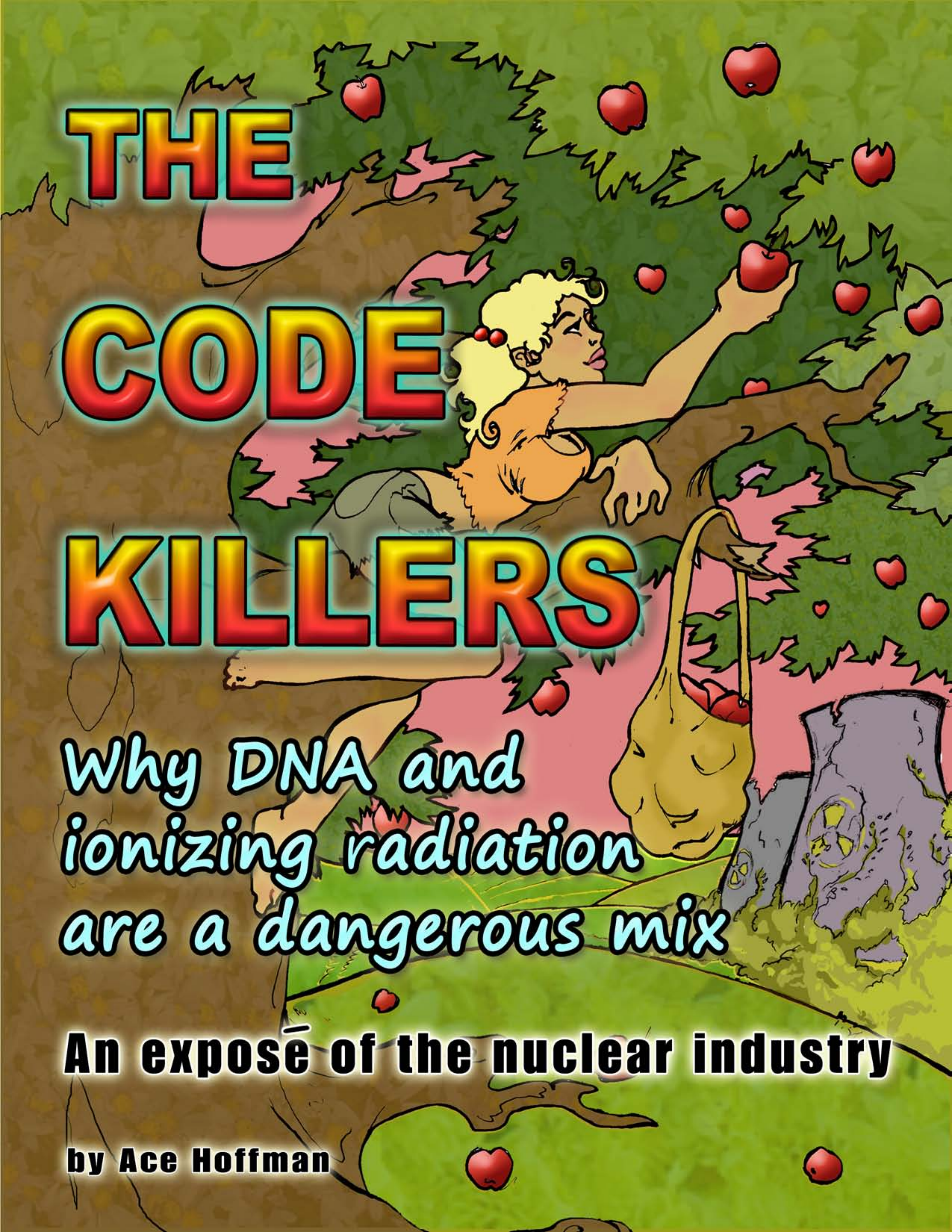
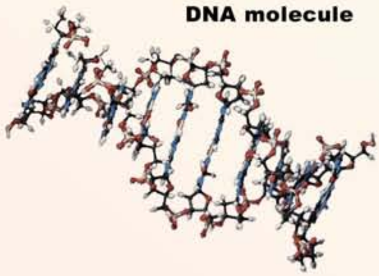

THE
CODE
KILLERS
Why DNA and
ionizing radiation
are a dangerous mix
An exposé of the nuclear industry
by Ace Hoffman

THE CODE KILLERS

Why DNA and ionizing radiation are a dangerous mix

An exposé of the nuclear industry

DNA molecule



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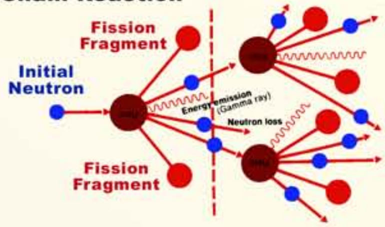
Chain Reaction



The Code Killers

First published (by the author): October 2008

Current version: August, 2010

(please see web site for errata and upgrade info)

Dedicated to:

The millions of victims of radiation poisoning, and the scientists, whistleblowers and citizens who, through books, videos, reports, emails, telephone calls and conversations, taught the author everything he is now trying to pass on to you.

The Code Killers

"A monumental work" . . . "a wonderful compendium" . . . "superb!" . . . "a million thanks" . . . "a stunning effort and a wonderful resource." . . . "like a graphic novel, but true!"

This book may be downloaded at no charge from the author's web site: www.acehoffman.org

Cover art by Zoe Friend

For those who want to find the edges of a nuclear advocate's knowledge: *Use this guide to discuss each of the issues. The author has never met any pro-nuker who will claim to understand all these issues. Yet we all MUST be able to interlock ALL the pieces of a puzzle to solve it properly!*

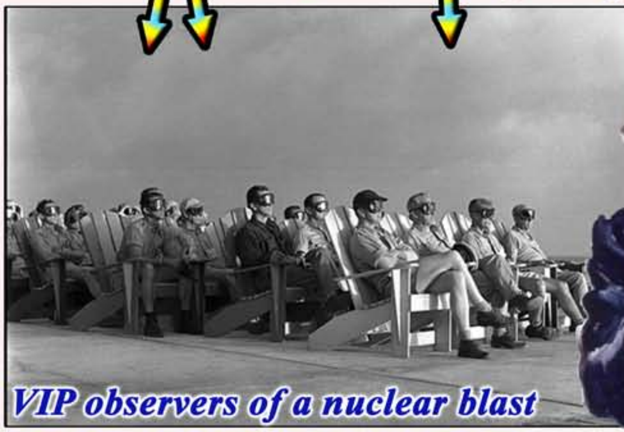
This document was created by someone who wishes to be called a writer, or an educator, or a humanist, or a futurist, or a technologist, or a gadfly . . . but NOT an "activist!" Not that there's anything really wrong with activism, except that so-called "activism" is a last resort. Attending public hearings makes you a CITIZEN, NOT an activist. I've done a lot of that. Writing makes you a writer. I've done a lot of that, too. Programming makes you a programmer -- I do that, too. I am an artist. This is my painting. This is a "legal" document -- a testimony. It is the truth, the whole truth, and nothing but the truth, as plain as I can say it.

Contrast that claim with the following, from a letter to this author from the NRC: ***"Statements made by the public affairs officer of a NRC licensee are not regulated activities. Therefore, the veracity of such statements will not be investigated by the NRC."***

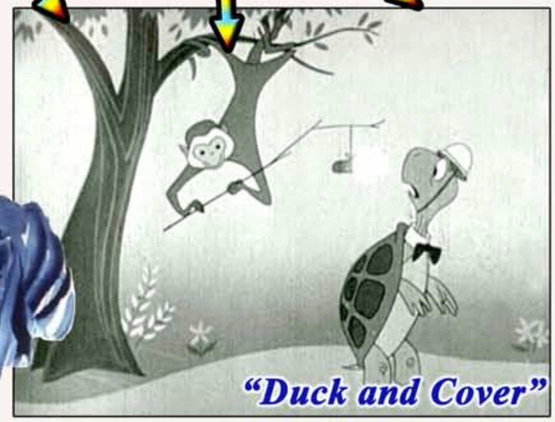
Table of Contents

Table of Contents (cont.)

WHO THIS BOOK IS FOR



VIP observers of a nuclear blast



"Duck and Cover"

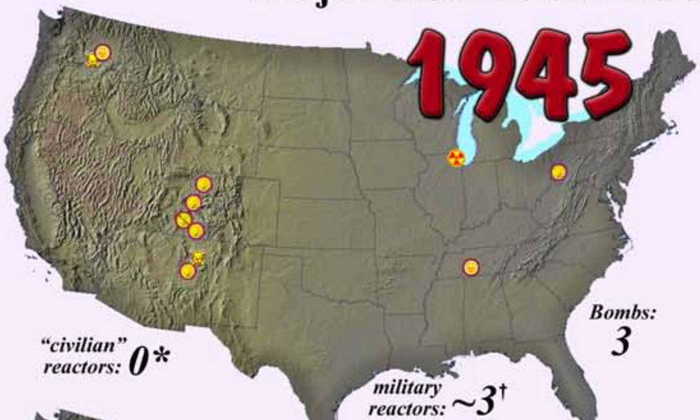
I had every resource imaginable available to help create this book (except infinite time). Whoever, pro- or con-, had the best descriptions, I based my own artwork on. This is what YOU most need to know about nuclear issues. It will be a refresher course for some, an introduction for others. Hopefully you'll want to know more -- but everyone should know *this*.

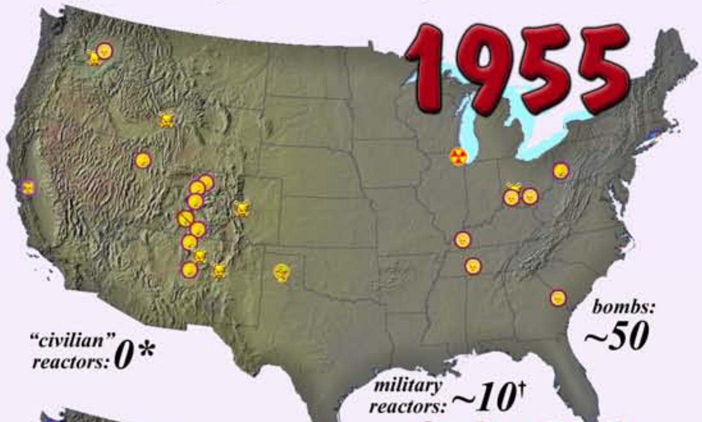
This book is especially for:

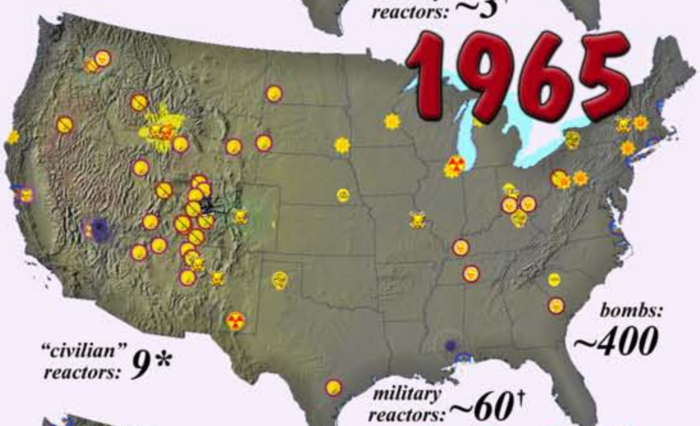
- **STUDENTS and YOUNG PEOPLE**
  exploring nuclear issues for the first time. You'll sound like a "pro" in no time!
- **NEW ACTIVISTS and NEW ENVIRONMENTALISTS**
  who, while all for reducing fossil fuel use, etc., wish to solve even bigger problems.
- **THE CURIOUS**
  who want the facts, fast, and don't want to wade through minutia, or waste time.
- **SEASONED ACTIVISTS**
  who want a handy reference and memory jogger. What's a rem, rad, α, β, γ, etc.?
- **PEOPLE WHO SUSPECT THEY ARE RADIATION VICTIMS**
  who want to begin to grasp how radiation can cause so many different illnesses.
- **VICTIMS' LAWYERS, STATE ATTORNEYS GENERAL, JUDGES**
  who want to understand the "big picture" so they can enter court prepared.
- **MOTHERS, FATHERS, and MOTHERS- and FATHERS-TO-BE.**
  who want to protect their children's DNA and their environment.
- **NUCLEAR WORKERS and FIRST RESPONDERS**
  who are concerned about potential accidents, and / or their personal risks.
- **HEALTH CARE PROFESSIONALS**
  who want to protect their patients from an excess of radiation.
- **ELECTED OFFICIALS**
  who want an unvarnished assessment from someone with no "vested" interest.
- **TEACHERS**
  who want a guide to the science and politics of nuclear issues.
- **REPORTERS**
  who don't like being lied to by government and industry toadies.
- **OPTIMISTS, FUTURISTS, HUMANISTS and HUMANITARIANS**
  who want to grasp the full magnitude of the problem, so they can get us out of it.

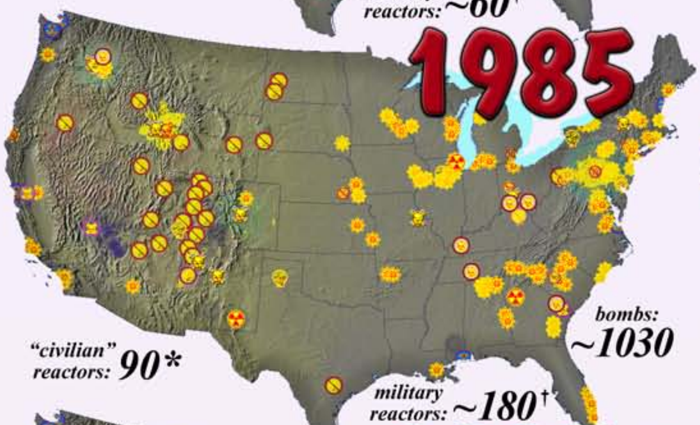
POISON FIRE USA

Major U.S. nuclear incidents, events, structures, etc.

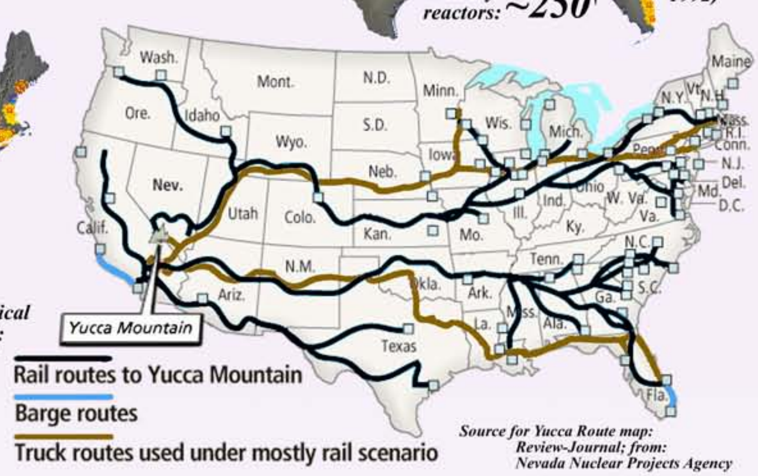








** Actively making waste*
† Cumulative built to that date
• Bomb totals include all U.S. blasts
(This animation is available at the author's web site.)



