production. There was disagreement among participants about whether the fissile material cut-off negotiations in Geneva should include stockpile declarations and whether a cut-off of only military production would be a useful measure. It was pointed out that the NPT review and extension conference in New York could provide an opportunity to raise awareness of fissile materials issues.



Masa Takubo of the Japan Congress Against the A- and H-bombs (Gensuikin) signs the *Declaration on the Liabilities of Plutonium,* a call to the five remaining reprocessing countries to declare plutonium a liability and to halt all plutonium separation activities.

Fissile Materials in Russia

Four Russian citizens spoke about the health and environmental costs of reprocessing in Russia and about the security of fissile materials in Russia. They said that information on Russia's nuclear past, such as underground injections of radioactive waste, is beginning to come to light, but they also pointed out that citizens still have a very difficult time obtaining basic information about nuclear facilities. Several of the Russian speakers were concerned about the incomplete RT-2 reprocessing plant in Krasnoyarsk. Construction of the plant was recently suspended due to a lack of funds, but a Presidential decree would allow resumption if Russia can find the funds. Russian citizens were concerned that RT-2 would cause environmental damage and could increase proliferation threats from plutonium. The Russian presentations were followed by a general discussion about what activists and governments around the world can do to improve the security of fissile materials in Russia.

The Civilian Plutonium Programs of Japan, Britain, France, and India

Speakers from each of the four countries outlined their country's current plutonium policies and plans for future plutonium utilization. All of the speakers cited the wasteful economics of plutonium use, and speakers from Japan, Britain, and India discussed the weapons-potential of their country's civilian plutonium programs. There was strong agreement that international cooperation among NGOs is necessary to counter the powerful political and financial interests backing the plutonium programs. Many participants also felt that if NGOs are to oppose plutonium use they should propose viable energy alternatives. This would involve researching

See **Symposium**, *page 14*

IEER Meets with NPT Delegates about Plutonium

By Noah Sachs

At the Review and Extension conference for the Non-Proliferation Treaty, which was held between April 17th and May 12 at the United Nations, many non-nuclear weapon states urged the nuclear weapon states to quickly conclude an agreement to halt the production of fissile material for military purposes. This fissile material "cut-off" would be one signal that the nuclear weapon states are committed to disarmament. The issue of halting the *civilian* use of plutonium, however, was largely ignored by the NPT delegates, even though civilian plutonium can be used to make nuclear weapons. Indeed, many states continue to view plutonium as the key to their energy futures.

Civilian plutonium can be used to make nuclear weapons.

On April 25, IEER hosted a breakfast meeting in New York for delegates to the NPT conference in order to discuss the dangers from the world's growing stockpiles of plutonium. The goal of the meeting was to educate the delegates, who were influential officials in their governments, about the consequences of both military and civilian plutonium programs. Over thirty delegates, including ambassadors, experts, and counselors, attended from countries such as Russia, Japan, the Netherlands, Hungary, China, Italy, and Australia.

Arjun Makhijani spoke to the delegates for about fifteen minutes, outlining the security, economic, and environmental liabilities of plutonium, and then opened the floor to discussion. One delegate disputed that commercial plutonium could be used in nuclear weapons. After some debate about this issue, Paul Leventhal of the Nuclear Control Institute, a DC-based NGO, quoted Robert Selden of Lawrence Livermore National Laboratory: "All plutonium can be used directly in nuclear explosives. The concept of....plutonium which is not suitable for explosives...is fallacious." This quote seemed to end the debate at the breakfast, but denying the weapons-usability of civilian plutonium will undoubtedly remain a key tactic of those who support civilian plutonium programs.

Another delegate admitted that his countries' plutonium program was not economical at present, but he argued that it needed the technology for the future, when uranium, which is the main alternative to plutonium, might become scarce. Makhijani responded that this reasoning is like building un-needed apartment buildings now because they might be needed in fifty years. He added that an international reserve of uranium reactor fuel should be created by "blending-down" highly-enriched uranium from dismantled warheads so that countries would not be so concerned about uranium scarcity.

One diplomat approached Dr. Makhijani after the meeting and asked if he really thought that morality had a role to play in policy-making about plutonium and in international relations in general. Makhijani responded that he realizes that morality does not play much of a role now but he hopes that by raising moral questions, morality may come to play a role in the future.

All of the delegates were provided a copy of IEER's recent book, *Fissile Materials in a Glass, Darkly*, and many delegates took notes during the meeting. The meeting was useful in providing a note of realism about the dangers posed by plutonium, since the governments and nuclear establishments in many of the countries represented at the breakfast remain very wedded to plutonium use.