Source for Yucca Route map: Review-Journal; from: Nevada Nuclear Projects Agency

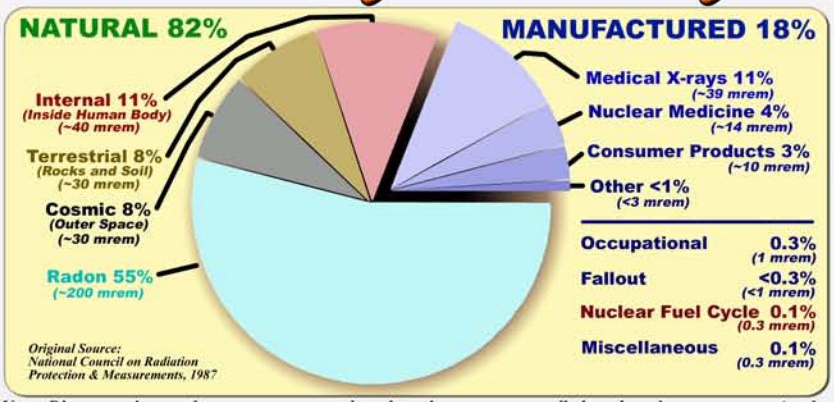
Written, designed, and colorized by Ace Hoffman (2008) ***May be freely copied*** **www.acehoffman.org**

Radiation: What's in you today?

200 **Radon 55%**

Annual Exposure Expressed in "Effective Dose Equivalent"	mrem
Natural:	
Radon	200
Other	100
Occupational	0.90
Nuclear Fuel Cycle	0.05
Consumer Products:	
Tobacco	(?)
whole body dose equivalent	
dose estimate to a portion of lung	16,000
Other	5 - 13
Environmental Sources	0.06
Medical:	
Diagnostic X-rays	39
Nuclear Medicine	14
Approximate Total:	**360**

Source: U.S. NRC; NCRP Report #93, 1987



Note: Discrepancies, math errors, etc., even when the values are supposedly based on the same source (such as with the nuclear fuel cycle values shown above) are not uncommon in science...

55 **External Background Radiation 15%**

53 **Medical 15%**

39 **Internal (in the body) 11%**

10 mrem Consumer Products 3%

3 mrem Other 1%

Source: Yucca Mountain, 2001

It's as if you took a plane from LA to NYC... *You get about 4 mrem (0.04 mSv) round trip. If there is a solar storm and/or the pilot flies at an unusually high altitude, your exposure could be significantly higher.*

Medical Procedure	mSv	chest x-ray equivalent	natural background time equivalent
Chest x-ray (PA film)	0.023	1	2.4 days
Skull x-ray	0.07	4	8.5 "
Lumbar spine	1.3	65	158 "
CT head	2	100	243 "
I.V. urogram	2.5	125	304 "
Upper G.I. exam	3	150	1 year
Barium enema	7	350	2.3 years
CT abdomen	10	500	3.3 "

Source: Radiology Today, 2004, adapted from the European Commission

They used to say (1940s and earlier) that you got about 100 mrem per year. Then 160. Then 240. Then 320. Now 360, and sometimes 380 or more. What changed?

The longer you live, the more radiation your body must endure. Radiation is everywhere. But nevertheless, the less you get, the better. To some extent, and maybe to a large extent, your cumulative dose determines your risk.

Natural radioactive "hits" per second: ~15,000*

∴ *cumulative over 80 years:* ~38,000,000,000,000

"Hits" per second in your body allowed by U.S. EPA from tritium alone: 29,600

∴ *cumulative over 80 years:* ~75,000,000,000,000

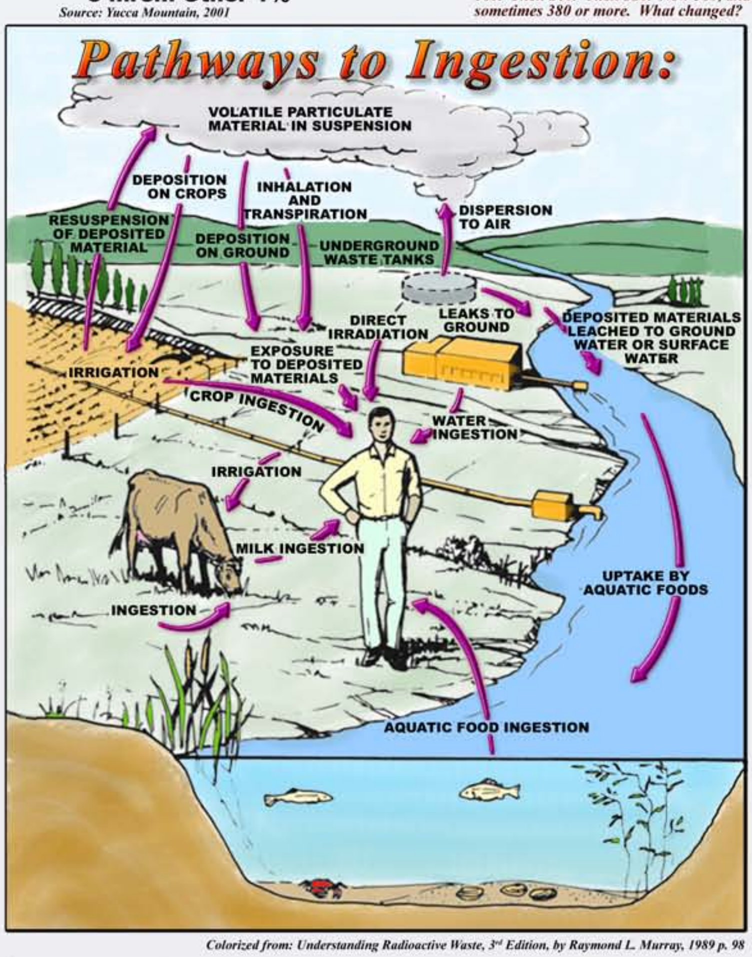
From a "typical" medical x-ray: >1,000,000,000,000*

∴ from one CT-Scan ~500,000,000,000,000

The risk of cancer from one CT Scan is currently estimated at about one in one thousand -- but even after all these years, nobody really knows.

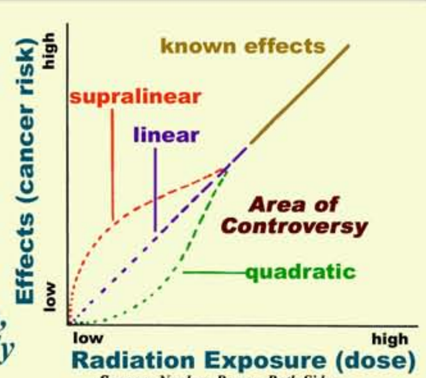
** Source: Cohen: The Nuclear Energy Option, Chapter 5.*

Pathways to Ingestion:



Colorized from: Understanding Radioactive Waste, 3rd Edition, by Raymond L. Murray, 1989 p. 98

The controversy about so-called low-level radiation, (greatly simplified: Cancer, for example, isn't the only "effect").



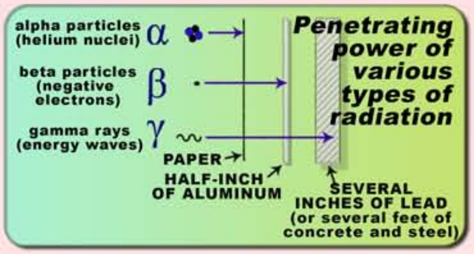
***Source:** Nuclear Power: Both Sides, Edited by Kaku & Trainer, 1982, p.30*

Biological Half-life

The biological half-life of an element (the point in time when half of a foreign substance once in the body is no longer in the body) is NOT the same as the radiological half-life. After 20 radiological half-lives, only 2^{-20} of a substance will remain (about one millionth of the original amount). But when, for example, tritium poisons the body, some of it will bind "permanently," masquerading as a stable, useful hydrogen atom, until the moment of radioactive decay.

IONIZING RADIATION

High-energy, high-speed emissions, such as alpha (α) and beta (β) particles, neutrons, protons, x-rays and gamma (γ) rays, penetrate the human body and other things, causing biological, chemical, and /or physical damage. Energy of emissions is usually measured in megavolts (MeV). The biological half-life will be the same for all isotopes of a substance but will *not* always be the same for all organs. In any case, the biological half-life should be taken with a large "grain of salt" since some portion of *any* biological assault usually remains permanently in your body. Short radiological half-lives have no biological half-life listed: The assumption is that they will probably decay internally before the body might expel them.



Key: Symbol $^{\text{atomic weight}}$ *emission type* [max. MeV] (2nd type), half life / biological half-life (2nd component)

She is smiling because radiation is odorless, tasteless, and colorless. It cannot be detected by any sense organ. She cannot feel herself being irradiated.

BRAIN

- At^{211} α [5.87 MeV], 7 h

SKIN

- S^{35} β [0.16 MeV], 87.4 d / 623 d (90 d)

If you are contaminated with beta emitters on your skin:

"First, decontaminate yourself! ***Flush*** with plain soap and water (***no*** scrub-brush!). Remove any contaminated clothing." *(Source: Duke U.)*

THYROID

- Tc^{99} β [0.29 MeV], 211,000 y / 12 h
- I^{131} β [0.97 MeV] (γ), 8 d / 110 d
- I^{132} β [2.12 MeV] (γ), 2.3 h
- I^{133} β [1.27 MeV] (γ), 20.8 h
- I^{135} β [2.63 MeV] (γ), 6.6 h

LIVER

- Mn^{56} β [3.70 MeV] (γ), 2.6 h / 4 d (40 d)
- Co^{60} β [0.31 MeV] (γ), 5.72 y / 6 d (60 d)
- Ce^{141} β [0.58 MeV] (γ), 32.5 d / 9 y
- Ce^{144} β [0.31 MeV] (γ), 285 d
- Pr^{143} β [0.93 MeV] (γ), 13.5 d
- Pr^{144} β [2.99 MeV] (γ), 0.3 h
- Nd^{147} β [0.90 MeV] (γ), 11 d
- Pu^{242} α [4.98 MeV], 373,300 y / 82 y

PANCREAS

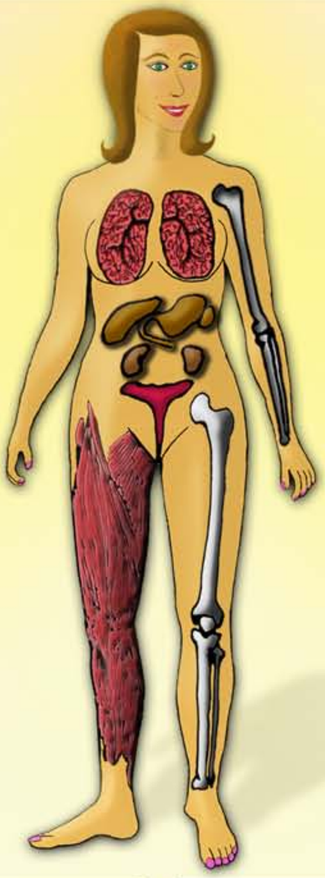
- H^{3} β [0.02 MeV], 12.3 y

OVARIES

- K^{42} β [3.52 MeV] (γ), 12.36 h
- Kr^{85} β [0.67 MeV] (γ), 10.72 y
- Co^{60} β [2.82 MeV] (γ), 5.27 y
- Cs^{134} β [2.06 MeV] (γ), 2.1 y
- I^{131} β [0.97 MeV] (γ), 8 d / 4 d
- Pu^{241} α [4.90 MeV] (β,γ), 14.4 y / 80 y

MUSCLE

- K^{42} β [3.52 MeV] (γ), 12.36 h
- Cs^{135} β [0.21 MeV], 2,300,000 y / 70 d



WHOLE BODY

- H^{3} β [0.02 MeV], 12.3 y / 9.4 d
- C^{14} β [0.16 MeV], 5,715 y / 12 d
- P^{32} β [1.71 MeV], 14.3 d / 257 d
- Cs^{137} β [1.18 MeV] (γ), 30 y / 70 d
- Ce^{144} β [0.31 MeV] (γ), 285 d / 9 y
- Pu^{240} α [5.17 MeV] (γ), 6,563 y / 175 y

LUNGS

- Kr^{85} β [0.67 MeV] (γ), 10.72 y
- Ce^{144} β [0.31 MeV] (γ), 285 d / 180 d
- Rn^{222} α [5.59 MeV] (γ), 3.8 d / 10 y
- U^{238} α [4.2 MeV] (γ), 4,500,000,000 y / 3.8 y
- Pu^{238} α [5.50 MeV] (γ), 87.75 y / 1.5 y

SPLEEN

- Po^{209} α [4.88 MeV] (γ), 103 y / 50 d
- Po^{210} α [5.31 MeV] (γ), 138.4 d

KIDNEYS

- Ru^{106} β [0.04 MeV], 372 d / 7.2 d

....and everything else...

BLADDER

- Po^{210} α [5.31 MeV] (γ), 138.4 d

....and everything else...

BONE

- P^{32} β [1.71 MeV], 14.3 d / 3 y
- Ca^{45} β [0.26 MeV], 163 d
- Mn^{56} β [3.70 MeV] (γ), 2.6 h / 40 d
- Sr^{89} β [1.46 MeV] (γ), 55.6 d / 40 d
- Sr^{90} β [0.55 MeV] (γ), 29 y
- Y^{90} β [2.27 MeV] (γ), 64.1 h
- Y^{91} β [1.55 MeV] (γ), 58.5 d
- Ba^{140} β [1.02 MeV] (γ), 12.7 d
- La^{140} β [3.76 MeV] (γ), 40.3 h
- Ce^{144} β [0.31 MeV] (γ), 285 d / 9 y
- Nd^{147} β [0.90 MeV] (γ), 11 d
- Ra^{226} α [4.78 MeV] (γ), 1,600 y / 10 y
- U^{233} α [4.82 MeV] (γ), 160,000 y / 200 y
- U^{235} α [4.70 MeV] (γ), 710,000,000 y
- Pu^{239} α [5.15 MeV] (γ), 24,131 y / 200 y

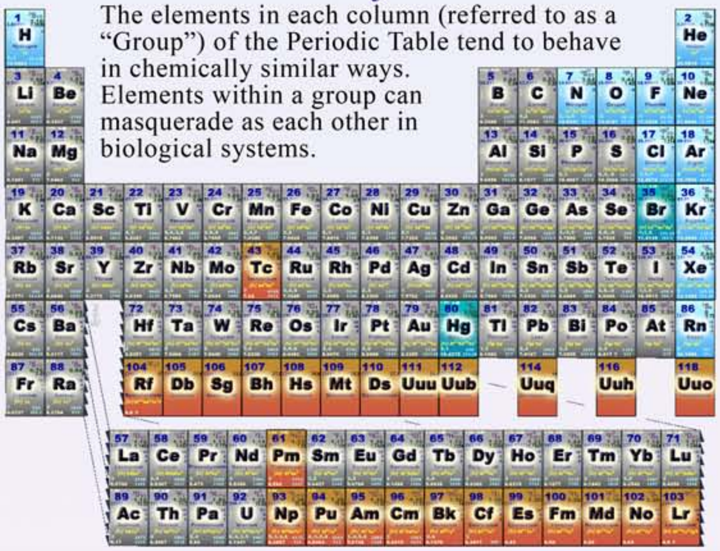
"It is the ability of some radioisotopes to masquerade as their close chemical cousins (e.g., strontium 90 as calcium, radioactive iodine as natural iodine, cesium 137 as potassium), and thus be absorbed into the body, that makes them particularly dangerous. The body has very efficient mechanisms for capturing iodine and concentrating it in the thyroid gland, for directing calcium and other bone-seeking elements to the skeleton and holding them there, and for concentrating other elements at specific points. Consequently the full destructive force of a radioactive material may focus on a single organ."

-- W. O. Caster, From Bomb to Man (Fallout, Basic Books, 1960, p 41)

All reproductive organs are attacked by radiation. Many isotopes cross the placenta. Plutonium also concentrates in the gonads. Radiation causes birth defects, mutations and miscarriages in the first and / or successive generations after exposure. A fetus is much more vulnerable to radiation than an adult. Girls are more vulnerable than boys. Women are more vulnerable than men. Nevertheless, radiation "safety" standards are based mainly on adult male resistance levels. Cancers, leukemia, heart failure, amnesia, neuromuscular diseases, and many other health effects may take years to develop. There is no minimum dose; *any* dose can be fatal and any dose causes some amount of damage.

Elements and Isotopes

The Periodic Table of the Elements



The elements in each column (referred to as a "Group") of the Periodic Table tend to behave in chemically similar ways. Elements within a group can masquerade as each other in biological systems.

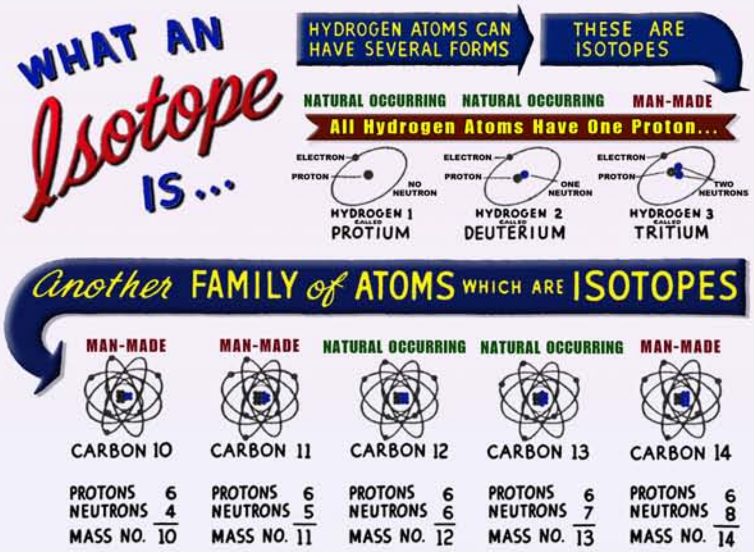
***(Left)* The atom as envisioned by Niels Bohr, utilizing Max Plank's Quantum Theory of discrete energy levels.**
***(Right)* Typical positions for a hydrogen atom's lone electron.**

An atom is about a million times smaller than the width of a human hair. A uranium atom (#92) weighs more than 200 times as much as a hydrogen atom (#1), but the diameter is only about three times greater.

Every solid thing in the universe (including you) is made of atoms. Atoms are made of protons, neutrons, and electrons. The number of protons determines which element an atom is, and the number of electrons orbiting the nucleus is normally (in the "ground state") the same as the number of protons in the nucleus.

Along with protons, neutrons also occupy the nucleus. The number of neutrons, however, can vary for any particular element. Atoms with the same number of protons but different numbers of neutrons are called different isotopes of the same element. Only the first element -- Hydrogen -- exists (most of the time) without any neutrons.

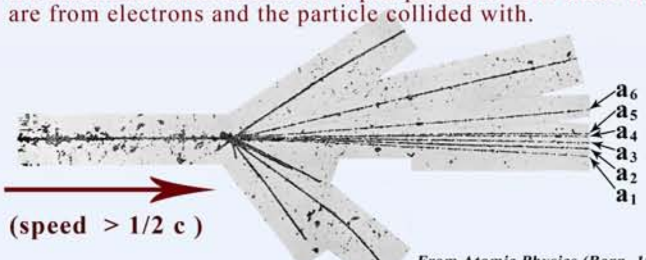
For some elements, there are no stable isotopes. Prior to the atomic age, only a few radioactive isotopes existed in the environment.



From: The Story of Atomic Theory and Atomic Energy (Feinberg, 1960)

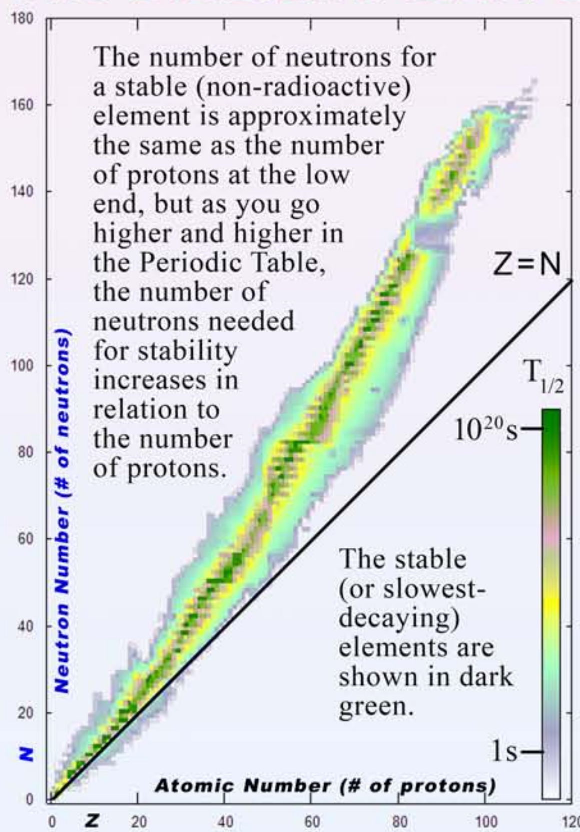
The nucleus forms into alpha particles as much as possible...

An aluminum nucleus traveling at a little over half the speed of light collides with a particle in an emulsion, which decomposes the aluminum nucleus into six alpha particles. The other tracks are from electrons and the particle collided with.



From Atomic Physics (Born, 1935...1962)

THE STABILITY CURVE



Particles, Rays, Mass, & Energy

Powerful Emissions from the Nucleus of the Atom

Ionizing Radiation is usually described as being composed of energy waves (also known as rays) and / or of extremely fast particles.

In any case, ionizing radiation has enough energy to knock other atoms' electrons out of their orbits and to break all types of molecular bonds, including all biological bonds.

*Alpha particles are composed of two protons and two neutrons. They have a charge of +2. Alpha particles have tremendous mass compared to other radiations: They are about **7,345** times more massive than beta particles. When ejected from the nucleus of an atom, alpha particles are traveling at about **98%** of the speed of light. After slowing, they are normal (stable) nuclei of the second-lightest element (helium).*

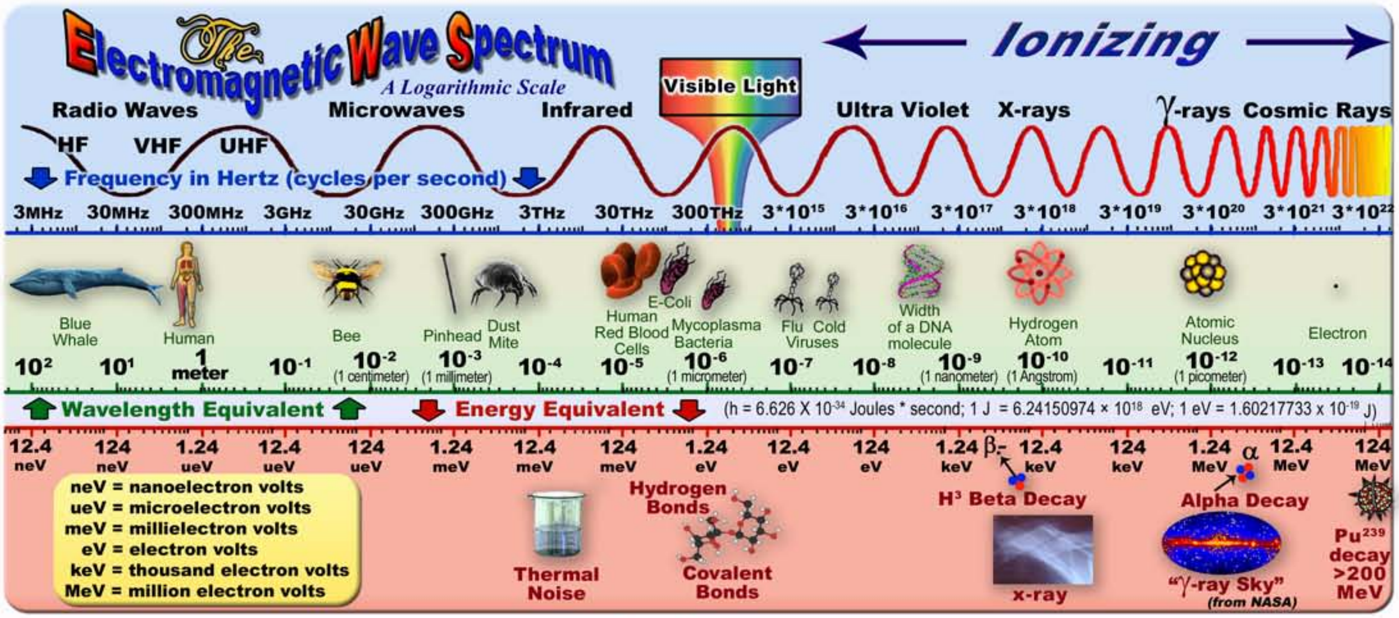
*Beta particles have a charge of **-1**, and shoot out of the nucleus of an atom at **>~99.7%** of the speed of light. After slowing, they are normal electrons.*

Tracks from alpha particles (He^4) emitted from a blend of Pb^{212} and Bi^{212}. One alpha particle has struck an N^{14} nucleus. As a result, a proton (H^1) has gone flying a long way off.

Meanwhile, the N^{14} nucleus has rebounded too, and become O^{17}.

From Atomic Physics (Born, 1935...1962)

Particles slow down as they hit things or, if they are charged particles, if they just simply go near things that are also charged. Gamma rays and x-rays do not slow down; they either hit things which absorb them (usually giving off another ray, or a particle, later), or they ricochet. Most often, of course, they miss things entirely, which is why they can penetrate so deeply.



Radiation Conversion Factors

1 rad = an ***absorbed dose*** of **0.01 joules (J)** of energy per **kilogram (kg)** of tissue, or **100 erg** per **gram**

1 rad = 1,000 millirad

1 gray (Gy) = 100 rad = 1 J / kg

1 roentgen = 0.876 rads (*in air*)

1 rem = 1.07185 roentgen

(**rem** stands for "**r**oentgen **e**quivalent in **m**an")

1 rem = 1,000 millirem

1 sievert = 100 rem

1 becquerel = 1 disintegration per second

1 curie = 37,000,000,000 disintegrations per second

1 curie = 37,000,000,000 becquerel

1 becquerel = 2.7E-11 curies

1 becquerel = 27 picocuries

1 curie = 1,000,000,000,000 picocuries

1 picocurie = 0.037 disintegrations per second

1 microcurie = 37,000 disintegrations per second

1 megacurie = 1,000,000 curies

1 kilocurie = 1,000 curies

Units of Measure for Radioactivity

Becquerels
A count of decays

The ***number*** of apples that fall in a given unit of time can be compared to the **curie** or **Bq** (**decays per second**).

Grays
An energy density

The total ***energy*** of all the apples that hit the sleeper in a given unit of time can be compared to **rads** or **grays** (**absorbed dose**).

Sieverts
A damage assessment

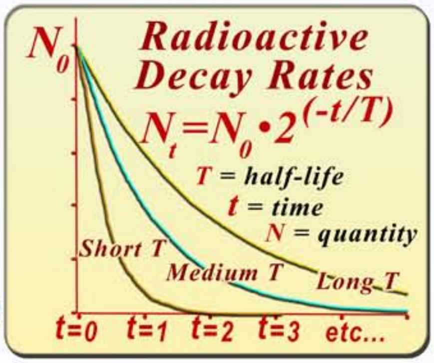
The ***effect*** on the body, depending on the size, weight, and speed of the apples, can be compared to **rems** or **sieverts** (**effective dose**).

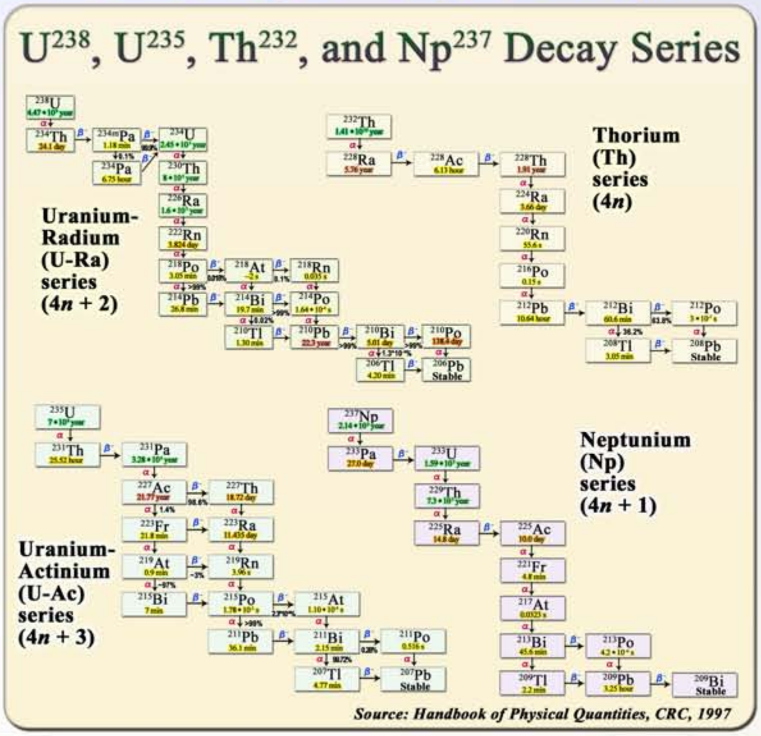
WHAT IS A HALF-LIFE?

A half-life is a statistical value

It is the time it takes for half the atoms in a pure sample of a single isotope of an element to decay into some other element. After one half-life, half the atoms of the original isotope will still be unchanged. After two half-lives, a quarter of them will still be unchanged.

If you start with 1,000,000,000 (one billion) atoms, after 20 half-lives about 1000 atoms of the original isotope will remain -- about one millionth (0.000095%) of the initial amount.



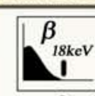


Specific Activity

The specific activity is the rate of decay times the quantity. The specific activity of Radium-226 is one curie per gram.

isotope	primary emission type	half-life	specific activity in curies per gram
Noble Gases:			
Krypton-85	β	**10.72 *y***	**392**
Xenon-133	β	**5.27 *d***	**186,000**
Other Fission Products:			
Strontium-90	β	**28.1 *y***	**141**
Molybdenum-99	β	**66.7 *h***	**474,000**
Iodine-131	β	**8.07 *d***	**123,500**
Cesium-135	β	**2,500,000 *y***	**0.0008**
Cesium-137	β	**30.2 *y***	**86.4**
Cerium-144	β	**285 *d***	**3,182**
Natural Elements:			
Uranium-235	α	**710,000,000 *y***	**0.00000241**
Uranium-238	α	**4,500,000,000 *y***	**0.000000334**
Transuranics:			
Plutonium-238	α	**86 *y***	**17.47**
Plutonium-239	α	**24,400 *y***	**0.0613**
Plutonium-240	α	**6,580 *y***	**0.226**
Plutonium-241	β	**13.2 *y***	**112**
Americium-241	α	**458 *y***	**3.24**
Americium-243	α	**7,370 *y***	**0.200**

β Tritium (H^3): ...nothing "soft" about it!