It Pays to Increase Your Jargon Power

by Dr. Egghead

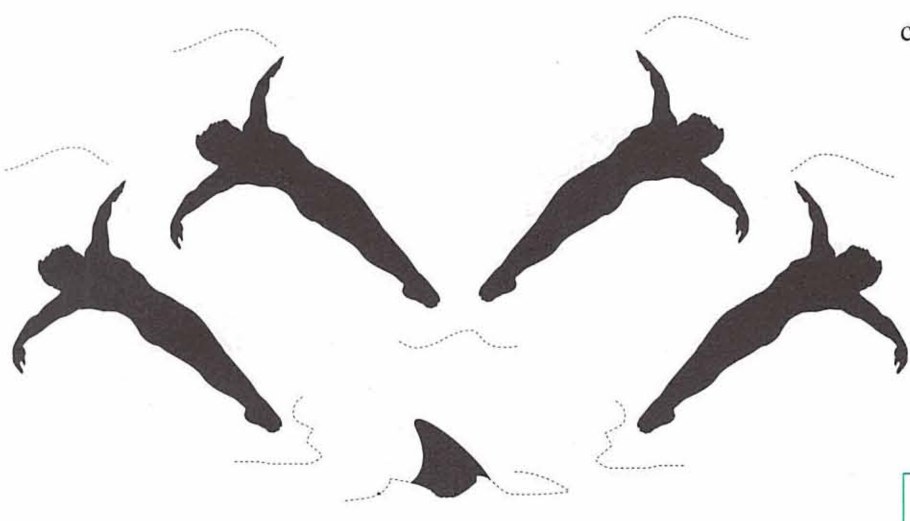
1. **hydrodynamics**
a. water ballet gone awry
b. the legendary 1950s rock-n-roll group submerged under water
c. the study of the flow of fluids under various physical conditions.

2. **one point safety**
a. the "just say no" approach to birth control
b. a little known, but highly effective, point rule used in high school football
c. determining whether a nuclear explosion would result if any point on the conventional explosive that surrounds the fissile material were accidentally detonated.

3. **supercritical mass**
a. what your relatives become upon meeting your future spouse
b. (CENSORED)
c. a mass of fissile material which can sustain a growing chain reaction. If the chain reaction grows fast enough, an explosion results. Fissile materials are compressed to form supercritical masses in all nuclear weapons. Conventional explosives are used to initiate this process.

4. **"zero yield" test**
a. a weapons designer's worst nightmare
b. what your final exam looks like after an all night party
c. a nuclear test in which there is no nuclear yield. Some zero yield tests have explosion yields greater than zero but small enough to be contained in a fabricated container. Such zero yield tests can be carried out in a laboratory or building without destroying it, in contrast to the full-scale test of a nuclear weapon which cannot. Note: there is no official definition of a nuclear explosion.

5. **NIF**
a. National Institute of Fungus
b. An expression of excellence (i.e. niftiness) used in the San Fernando Valley (as in, don't you think my new jeans are just like totally **NIF**?!)
c. National Ignition Facility - a billion dollar machine in which lasers are to be used to trigger tiny thermonuclear explosions, proposed to be built at Lawrence Livermore National Laboratory.



Hydrodynamics ...

ANSWER KEY:
1. c., 2. c., 3. c., 4. c., 5. c.

Dr. Polly C. Wonk time travels to France

Dr. Wonk is IEER's esteemed consultant who regularly writes a column of advice to Washington officialdom. She is visiting eighteenth century France to interview philosopher J.J. Her report will appear in the next issue of *SDA*.

Dr. Wonk 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.

Answers to the Last Atomic Puzzler (Vol. 4, No. 1)

ACROSS

1. sourceterm
7. plutonium
8. fallout
9. spentfuel
11. ALARA
12. vitrification

DOWN

2. reprocess
3. MOX
4. HEU
5. background
6. curie
7. pathway
10. Britain

Symposium, *from page 11*

other energy sources and preparing an independent economic analysis of the energy economies in the countries with civilian plutonium programs.

In general, participants concurred that plutonium represents a security, economic, and environmental liability. Many of the participants signed IEER's *Declaration on the Liabilities of Plutonium*, which was delivered to official delegates at the NPT Prepcom.

A summary of the proceedings is available from IEER.

Dear Arjun, *from page 6*

nuclear weapons design to be done and to be verified at least partly in the laboratory through a small-scale nuclear explosion. But they are not full-scale tests of all aspects of a nuclear warhead's functioning since they do not involve a full-scale explosion.