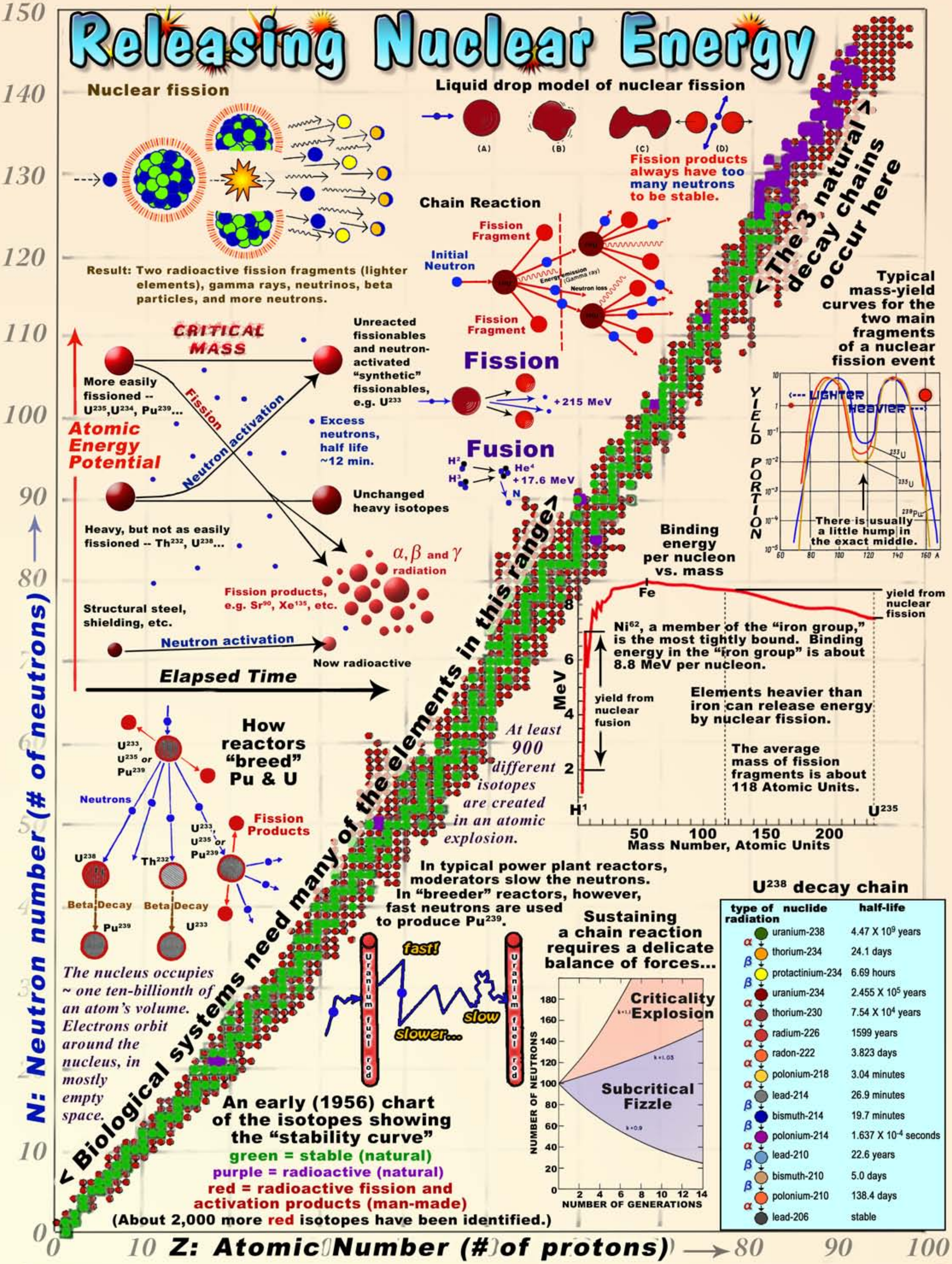


Tritium is a hydrogen isotope with two neutrons. Tritium has a half-life of about 12.3 years. It decays by beta emission: 6 keV avg., 18 keV max..

There are about **10,000** curies in a gram of tritium, or **3.7 * 10^{14}** decays per second per gram. There are about **3.7 * 10^{11}** stars in the Milky Way -- a thousand times LESS than the number of decays per second emanating from a single gram of tritium. U.S. nuclear reactors routinely release about a tenth of a gram of tritium every year, but an entire gram might be released in a bad year -- about once per decade per reactor. CANDU reactors release ~ 20X more tritium than U.S. reactors.

And just how much damage can a single one of those **370 trillion** (**370,000,000,000,000**) decays per second do if it occurs inside our bodies? One decay can break your DNA chain and begin a cancer. One gram of H^3 would kill you instantly. But a millionth of a gram (**370,000,000** decays per second) would kill you pretty quickly, too. The power plants have to dilute it a lot more than that to be allowed to release it.

The United States' EPA standard for tritium in drinking water allows **740** nuclear decays per second per liter. Your body has about 40 liters of water, so the EPA thinks that adding a burden of about **30,000** additional nuclear breakdowns PER SECOND to your body -- just from tritium alone -- is PERFECTLY OKAY (but more is not). This compares with **4,400** nuclear breakdowns per second for all **17** milligrams of natural radioactive potassium (K-40) in your body, which doesn't have nearly as many additional effects. Is K-40 dangerous? Yes, a little -- but it's utterly unavoidable.



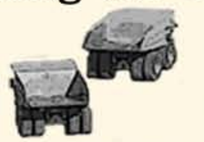
Designed, written, and colorized by Ace Hoffman (2008) *May be freely copied* www.acehoffman.org

Steps in the Nuclear Process

Prospecting for Uranium Ore

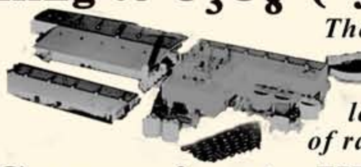
Uranium is a plentiful metal, found in dozens of countries, but high-grade ore is much more rare -- and costly.

Mining the Uranium Ore



Mining uranium ore is dirty and carbon-intensive. It often involves some amount of "environmental racism," too.

Milling to U_3O_8 ("yellowcake")



There are several dozen uranium mills in the U.S.. Each leaves enormous piles of radioactive "tailings."

Conversion to UF_6 ("hex")

A very dirty step in the process. Currently there is only one facility in the U.S., in Metropolis, IL.

U^{235} Enrichment

"K-25"

Another very dirty step in the process. Of three facilities in the US., only Paduca, KY operates. But AREVA wants to build another.

Fuel / Bomb Fabrication

"Fat Man" -- destroyed Nagasaki

Reactors / Bombs

104 U.S. reactors

Naval Propulsion

"Trinity" at 0.034 seconds

Spent Fuel Pools

Most pools are so full they are triple-racked; Total: About 60,000 tons (as of 2008).

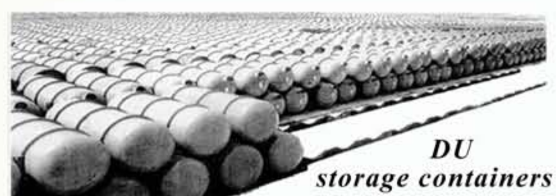
Dry Storage Casks

Natural uranium is ~0.7% U^{235}, ~99.3% U^{238}, and a little U^{234}, too. Most nuclear power reactors and all atomic bombs require U^{235} enrichment. The remaining "depleted" uranium is ~99.5% U^{238}, with from 0.2% to 0.4% U^{235}. DU is used by the U.S. military for shells, missiles, bombs, armor, and counterweights. DU is pyrophoric, so on impact, DU projectiles usually burst into flame, producing radioactive poisonous plumes of extremely fine aerosols, nanoparticles, and dust.

Nuclear reactors and atomic bombs create new radioactive elements, including Pu^{239}. Isotopes such as Ce^{137} and Sr^{90} can bioaccumulate in living organisms, multiplying their dangers tens of thousands of times. Nuclear reactors release radioactive poisons to the environment continuously.

Used nuclear reactor cores are lethal for millions of years. There is no safe, cost-effective storage or transportation solution.

The nuclear industry is very profitable for the corporations. Most costs are paid later, by victims (incl. industry workers) of radioactive pollution. The taxpayer (YOU!) pays many of the "up-front" costs. Government enthusiastically licenses each step AND prevents true public scrutiny by sealing virtually all records of accidents, leaks, etc.. Opportunities to lie, falsify records, cover things up, etc., are taken with frightening regularity.



DU storage containers

DU projectiles

DU armor

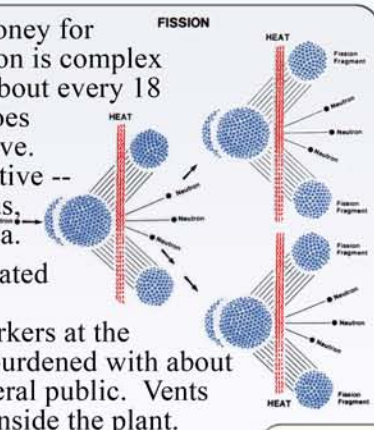
Tomahawk Cruise Missile

Thousands of Dry Storage Casks are being built across the U.S.. A fraction of one can contaminate a large state. Dry Storage Casks are vulnerable to terrorists (including "inside jobs"), tornados, tsunamis, jets, accidents due to poor construction, etc..

How Do Reactors Work?

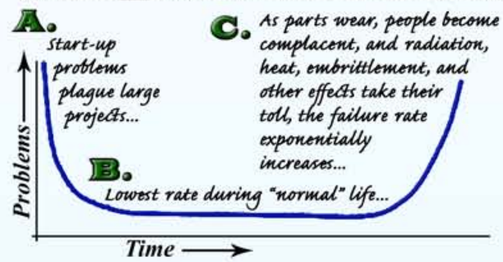
Nuclear reactors boil water to make money for their owners. Turning a reactor off or on is complex and costly. 1/3 of the fuel is replaced about every 18 months to two years. When the fuel goes into the reactor, it is "mildly" radioactive. When it comes out, it is wildly radioactive -- expensive to handle and very dangerous, releasing decay heat for many millennia.

Radioactive activation isotopes are created in the fuel rods, in the coolant water, throughout the building, and in the workers at the plants. Nuclear industry workers are burdened with about five times more radiation than the general public. Vents prevent build-up of radioactive gases inside the plant.



The "Bathtub Curve" of Product Reliability

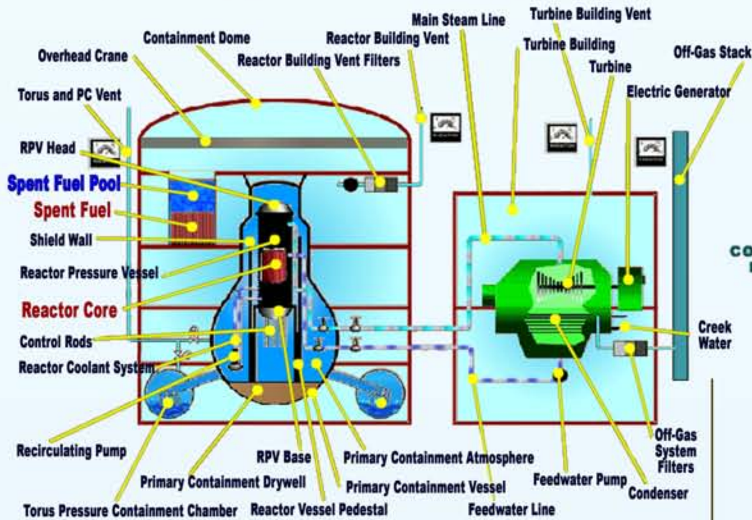
(applies to <u>any</u> large and complex engineering project)



"The most intolerable reactor of all may be one which comes successfully to the end of its planned life having produced mountains of radioactive waste for which there is no disposal safe from earthquake damage or sabotage."

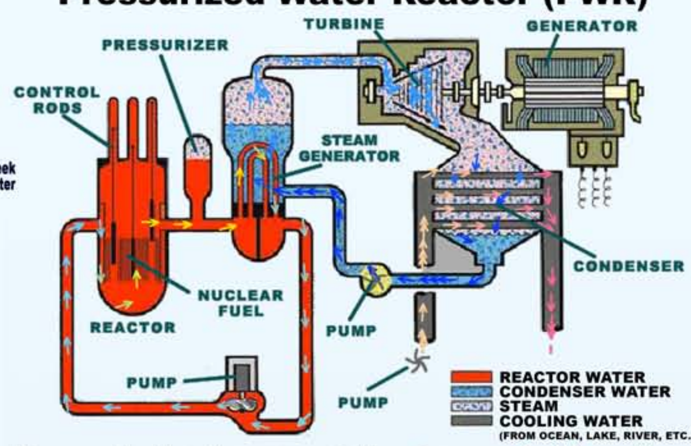
A. Stanley Thompson, early-era nuclear physicist and author of a college textbook on reactor technology, then later, the author of a book explaining the dangers of runaway power fluctuations.

Boiling Water Reactor (BWR)



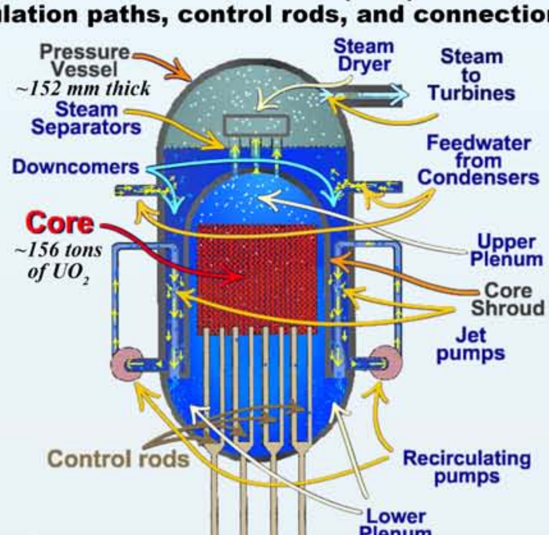
Note the location of the BWR's **spent fuel pool** -- above the reactor! BWRs are generally older, less reliable, and less efficient than PWRs. About one third of U.S. reactors are BWRs. The rest are PWRs.

Pressurized Water Reactor (PWR)



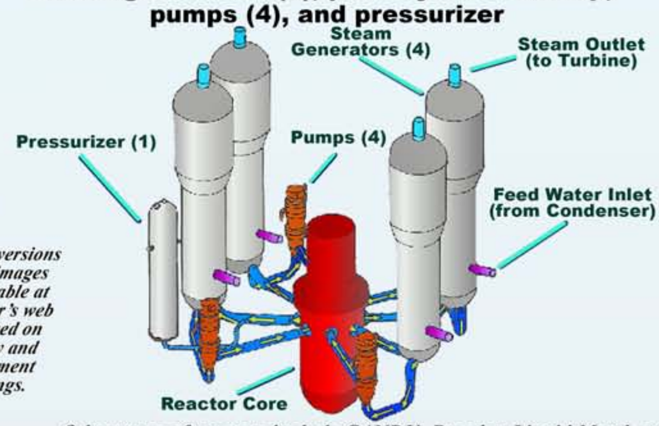
To prevent boiling, the pressure in the **primary coolant loop** of a PWR is ~2200 to ~2300 P.S.I.. Steam generators contain thousands of individual tubes for heat exchange. About 1,000,000 gallons per minute is drawn from the local water source, heated, and irradiated.

BWR Reactor Pressure Vessel (RPV) with main circulation paths, control rods, and connections



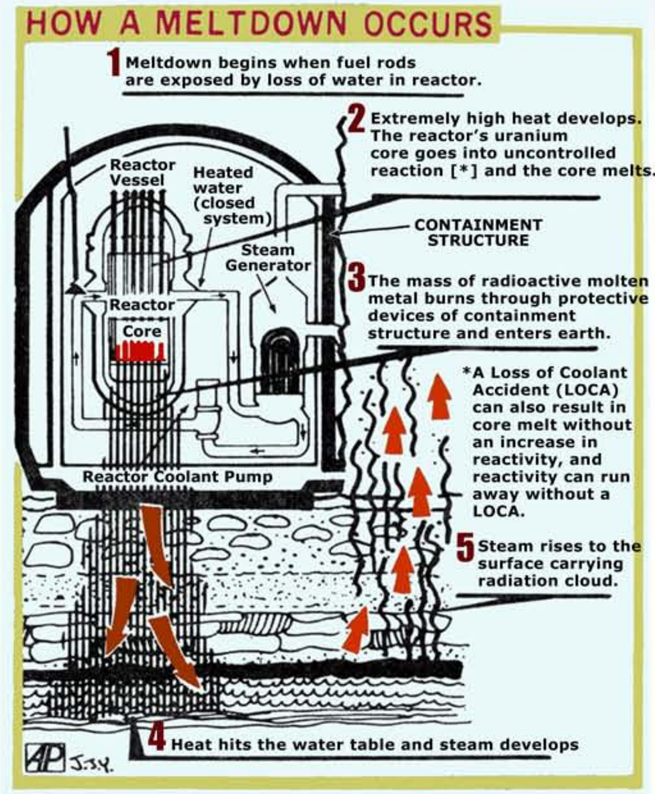
Animated versions of these images are available at the author's web site. Based on industry and government drawings.

PWR Reactor Pressure Vessel (RPV) with steam generators (4), primary coolant loop, pumps (4), and pressurizer



Other types of reactors include CANDU, Breeder, Liquid Metal, etc..

WHAT IS A MELTDOWN?



Adapted from: Bridgeport (CT) Post, March 31st, 1979 AP Laserphoto

In **1979**, the new Three Mile Island reactor partially melted down. The "root cause" was determined to be mainly human error. An estimated 15 million Curies of radiation was released, but numerous measuring devices failed during the crisis.

In **1986**, technicians at the Chernobyl reactor tried an unauthorized experiment, without proper safety equipment on-line. An explosion of the hydrogen and oxygen that had built-up occurred, as well as a partial core melt. An estimated ten billion Curies of radiation was released. Thyroid cancer rates in surrounding areas are dozens of times normal, and many other cancer rates are also elevated.

In **2002**, more proof of the nuclear industry's "failure-to-learn" came when the Davis-Besse reactor (in Ohio) nearly melted down. Pressure from the 2200 PSI primary coolant loop was pushing out the stainless steel reactor pressure vessel liner when the RPV head's boron corrosion was found. This was hardly D-B's first close call or long shut-down.

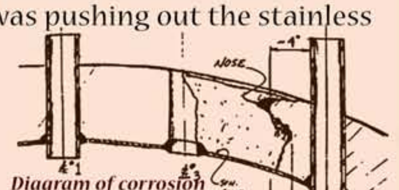


Diagram of corrosion hole in Davis-Besse reactor (from NIRS)

HOW DANGEROUS IS A MELTDOWN? *(very)*

Reactors contain about 15 billion Curies of radiation. A museum near (but not too near) Chernobyl is dedicated to deformities caused by the accident.

Birds fell dead out of the sky, and people collected them from their yards by the bushel-basket after Three Mile Island.

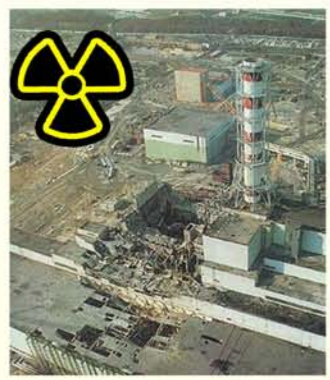
Most military nuclear disasters disappear without a visible trace, in the dust of a bomb or the poison from a sunken sub.

Chernobyl's human exclusion zone is more than 1200 square miles. The area was once prime agricultural land; the pride of Ukraine.

These insects are from a series of technical drawings by Cornelia Hesse-Honegger, showing radiation-induced damage around Chernobyl and other nuclear facilities. Published in New Scientist in 2008. Genetic damage may take many generations to manifest its horrors.

HOW LIKELY IS A MELTDOWN? *(very)*

According to an infamous **1982** government study known as CRAC-2, a reactor meltdown can be expected for every 20,000 years of accumulated operation. That's an average of one meltdown every 192 years in America, with 104 reactors. However, CRAC-2 ignored or underestimated the risk of scores of meltdown causes, such as Emergency Core Coolant System (ECCS) failure, including ECCS failure ***after*** shutdown. The NRC ***still*** will not even attempt to quantify the risk from terrorism, nor does it properly quantify other risks. Since CRAC-2 was released, nuclear reactors have aged, fuel pools have filled, dry casks have been built, and populations near the plants have skyrocketed.



Much of the Chernobyl reactor was "missing" after the accident!

What's Worse Than A Meltdown?

A spent Fuel Pool Fire

How could this be worse than a meltdown? Because there is often 30 or 40 times MORE fuel in the pools than in the reactor. A significant portion of the full load of many of the most dangerous fission products still remains in the fuel. The zirconium cladding of the fuel pellets is pyrophoric. The pools are overcrowded and, in the case of some older BWRs (the General Electric Mark 1s, for instance), the pools are five stories above the ground -- and protected from airplanes by a corrugated steel roof!

This is worse than unsafe. It's criminally negligent. Too bad there aren't any solutions that are much better.

ISFSIs
Independent
Spent
Fuel
Storage
Installations
Source: NRC, 2008

A Dry Cask Fire

Dry casks were invented because spent fuel pools are expensive to maintain and take up a lot of space. Dry casks look harmless enough. Some are built vertically, some in a horizontal configuration, which just shows that the nuclear industry doesn't have a clue as to which way is better. However, dry casks are inherently more dangerous than spent fuel pools for several reasons: The zirconium will be exposed to air in virtually any accident since the fuel is not in water, and does not have 30 feet of water above it. Also, the fuel rods cannot be inspected as easily, or removed for special handling if they are found to be flawed.

A single dry cask contains enough poisons to cause the permanent evacuation of a large state, such as Pennsylvania, or virtually all of New England. But evacuation will always come too late for many -- millions could be killed if an airplane were to crash into a series of dry casks, and half of America could be rendered uninhabitable.

One of these days, inevitably, a dry cask will be ignited, because there is no end to how many of these there will be -- dozens now, and within a decade several hundred. Then thousands, and then tens of thousands. The more **opportunities** there are for that "one in a million" (which often isn't anwhere near that rare) accident to happen, the more **likely** it is to happen.

A Steam Explosion with a Zirconium Fire and / or a Complete Core Rubblization

The NRC has what they call the "design basis accident" and this scenario doesn't fall within those specifications. Does that mean it's impossible?

Absolutely not! All it means is that at some time in the distant past, some government committee decided that the likelihood of such an accident was below one in one million, or perhaps one in ten million.

The scientific basis for their decision is unavailable to anyone and was probably not properly documented to begin with. But the ramifications are devastating.

Any time these seemingly-Rube Goldberg-ish (to the NRC) but utterly plausible accidents are brought up by a citizen, the NRC says they are "outside the design basis accident" which, for some reason, means they will not be discussed. Try it. You'll see.

Yet, all actual near-misses in the past were later determined to have come as a "complete" surprise...

Being Lied To

Once you've lost the truth, there is no hope for anything else going your way. Lies can be built on other lies, compounding the problem.

The nuclear industry is not known for honesty, and never will be. Yet honesty is a fundamental principle of democracy and of fair commerce and proper science.

All Of The Above

A meltdown can cause a spent fuel pool fire, a dry cask fire, the rubblization of the core, and the meltdown of other nearby nuclear power plants. And all this will be followed by lies. Lots and lots of lies.

What Else Can (and does) Go Wrong?

Lax Security

Sleeping on the job and falsifying records are recurrent themes among the security teams at nuclear power plants. The job is boring, the pay is low, the hours are bad, and if anything ever DOES go wrong, you'll probably be overwhelmed with "superior" forces and killed anyway. So why bother doing a good job?

"Inside Jobs"

The average nuclear power plant has about 1500 employees. Some are alcoholics, some are on unprescribed medications, some are on prescribed medications that cause mood swings the Nuclear Regulatory Commission has ignored. Some are improperly cleared foreign nationals.

Staffing Problems

The shortage of qualified workers at nuclear power plants is severe and will likely remain so forever. Why? That's simple enough to understand -- most people are smart enough not to want to go into a field which is so dangerous, so disliked, and so ruthless and dishonest.

Radioactive Drinking Fountains

A nuclear power plant in Florida had a drinking fountain which dispensed water from a radioactive holding tank, because the pipes had been crossed when the plant was built. Luckily, someone with a Geiger counter just happened to test the water.

Lax Maintenance

The basic attitude at all nuclear power plants these days is "if it hasn't broken yet, don't fix it."

Pumps, pipes, valves, vessels, control cables, instrumentation, and everything else that can fail is allowed to, and then fixed afterwards.

Riots, floods, tsunamis, earthquakes, asteroids, wars, tornados, airplane crashes, nearby chemical explosions, wildfires, avalanches, space weapons malfunctions

The nuclear industry considers everything they can't control (and many things they can but which they consider too expensive) to be so unlikely as to not be worthy of serious consideration. Airplane strikes like we saw on 9-11? No worries -- the TSA will keep the skies terrorist-free forever! The nuclear industry assumes everyone is perfect -- and equipped with the proper tools.

Lax Fire Safety

For at least four years, the fire records at San Onofre Nuclear Generating Station in Southern California were faked, and the inspection rounds were not performed. This was AFTER 9-11. Did anyone go to jail for this violation? Oh, come on! Not a chance!

Hidden Design Flaws

The Emergency Core Cooling System is a nuclear power plant's final backup before meltdown. Some plants even maintain thousands of large buckets of ice "just in case." None of these systems have ever been properly tested. One ECCS, for the Monticello nuclear power plant, was found to be inoperable for 30 years, because shipping bolts had been left on during initial installation. It NEVER would have worked!

Lax Oversite

The Nuclear Reguatory Commission cannot watch everything that happens at a nuclear power plant, so they rely on industry to police itself. Industry loves this, since it means they don't have to do anything.

"We're working on it"

Go ahead. Complain all you want. But even if your complaint is so ironclad that even the NRC cannot entirely dismiss it, the best you can ever expect is to be told they are aware of the issue and are working on a solution. And that can go on for decades.

Information Overload

The situation in the control room of a nuclear power plant can go from normal to meltdown in a fraction of a second. When problems start, panic among the workers -- even if they are highly trained -- can cause them to make bad decisions, or fail to make decisions at all.

Lax Safety Standards

This pilot was grounded for 30 days after pulling this "stunt" near the nuclear aircraft carrier J.C. Stennis. He reportedly likes the picture and thinks it was "worth it."

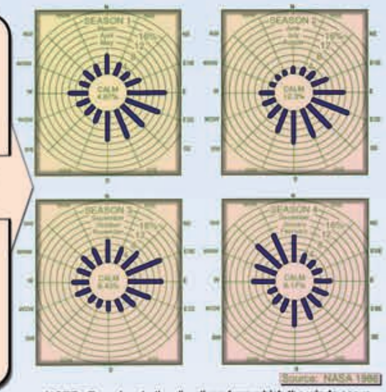
This "cowboy" attitude is especially pervasive among nuclear workers.

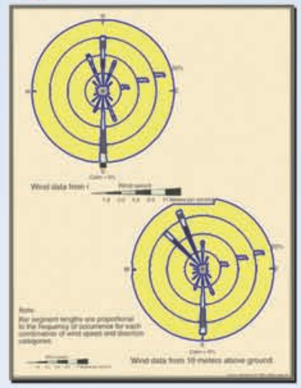
No One Understands How The Things Work

Nuclear power plants are complicated and require tens of thousands of "man-years" to complete. At that point, there is not one person who understands the entire plant, then the best experts start retiring.

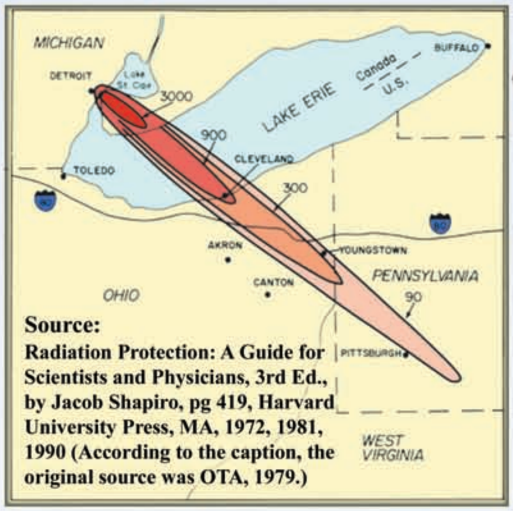
How Far Does Radiation Spread?

Shown on the right are "wind roses" from typical Environmental Impact Reports. But, when evaluating the costs of nuclear power, no state environmental agency will consider the effects of meltdowns, including where a meltdown's deadly plume will travel. "Not our jurisdiction" they'll claim, saying only the Federal Nuclear Regulatory Commission or Department of Energy have any authority over "safety." State agencies are only too happy and quick to give up authority over things they don't understand very well anyway.





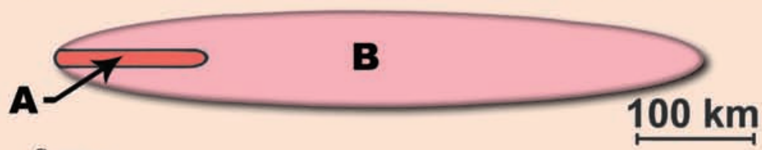
NOTE: Bars denote the directions from which the winds occur.



Source:
Radiation Protection: A Guide for Scientists and Physicians, 3rd Ed., by Jacob Shapiro, pg 419, Harvard University Press, MA, 1972, 1981, 1990 (According to the caption, the original source was OTA, 1979.)

On the left is a "typical" plume from a one megaton nuclear explosion. The plume stretches from Detroit, MI ("Ground Zero") to beyond Pittsburgh, PA. The graphic assumes a uniform 15-mph northwest wind. Contour lines show the one-week accumulated dose of 3000, 900, 300, and 90 rem (assuming no shielding).