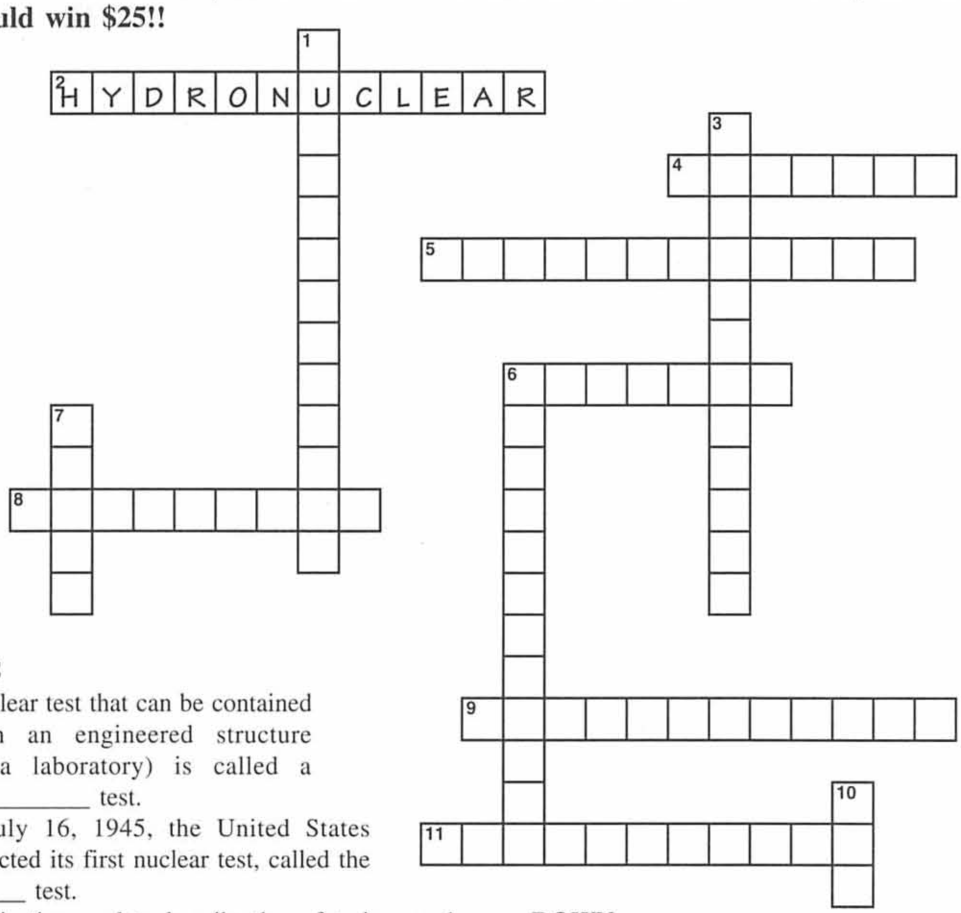
Since hydronuclear tests can be used to assist in the design of new nuclear weapons, the discussions on a comprehensive test ban treaty, the achievement of which was a commitment that the nuclear weapons powers made in the Nuclear Non-Proliferation Treaty, have become complex. The United States weapons laboratories want hydronuclear tests. Other weapons powers believe that this would give an unfair advantage to the U.S., since these are "high-tech" tests and since they would be complemented by sophisticated computer programs and by a laser fusion facility that may be built at Livermore, California. This is called the National Ignition Facility. (Dr. Polly C. Wonk has observed that this facility may be so named because it is going to burn such a big hole in the nation's pocket book.)

The term "hydro" is used in the expression hydronuclear testing because the material being tested behaves like a fluid under the high temperature and pressure conditions of the test.

ATOMIC PUZZLER

Back by popular demand, it's the Atomic Puzzler—**Crossword Edition.** Yes, that's right! It's time once again 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

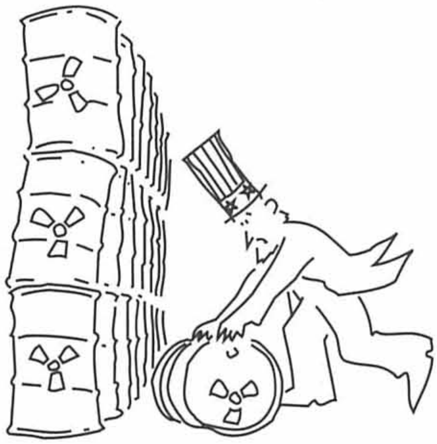
2. A nuclear test that can be contained within an engineered structure (i.e. a laboratory) is called a ___________ test.
4. On July 16, 1945, the United States conducted its first nuclear test, called the _______ test.
5. An adjective used to describe the safety in a nuclear weapon.
6. The acronym for an international committee that studies radiation effects.
8. A nuclear test in which there is no nuclear yield is called a _________ test. (two words)
9. The radioactive isotope of an element.
11. A process that uses intense light to produce tiny thermonuclear explosions.

DOWN

1. A mass of fissile material which can sustain a growing chain reaction is considered a _______ mass.
3. The mass of a fissile material that will sustain a chain reaction.
6. The country that has performed the most nuclear tests.
7. The energy released in a nuclear explosion.
10. The ____ equivalent is the unit most commonly used to measure the energy released in nuclear explosions.

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 **June 26, 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.



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The Institute for Energy and Environmental Research
6935 Laurel Avenue
Takoma Park, MD 20912

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