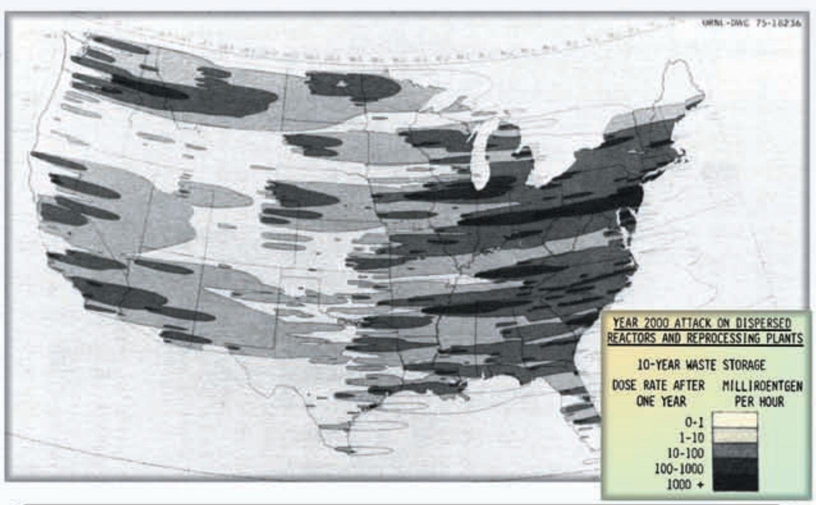
Below, again, is a typical bomb plume (area "A"). Area "B" is the expected plume from a nuclear attack against a nuclear power plant. A standard evacuation planning area for a nuclear power plant, however, is only 10 miles in radius.

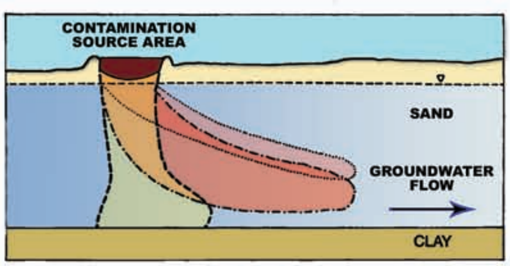


Source:
Environmental Consequences of Nuclear War, SCOPE 28, Vol. 1, Physical and Atmospheric Effects, 2nd Ed., pg 271, Scientific Committee on Problems in the Environment, John Wiley & Sons, 1985, 1989.

The map in the lower-right shows plumes from potential attacks on our reactors and fuel reprocessing plants. Dose rates are shown in the inset. Reactors now store much more fuel than the assumed ten years' worth.

The map is from:
Nuclear Power Plants as Weapons of the Enemy: An Unrecognized Military Peril by Bennett Ramberg, Univ. of CA Press, 1980, original source: Chester & Chester, "Civil Defense Implications for the U.S. Nuclear Power Industry," p. 334.





LEGEND

- .... **Light Immiscible Plume**
- -.- **Main Plume**
- -- **Heavy Immiscible Plume**
- -▽- **Top of Water Table (Piezometric Surface)**

The graphic on the left shows typical ground contamination. Radioactive contamination -- or any contamination -- in our water system is nearly impossible to remove. Our aquifers, farmland, lakes and rivers are all at great risk of destruction from nuclear accidents. Many are already contaminated.

Source for diagram on the left:
The American West at Risk (2008) p. 362, originally based on U.S.EPA 1985

Nuclear Waste: Your Gift to Tomorrow

If you thought your share of the "national debt" was big (and it is), your share of the fission burden on this earth is more dangerous to the future than your debt. After all, a debt can be wiped out with a pen. But nuclear waste is the gift that keeps on sucking your money and causing cancers, etc..

Some gift!

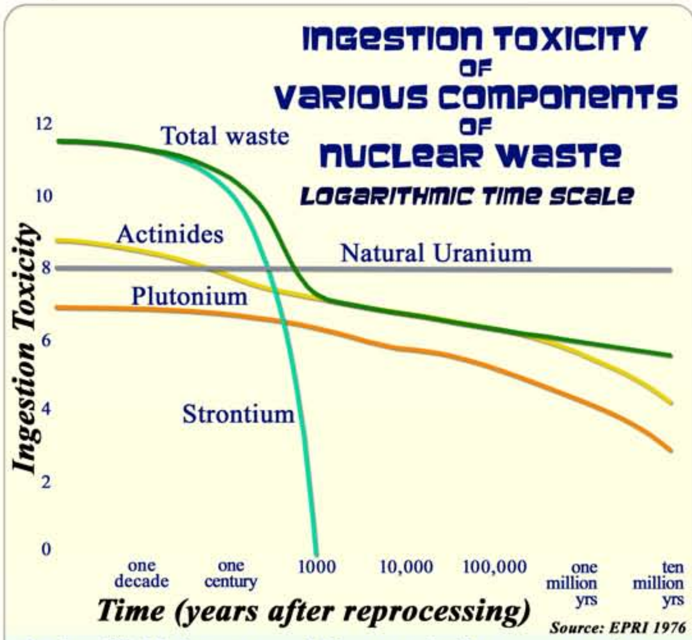
Pro-nukers like to point out the VOLUME of nuclear waste produced in a year for a family of four, which may seem like a small amount -- for example, a beer can, or half a beer can, or something similar. But only a millionth of a gram of many of these fission products is a deadly dose -- and half a beer can could hold hundreds of billions of lethal doses.

How many deadly doses are you willing to make, and leave for the future, each day, just so you can power your lights one way, instead of a safer way? Radioactive poisons are stealthy: INVISIBLE, DIFFICULT to CONTAIN, and COSTLY to ISOLATE. Even if you reprocess the waste to use more of the U^{235} and Pu^{239}, you'll still have no use for virtually all the thousands of other radioactive isotopes which are created, and which remain hazardous for thousands of years.

The most polluted, poisonous places on earth are the nuclear wastelands such as Hanford, the Nevada Test Site, the Savannah River Site, and so on (Russia and other countries have similar areas of devastation). Where will it end? In an unsurvivable global poisoning, or in closing the plants and stopping the failed "experiment"? YOU will decide: ***CHOOSE A SUSTAINABLE FUTURE!***

An estimated $60 Billion dollars have been put into finding a solution so far, and NOTHING'S WORKED. This should come as no surprise to anyone who has studied the problem carefully, since radiation destroys any container you put it in, and since a wide variety of decay rates and all possible types of radiation, at all possible energy levels, result from the fission process.

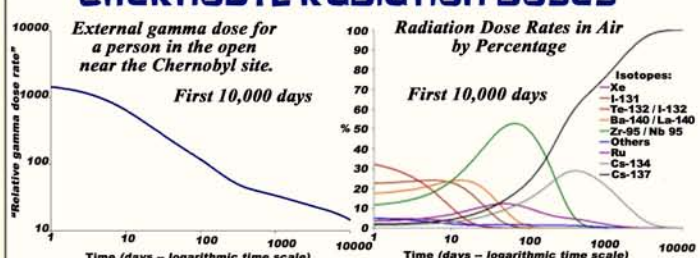
You cannot store nuclear waste safely. You cannot transport it safely. You cannot reprocess it safely, and there is no good reason to reprocess it anyway, since ALL the reactors should be shut off, forever.



Cesium[137], if shown, would have a similar curve to the Strontium[90] curve. Other shorter-lived isotopes would have curves that drop off more steeply. The seven fission products with half-lives >200,000 years don't seem to appear at all in the graphic above, but they are polluting our planet (and our bodies) in ever-increasing amounts.

The ignoble seven: *Technetium-99, Tin-126, Selenium-79, Zirconium-93, Cesium-135, Palladium-107, Iodine-129*

Chernobyl Radiation Doses

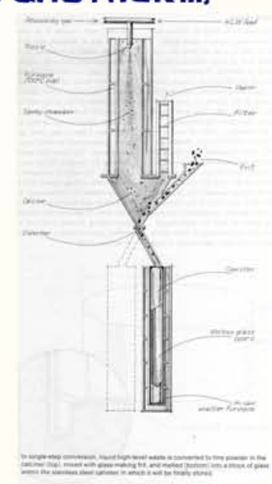


Source for above images: Wikipedia, 2008

One Bad Idea After Another (and another, and another...)

The nuclear waste control idea shown here didn't work, and nor did anything else ever proposed by anyone. Do YOU have ANY idea about what to do with nuclear waste?

Someone will say your idea is going to solve the problem, and the industry will continue for a few more decades. No matter how stupid your idea is, or how unworkable, and even if it was tried years earlier and didn't work. In that case, just give it a new name. And of course, you'll be well-paid for your efforts.



At Lea$t I'm In$ured, Right?

WRONG! *(unless you **own** the nuke plant)*

Read Your Homeowner's Insurance Policy!

In the 1950s the nuclear industry just wasn't getting started. Try as they might, the U.S. government could not get investors to pay for new nuclear power plants, because investors couldn't get insurance for their investments.

So the utilities and government formed a collusion to simply DENY insurance by PRETENDING to self-insure themselves. And thus, the PRICE-ANDERSON ACT was formulated and passed. The capitalist system was thrown out the back door, on the grounds that nuclear power was simply too new for any insurance company to have enough faith in it. It didn't occur to the government (let alone, to the fledgling nuclear industry) that insurance companies would have been perfectly willing to insure the plants if only they could have been proven safe. Can't get insurance? That means you're doing something which is too risky, or even simply foolish. Nuclear plants ***still*** can't get insurance, and we ***still*** have Price-Anderson, which has been periodically (and idiotically) renewed.

It ***is*** a unique situation: Namely, the COST of a potential accident would bankrupt even the largest insurance company. On this, there is little disagreement. After a nuclear accident do not expect more than a hundredth of a cent on the dollar for your losses. And then, only if you can PROVE incontrovertably that there was DIRECT damage from the accident.

Look for the exclusion about nuclear accidents. You'll find it.

Check the fine print.

Any policy. Any insurer. Anywhere in the world.

All countries operating nuclear power plants have adopted some form of the U.S.'s Price-Anderson Act.

But at least OSHA and other federal agencies are protecting workers and the public, right?

WRONG AGAIN!

OSHA and many other federal watchdog agencies were pushed out of nuclear power plant regulation long ago. The Nuclear Regulatory Commission (NRC) takes on ALL the regulatory activities at nuclear facilities -- not JUST the nuclear side of regulating the power plants.

This is extremely unusual, and has helped destroy the normal "checks and balances" of government regulation (which is as much about protecting against corruption IN goverment as it is about using the government to protect the public from illegal private enterprises).

That huge overhead crane in the containment dome? OSHA, which regulates virtually every other crane in the country, doesn't regulate it.

What about local and state agencies? Aren't they helping to protect the public from harm?

NO!

State agencies were so quick to abdicate their responsibilities and authories in the field of nuclear, that nobody noticed such abdication was illegal, immoral, and unjustified. But there it is.

More than 30 states signed "Abdication of Responsibility" agreements (they are now known formally simply as "agreement States") so that people opposing nuclear power could NOT turn to ANY state agency, EVER, for relief or to insist on proper regulation.

So, once a year the Feds (NRC) sweep through town, listen to a few citizens complain (NOT UNDER OATH) and promise (NOT UNDER OATH) to get back to the citizens soon, but they never get back on ANY hard question, ever.

Visible Effects of Radiation

Immediate Damage

A Japanese female noncombatant victim of the atomic bomb, 1945.

The pattern of her dress has been etched into her skin by the intensity of the blast.

She received alpha, beta, gamma, and neutron radiations, as well as thermal radiation, pressure blasts, and debris injuries, followed by intense thirst and anguish.

Delayed Damage

In November, 2006, KGB whistleblower Alexander Litvinenko, who had defected to the United Kingdom and been granted U.K. citizenship, was poisoned in London with Po^{210}, apparently by his former employers. Po^{210} has a half-life of 138 days. Less than a millionth of a gram caused his organs to shut down, one by one, and he died within a few weeks.

A hero's dying words:

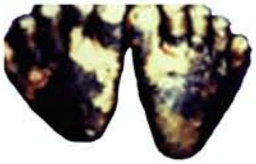
"The bastards got me, but they won't get everybody."

Radiation doses of 600 rem are almost always fatal within two weeks. Lower doses can also be fatal, although very low doses will not show an immediate effect, except in the case of causing a heart attack by fizzling the heart's electrical system at a vulnerable moment or due to an existing weakness of that person's heart.

New Symbol for Ionizing Radiation Danger

Radiation damage causes cancer, leukemia, birth defects, heart disease, and many other health effects. Damage can take many years or many generations to show up. One gamma ray can damage a pregnant woman, her fetus, and the fetus's own forming egg cells, thereby damaging three generations of human life with one radioactive decay event.

Child's feet after radiation burns from Bikini test



Bikini baby's hair falling out after irradiation from bomb test

Marshallese Islands Deformed Child

Atomic bomb veteran's daughter -- on oxygen

A lethal dose / LD50

As with many pollutants, it is difficult, and, surprisingly, not especially useful, to find an exact value for a 100% "lethal dose." So in radiation research, and elsewhere, scientists often search for the dose which will be a lethal dose (LD) to 50% of a given population.

While claiming to give humane treatment to all animals, the Atomic Energy Commission (AEC, forerunner of the DOE and NRC) and all the other radiation labs actually performed / perform countless cruel (and crude) experiments -- sometimes on humans -- but mostly on millions of mammals, birds, lizards, fish, crustacea, and hundreds of millions of insects. This picture is of beagles arriving in their "new" home. They are happy now...

No Safe Dose

"Any dose is an overdose" -- John W. Gofman

Categories of papers (over 150) published by John W. Gofman (1918 - 2007)

- Lipoproteins, atherosclerosis, and coronary heart disease.
- Ultracentrifugal discovery and analysis of the serum lipoproteins.
- Characterization of familial lipoprotein disorders.
- The determination of trace elements by X-ray spectrochemical analysis.
- The relationship of human chromosomes to cancer.
- The biological and medical effects of ionizing radiation, with particular reference to cancer, leukemia, and genetic diseases.
- The lung-cancer hazard of plutonium.
- Problems associated with nuclear power production.

Dr. Gofman's many honors and awards included the Gold-headed Cane Award as a graduating senior from UC Med. School in 1946, the Modern Medicine Award in 1954 for outstanding contributions to heart disease research, the Lyman Duff Lectureship Award of the American Heart Association in 1965 for research in atherosclerosis and coronary heart disease, the Stouffer Prize (shared) in 1972 for outstanding contributions to research in arteriosclerosis, and in 1974, the American College of Cardiology selection as one of 25 leading researchers in cardiology of the previous quarter century.

Gofman was Associate Director of Lawrence Livermore Laboratory from 1963 to 1969 and held three patents. One was on the slow and fast neutron fissionability of Uranium-233, one on the sodium uranyl acetate process for separation of plutonium from uranium and fission products from irradiated fuel, and one on the columbium oxide process for the separation of plutonium from uranium and fission products from irradiated fuel.

Hidden Effects of Radiation

Inflammation

Your body's ability to repair itself is remarkable, but NOT infinite. Your DNA is most vulnerable during cell division.

Inflammation occurs when your body uses its white blood cells and other tools to fight an invading organism or poison. When a cut gets infected or inflamed it is easy to see the effects, but when ionizing radiation damages your body, the effect is not necessarily visible. A person receiving a fatal dose of radiation may feel nothing at the time and show no signs of distress for some period of time after the dosing.

So-called low levels of radiation also do the same kind of damage, but not to a fatal degree. However, these doses can cause premature aging, neuromuscular problems, cardiovascular problems, and many other diseases.

Ionization Damage

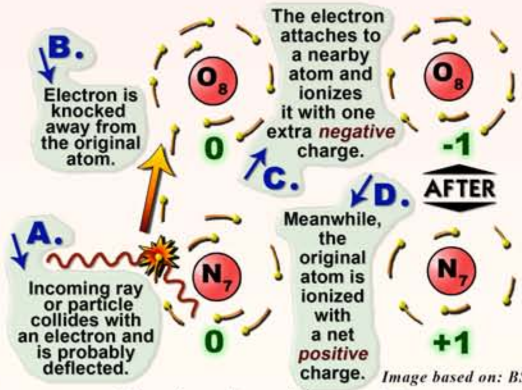
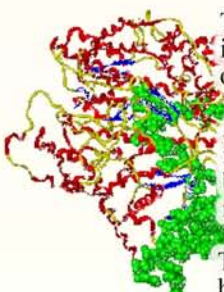


Image based on: BS of A

One radioactive decay can create thousands of "pairs" of positive and negative ions.

These ions can be very damaging to biological systems.

Leftover / Recoil Damage



A "transcribing T7 RNA polymerase initiation complex" (from LLNL)

Tritium (H_3) and other radioactive isotopes also cause damage by the recoil of the remaining nucleus after a decay.

Additionally, whatever the new element is, it's not the element that might have been part of some complex protein molecule, for instance, or DNA, etc..

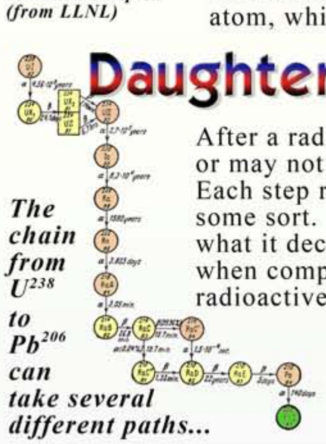
Tritium atoms masquerade as common hydrogen atoms, so they might be found anywhere in your body. When the tritium atom decays, it becomes a helium atom, which the body cannot use.

Catalytic Damage

The electron shells of a uranium atom hold 92 electrons, making U both adaptive and destructive.

Many radioactive elements are significant catalysts, as well as heavy metal hazards, in addition to their radiological threat. The nuclear process releases these dangerous elements into the environment where they have been shown to mimic hormones in mice, and to cause dozens of serious ailments. Catalytic effects of DU are considered one possible factor in "Gulf War Syndrome."

Daughter Products



The chain from U^{238} to Pb^{206} can take several different paths...

After a radioactive atom decays, it may or may not decay a second time, or more. Each step releases ionizing energy of some sort. How an isotope decays, and what it decays into, must be considered when comparing dangers of various radioactive exposures.

Decays by Alpha
Decays by Beta
Stable

Image source: Atoms A- Z

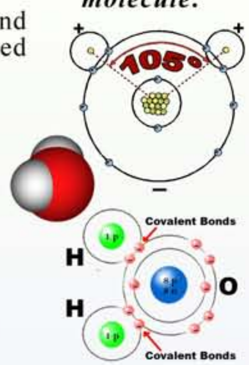
Hot Particles

A single particle of Depleted Uranium one milligram in size is very small. Many U.S. soldiers, enemy combatants and civilians caught in the crossfire have far more than that lodged in their bodies. Such particles are known as "hot" particles and leave a path of destruction in their wake.

Despite DU's long half-life of **4.5 billion years**, and its extremely high density, there are still enough atoms of DU in one milligram (about **2,530,000,000,000,000,000**) so that more than **a million atoms** will decay every day.

"Free Radical" Damage

Three ways to depict the H_2O molecule:



A particularly damaging type of atom or molecule is known as a free radical. A free radical has one or more unpaired electrons. Uranium has four unpaired electrons in its outer shells.

The free radical will find an atom which holds its outermost electron less tightly, and will grab that electron. Then that atom will be "ionized," and so on down the ladder of energy levels, one atom ionizing another, in a long sequence.

When tritium decays, the decayed atom might have been part of a water molecule. The left-over OH molecule is a free radical and is particularly hazardous to living cells because it is a strong oxidizer and can suddenly appear anywhere in the body when created by this method.

Bystander Effect

When one cell in your body is damaged, the death or altered behavior of that cell can cause other cells to also fail. When mice were irradiated on just the lower half of their bodies, they developed brain tumors.

. . . THERE ARE MANY OTHER HIDDEN AND SUBTLE EFFECTS OF RADIATION POISONING . . .

IT'S ALL ABOUT THE DNA

Direct DNA Damage

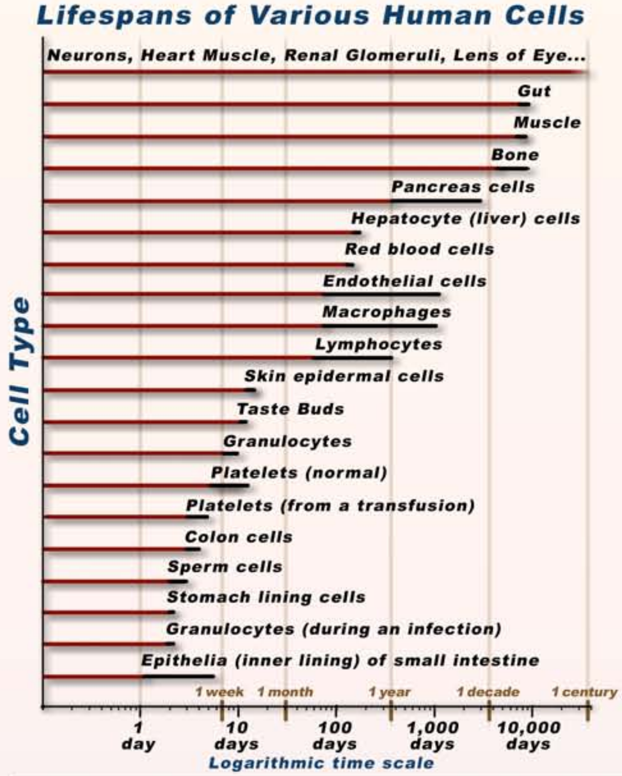
Ionizing radiation (even a so-called "weak" beta decay) has enough energy to break thousands of chemical bonds in your body, or in other structures. Sometimes the body can repair direct DNA damage, but sometimes repairs are incomplete or produce cancerous results.

ANY damage to ANY cell can cause problems

During the life of a cell, it performs tens of thousands of functions (e.g., making proteins and other molecular building blocks of life, filtering crud out of, or nutrients into, your body, etc., etc.). In some cases, it does these things thousands of times every second.

Short-lived cells may have thousands of generations of daughter cells during your lifetime, and many opportunities for altered DNA to express itself (e.g., cancer).

Lifespans of Various Human Cells



Mitochondrial DNA Damage

Mitochondrial DNA is inherited much more directly than "normal" or nuclear DNA -- and damage is more likely to be permanent. Unlike nuclear DNA, mitochondrial DNA is NOT recreated every generation from the DNA strands of two different people, with the opportunity that gives for repair. Mitochondrial DNA is inherited directly from the mother, and then replicated thousands of trillions of times, and then one cell's mitochondrial DNA is passed on to the next generation.

Also, mitochondrial DNA is not as protected within the individual cell as is nuclear DNA.

Lastly, mitochondrial DNA is the "workhorse DNA," responsible for much of the activities of the cell, while the nuclear DNA is mainly for cellular reproduction. Because of its frequent use, damaging mitochondrial DNA can cause immediate, if subtle, effects.

DNA Damage and Radiation: There's NOTHING good about it!

Your DNA strands -- all 100,000,000,000 of them (more exactly, between 10 trillion and 100 trillion, with 100 trillion the more commonly seen number) -- are each about four billion (4,000,000,000) bits long in a base four system.

No one knows why, when sperm meets egg and their DNA join, a particular part of "A" is taken and a particular part of "B" is taken. But it is known that the number of possible combinations probably exceeds the number of atoms in the known universe. (The author writes "probably" because it is possible that many combinations are impossible. But even so, the number of possibilities so greatly exceeds the number of humans that will ever live, that you can rest assured that your DNA is, and always will be, yours and only yours -- even as it changes and diverges throughout your life). Other forms of replication, besides the joining of two DNA strands, also do not need random mutation to "evolve" -- and in fact, "evolving" does not seem to be the grand design of most life forms. (It just happens.)

Nowhere in this scheme of things is there room for, or a need for, DNA damage by radiation. DNA replication in the thermal bath of life -- with all the other assaults (chemical, viral, bacterial, etc.) which all life must endure -- is a bit of a miracle. It does not need ANY amount of damage done to it by ionizing radiation.

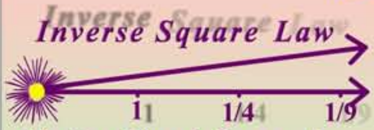
An enormous amount of variation is already inevitable, and variation is of questionable benefit, anyway. So the one last hope of the pro-nukers, that at least "natural, background radiation" is necessary for our DNA to "evolve," is dashed, without the need to resort to any religious arguments whatsoever.

And it's ungodly, too!

Out of respect, let us not ignore the religious arguments against ionizing radiation. If God made us in His image, then randomly damaging His image delivery system is blasphemous, dangerous, irreverent, and rude. Chaos rules regarding nuclear decay, whereas direction -- a positive direction -- IS God's will.

How Can I Protect Myself And My Family?

Staying Out of the Danger Zone



All other things being equal, doubling the distance from a point source of radiation will quarter the dose received, following the standard equations for the increasing area of a sphere.

To calculate the damage from an actual radiation exposure, one needs to use the RBE (Relative Biological Equivalent). Multiply the absorbed dose's energy (expressed in grays, for example) by the RBE (aka "Quality" factor, Q) for the type of radiation exposure to get the biological dose equivalent (in sieverts, for this example). The RBE for alpha particles is usually set to 20, while for gamma rays, x-rays, and beta particles it is set to one. For neutrons, it depends on the energy (speed).

International Radiation Warning Symbol

(Warning: Sign may be missing.)

Don't work for the "*Demon Hot Atom*"

It usually starts either with a job on a submarine, or as a "nuclear engineer." Sounds harmless enough, or even patriotic. BUT IT ISN'T.

If you feel compelled to study radiation, study the harm it causes. Study nuclear waste disposal. Or study medical uses, or even nuclear particle physics. But not "reactors."

Eat right, exercise, don't smoke

Staying healthy protects you in many ways. Tobacco smoke contains large amounts of Po^{210}.

Choose non-radioactive smoke detectors and other options

In normal everyday life, you seldom get options regarding nuclear choices, but you have a few. Choose non-irradiated food, non-radioactive exit signs, non-radioactive gun sights, etc. etc. etc..

Avoid unnecessary x-rays and other radiological procedures

When you need an x-ray, get an x-ray. But if you fall asleep during a CT-SCAN, which is not uncommon, they'll simply give you another. This will double your dose and *at least* double your risk. If you break a bone, they will often take 10 or more x-rays for a simple, easily-set fracture. Serial ultrasounds provide a better baseline than mammograms and are completely safe. Always ask: "Is there a nonradiological option?"

Get a radiation detector

Everyone should have one (or more) and online, real-time data should always be available to everyone. Keychain models are comforting (the author owns one), but the most accurate and useful detectors are quite expensive. But even an inexpensive one might give you a vital early warning -- and a more honest value than you will get from anyone else.

Don't live near a nuclear power plant

Scientists have written peer-reviewed ("vetted") reports showing the dangers of living near an operating nuclear power plant -- one that hasn't melted down. Published in peer-reviewed scientific journals are data showing increases in cancer and prenatal mortality in those living in proximity to nuclear power plants, but more importantly, there was an improvement in both parameters when local nuclear power plants were shut down. (Mangano, Sherman)

Keep KI handy

If taken early enough KI will prevent your body from taking up radioactive iodine after a meltdown or other radioactive release. Some states stock KI, but it will be too late if you don't own it yourself. (Do not take KI unless instructed by authorities.)

Take anti-oxidants every day

Damage from radiation comes in part from "free radicals," ionized particles with unpaired electrons. Each radioactive decay can create thousands of free radicals and other hazardous elements and molecules. Anti-oxidants, such as vitamins C and E, help your body deal with free radicals and other problems. So take your vitamins.

Change the laws

Local, state, and federal laws regarding nuclear issues are missing, illogical, unconstitutional, ambiguous, irrational, and / or criminally negligent and immoral.

You CAN'T

Radiation is odorless, colorless, and tasteless -- truly stealth. That is why good policies are our best hope.

An Industry in Denial

To be a pronuker, you must be willing to ignore obvious facts. You must be comfortable denying well-established scientific truths. You must be unable to follow simple logic, and unwilling to doubt your own opinion. You must be willing to abuse the public trust, and, perhaps most of all, you must be willing to make money from the death and suffering of others. Here are some of the many thousands of issues which pro-nukers are unable to face properly:

Hormesis (the idea that a little radiation is good for you)

The main government scientific body concerning radiation and human health, known as the BEIR committee VII (Biological Effects of Ionizing Radiation VII) confirmed -- AGAIN -- the LNT (Linear, No Threshold) theory, and -- AGAIN -- could find no basis for the theory of Hormesis. What few tests have shown any trends towards Hormesis have been small, short, and looked only at a few of the many health effects of radiation poisoning.

Nukes can provide electricity that is "too cheap to meter"

An infamous claim made in **1954** by then-chairman of the Atomic Energy Commission Lewis Strauss to the National Association of Science Writers, who for years thereafter apparently believed it would come to pass. In fact, it never came close. Nuclear power plants have to heat water, convert it to steam, turn a turbine, condense the water, store the waste, prevent meltdowns, and have a staff of about 1500 people per reactor. It's not efficient, and never can be. Renewable energy systems often are completely passive after installation, making them models of efficiency and reliability.

Legal releases of radiation are "safe"

All nuclear operations leak radioactivity into the environment. And for this, the industry has ALARA, which stands for As Low As Reasonably Achievable. ALARA is, in effect, a license to murder. They are allowed to release as much as necessary for them to continue operations in a cost-effective and efficient manner. Does such a philosophy of operation say anything about how much damage the released radiation can do? NO! NOT A WORD! Actual amounts allowed under ALARA vary greatly: Sometimes thousands of curies, sometimes thousandths OF a curie. But in neither case is your safety paramount. The successful operation of the industry is paramount.

Nukes create jobs

Anything costing tens of billions of dollars provides jobs. But nuclear jobs are particularly high paying so there are fewer of them per dollar, because they are highly specialized, dangerous, and carry an enormous amount of responsibility. Not everyone working in the industry meets these requirements, by any stretch of the imagination.

Nuclear energy was democratically chosen by the people

The people have never "chosen" nukes, and millions have marched, signed petitions, and risked being arrested during peaceful protests to try to stop nukes. First there was the "Atoms for Peace" program. Then there was Shippingport (in 1957) and other "loss-leaders" which pretended to be successes while covering up numerous leaks, near-misses, and cost over-runs. Then there were the cries of oil and gas shortages, which always came just when the opponents of nuclear power were making some headway.

Renewables can't compete

They can, in a fair market. But vested interests make money from burning oil, coal, and gas, and from fissioning uranium.

People who oppose nuclear power just don't understand how it works

If you believe that, I guess you'll believe anything. But more to the point, why not go out and confirm everything you've read here for yourself? There is no need to "believe" anything or anyone. Get the facts and decide for yourself.

The Future Looks Rosy to Those Who Are Blind

Tomorrow's nukes will be more efficient -- and safer

Tomorrow's nukes -- the ones they really are planning to build if no one stops them -- are NOT models of efficiency and design. They are nothing more than larger and smaller versions of the same old waste-producing devices for boiling water under pressure to produce steam to turn turbines. Even Niels Diaz, former head of the NRC, admitted that there can be no really great efficiency gain until we do away with the turbines, with boiling water (or other fluid), and convert to direct capture of the energy of decay.

What he neglected to mention was that we tried that, too. In fact, NASA still uses this method for space probes, the CIA uses it for deep sea, harbor, and spy satellite power sources, and we used it in pacemakers for a while. Tritium-laced exit signs and target graticles also use the energy of decay more-or-less directly. However, direct use of the energy of decay isn't practical on a large-scale, nor is it safe on ANY scale. Nuclear power is inherently unsafe because a small error at any stage can have large consequences. It is the nuclear industry's policy to describe these consequences as "unforeseen."

They'll solve the waste problem eventually

No they won't. Don't count on it, don't bet the farm on it, don't bank on it, don't plan the world's energy future on it. Ionizing radiation destroys any container you put it in. There is no chemical bond which can withstand even a thousandth of the typical force of an atomic decay. So building a containment structure is out of the question for this reason alone.

If containment doesn't work, what does? They considered everything: Rocketing the waste to the sun, dumping it at sea (still legal in many cases, but it should be completely banned), and they finally decided (at least in America) on this: Drive it 50 miles onto an Indian reservation and dump it. Getting it there is dangerous, storing it there is also dangerous, and reprocessing it is the most dangerous option of all. We are, literally, stuck with it, and it's going to cost us a fortune, year in and year out, for far longer than any human civilization or artifact has survived. By far the best thing to do is to stop making more nuclear waste *right now*, and forevermore.

Nukes can solve global warming

Nuclear power plants are part of a cycle that is very fossil-fuel intensive. Worse, the waste will warm the environment and require constant attention (wasting $ and resources) for thousands of generations. Accidents are a constant threat. For every dollar you put into nuclear power, you could buy much more carbon abatement by spending the money on wind, solar, geothermal, or efficiency. So in addition to nuclear's many direct contributions to global warming, spending precious dollars on nuclear gets you much less carbon reduction than if you used that money for clean, safe energy.

If we don't switch to nuclear power eventually, we'll run out of oil

Knowing we will run out of oil some day doesn't mean nuclear power is the solution. (It DOES make renewable energy the solution). Uranium like oil, is in short supply worldwide, and, like oil, its price is controlled by cartels. Nuclear power burns fossil fuels during construction, during fuel mining and enrichment, as well as all the fossil fuels burned by the workers (and their families). More fossil fuel is usually burned during shutdowns, too. And if there is an accident or a meltdown, the fossil fuel footprint will be enormous for that, too. Guarding nuclear waste will require a lot of fossil fuel, too.

They'll find a cure for cancer soon

Cancer is a mutation of a single individual's unique DNA code, causing those cells to mulitply too fast, die too slowly, or grow and die at the normal rate, but grow in place of a vital organ, or crowd one out, and in any case, stop that organ from functioning. By the time it is noticeable, cancer usually has many millions of cells, each with their disrupted version of your DNA. (The author had bladder cancer in '07.)

Unfortunately, there is no reason to believe we will ever "cure" -- let alone *prevent* many, if not most, cancers. Yet, *every* pro-nuker believes such a day is just around the corner. And they don't even care if the "cure" costs thousands of dollars, carries an enormous risk itself, and is painful and debilitating.

Even if they found a cure for cancer, to make radiation safe they would also have to find a cure for heart disease, Alzheimer's, leukemia, autism, and hundreds of other diseases WHICH HAVE BEEN LINKED TO RADIATION DAMAGE AS A CAUSE OR ACCELERATOR.

False Claims by Pro-Nukers about Anti-Nukers

A pro-nuker tries to make you ***believe*** they are right, and thus get you to stop ***investigating*** for yourself. They have a number of techniques they use to try to stop all reasonable debate. One of their favorite tactics is to portray the anti-nuker as stupid, ignorant, misguided, or even dishonest. If you believe any of those things, you won't bother to find out if the anti-nuker is right or not. So rather than argue the facts, an argument the pro-nuker cannot win, they will argue absurd secondary issues, or they will simply accuse the other person of being a scaremonger, a "commie," a "Luddite" or worse.

Claim	Reality
"Anti-nukers think nuclear power plants can blow up just like an atomic bomb -- but they can't."	There are several realities here. First, most anti-nuclear activists know that there normally isn't enough U^{235} and / or Pu^{239} in a reactor to make a "nuclear" explosion possible. Second, the first point doesn't really matter, because, in terms of radiological content, a nuclear power plant contains about a thousand times ***more*** poison than a nuclear bomb, so the fallout effects would be a thousand times worse if the radioactivity was released. Third, a steam explosion can cause the reactor to explode so violently, the "RPVH" (Reactor Pressure Vessel Head) could be thrown half a mile high.
"Anti-nukers are simply anti-technology."	Actually, pro-nukers are the ones who are against modern technology! They are against wind power, geothermal power, wave power, atmospheric vortex engines, solar rooftop panels, ocean thermal energy conversion technology, and every other green source of electricity possible. Nuclear power is old-fashioned. The clean energy of the future is available today.
"Anti-nukers are commies who want to live in a cave. They hate capitalism, democracy, and The American Way."	America started the nuclear age, but that doesn't mean supporting nuclear power plants, a failed technology, makes you a patriot. Should it be mentioned that Russia's nuclear policies are worse? Should it be mentioned that nuclear energy has never operated in a fair economic environment -- it has always been heavily subsidized? And should it be mentioned that numerous anti-nuclear groups are global in reach and outlook, and make extensive use of technology to communicate with each other and with their elected and appointed officials, and with the media and the public?
"Without nukes, more children will get asthma and more people will die of lung cancer caused by increased coal use."	There is no reason to simply compare nuclear, with all its problems, to the next-worse choice. And no reason to "lump that choice all in one (coal) bucket!" There are many energy choices available to serve our needs. Even if we choose coal, there are many different grades of coal, and many different ways of cleaning the coal, and many different ways of extracting the coal from the earth. Anyone who wants to urge Congress to adopt cleaner coal standards is encouraged to do so. But no one should presume that concerns about coal negate concerns about nuclear power. Coal plants aren't targets for terrorists, and don't create high-level nuclear waste or bomb material.
"Without nukes, the lights will go out."	No, they won't. Okay, they will if the power utilities, the transmission line owners, the government, or other unscrupulous groups want to scare you -- as HAPPENED in California in 2000 - 2001. There was plenty of energy -- we were using thousands of megawatts LESS than previous peaks that had NOT resulted in blackouts. However, with three of our four nuclear power plants down, the utilities did not want us to realize we could get by without them. So we had blackouts, instead. *It doesn't have to be that way!*

Beneficial Uses of Radioactivity

...always come with hidden costs...

Medical Diagnosis

X-rays for looking at broken bones are ionizing radiation and have been shown to cause low birth weight in a fetus after just ONE dental x-ray of the mouth for the mother.

CT-SCANS are vital tools, but many are given without proper cause, or are given when nonradiological options are available instead. Unfortunately, once a hospital has bought a CT-SCAN machine, the only way to pay for it is to use it as often as possible. And unfortunately, sometimes only a CT-SCAN will do, so even if a hospital would otherwise be willing to purchase a less harmful piece of equipment, they would still need to purchase a CT-SCAN device, so they often forego making two purchases.

Other Uses

Gizmos used for industrial measuring purposes, university research waste from goulish experiments on animals (and even occassionally on unsuspecting humans), and military waste of all sorts are included in this catch-all category of human health hazards.

And it all ends up where?

Shown below is a September 2008 article about the lack of disposal space for so-called low-level nuclear waste. (Note the blue ladder in the foreground for scale.) If even the LLRW cannot be properly stored, what chance is there that the spent fuel rods will ever be properly isolated from humanity for the quarter-million years (approximately) that they will be hazardous?


National / International

Nuclear waste, worries piling up

Landfill restrictions in S.C. took away an option for disposal of radioactive material. Experts are concerned.

From:Philadelphia Inquirer, September 28, 2008, page M1)

Cancer and other Medical Treatments

In the correct doses, properly administered, when no other options are available, radiation can save lives, and does, every day.

Rice-size pellets of cesium-137 are implanted directly into a tumor to irradiate it to death with gamma rays, killing the tumorous cells and hopefully not irradiating the healthy cells too much.

Pellets of cobalt-60 are used to create focused beams of gamma rays, which can kill cancerous brain tissue. Or cause cancer in healthy tissue.

Radioactive cobalt and cesium together are used to sterilize blood as well as medical equipment.

The last procedure in particular does not require the radioactive isotopes, but other options are somewhat more expensive.

The big problem for society, however, is that all these practices produce waste -- which is piling up at hospitals and medical centers across the country, since the only waste facility that used to take the so-called "low-level" radioactive waste, in Barnwell, South Carolina, closed its doors to most states in July 2008.

National Security

Scanning devices which can detect radiation are usually radioactive themselves, and may induce radiation in whatever they scan.

Space weapons are expected to be deployed some time in the coming years, time-frame unknown. However, the militarization of space has already occurred and continues at an ever-increasing pace.

Meanwhile the Chinese recently purposefully caused an explosion in "Near Earth Orbit" which created approximately a quarter-million pieces of new space debris, which will be in orbit around the earth for an estimated quarter of a millennia or more.

Nuclear "bunker-busters" are being designed and may be deployed against Iran. These will cause enormous releases of radioactive fission products since the explosions will invariably be very shallow blasts releasing lots of dirt -- and fission products -- into the atmosphere.

Radiological weapons including dirty bombs are expected to be used against America, as well, according to Dick Cheney, and has he ever lied to the American people?

What Is a Whistleblower?

It's easier NOT to blow the whistle. You get to keep your job, your friends, and your fragile beliefs. Studies have actually proven that if someone who appears to be in authority says something is okay, people will believe it is okay. Okay to torture. Okay to lie. Okay to steal. Okay to create and spread radionuclides throughout the planet. But WHO said it was okay? Was it someone who understood all the math, all the physics, all the biology, all the genetics, all the economics, all the stuff they didn't even know back when it started? No -- it was a committee! NOT someone committed to truth.

someone like Karl Z. Morgan

Karl Morgan was the father of the science of Health Physics, the director of health physics at ORNL for 29 years, and the first president of the Health Physics Society. But when Morgan realized there were serious problems, he -- and his views -- were simply rejected by the HP "society."

In written testimony to the DOE in 1989, Morgan wrote: "During the 58 years I have been working with ionizing radiation, I have seen so many mistakes, misstatements, cover-ups and untrue statements by members of our government agencies (e.g. AEC, DOE, NRC, NASA, etc.) and by representatives of the nuclear industry that I seek independant safety evaluations of radiation risks before I trust their accuracy."

someone like Leo Szilard

In August 1939, Leo Szilard coaxed his friend Albert Einstein into writing the famous letter that initiated the Manhattan Project. On March 25, 1945, Szilard again coaxed Einstein to write another letter -- his fourth -- to President Roosevelt, this time about the "lack of adequate contact" between scientists "who are doing this work and those members of your Cabinet who are responsible for formulating policy." Roosevelt died April 12, 1945, never having been shown the letter.The atomic bomb was used against civilians -- and against many scientists' unheard better judgment -- on August 6, 1945. A new age of global terror and lack of reason had begun.

someone like Doug Rokke

Doug Rokke has taught graduate courses in environmental science, environmental engineering, nuclear physics, and emergency management. Major Rokke has been subjected to ongoing retaliation from Department of Defense officials. They do not want information getting out regarding adverse health and environmental effects of uranium weapons, as well as their own mandatory requirements to provide medical care to *all* casualties, and to clean up *all* environmental contamination.

someone like Richard Webb

The author of The Accident Hazards of Nuclear Power Plants (1976). Webb earned a baccalaureate degree in Engineering Physics in 1962, and a doctorate in Nuclear Reactor Physics and Engineering in 1972. His doctoral research dissertation investigated explosive power transients in fast breeder reactors.

From 1963 to 1967 he served in the US AEC Division of Naval Reactors as a Junior Engineer for the reactor part of Shippingport -- the first "civilian" reactor. He received further reactor education at Bettis and KAPL, but when working at Big Rock Point (an old BWR), he quit in order to be able to do independent analysis.

someone like Oscar Shirani

Until Shirani was fired for telling the truth, he had no interest in the so-called "anti-nuclear" movement and simply did his job as an inspector at a dry cask storage manufacturer.

But when one area after another that he looked into had problems -- from bad welds to uninspected parts to substandard alloys, broken bolts, etc. -- he called for outside help from the Nuclear Regulatory Commission. He found one guy there who would listen -- but then the NRC ignored their own expert!

Although Oscar Shirani did not consider himself anti-nuclear, he said he was MORE worried about the safety of the nuclear plants than the activists, because he was from inside and knew how the nuclear industry was run: "By a bunch of crooks and mafia types who are willing to sell their mother for money."

someone like Jack Shannon

Jack Shannon designed nuclear propulsion reactors for the U.S. Navy, including the most widely-used design, the D1G. But when he saw asbestos-related health problems among the workers and fraudulent practices among the management at Knoll's Atomic Power Laboratories (KAPL) where he was director of plant safety, he began to realize that the entire framework of the nuclear navy and its prime contractors such as General Electric was designed so that real problems could be ignored at every level. Not only was no one in charge actually responsible for their mistakes, but if you complained, their only interest was in stifling your complaint.

someone like Hyman Rickover

When Admiral of the Navy Hyman George Rickover was 82, and giving his farewell address to a joint session of Congress he stated, "when we go back to using nuclear power, we are creating something which nature tried to destroy to make life possible... Every time you produce radiation, you produce something that has life, in some cases for billions of years, and I think there the human race is going to wreck itself, and it's far more important that we get control of this horrible force and try to eliminate it."

So it is not appropriate to dredge up comments Rickover made long before then, and pretend his conclusion, with all he had learned, was to keep going forward with the nuclear option. It wasn't.

Yet that is what Representative Roscoe Bartlett did in 2007, to "commemorate" the 50-year anniversary of an obscure presentation Rickover made to the Minn. State Medical Association on May 14, 1957!

There are PLENTY of Alternatives to Nuclear Energy

Wind Power Works

And it's cheap, too! Cheaper than nuclear, cheaper than coal, cheaper than just about anything else on the market today, but pro-nukers will always point out (as if you always don't know) that the wind doesn't blow all the time. They'll do this, and ignore the fact that nuclear power plants are lousy "baseline" electrical power generators too, prone to long, sudden, and expensive outages, at the worst possible times.

Anyone who says all hydro is bad doesn't know all hydro

Okay, maybe they know a lot about big hydro, how it periodically floods the discharge stream in unnatural ways (this can be mitigated), how it covers up great areas of nature's beauty to store the water (clean, fresh, non-radioactive water), or even that it creates pressure on the earth's surface, and lots of dams being filled by monsoons in one place are said to be responsible for earthquakes thousands of miles away. Okay, big hydro has problems. But what about in-stream, slow-speed turbines? These are tried-and-true, and they don't gobble fish like nuclear power plants do, when they suck in millions of gallons a minute from nearby lakes, rivers, streams, etc..

If ever there is an easy "devil's choice" to make, surely any hydro option is better than the best nuclear option.

Wave Energy is Reliable

It varies in intensity but it's always there. Combined wave-and-wind offshore energy farms could provide all the energy America uses. We have thousands of miles of coastlines. These systems can, in many cases, even be placed so far offshore as to be out of sight of land.

Atmospheric Vortex Engines are ideal in many ways

These are power turbines which use natural convection and even sometimes natural heat sources or waste industrial heat sources to produce a controlled vortex (you could call it a weak, man-made tornado) above the device.

Clean coal? It costs more, and it's worth the extra cost

Coal provides about three times more electricity for America than nuclear power does. And we have a lot of it. And it's relatively inexpensive. And it can't melt down. If it's a question of the lesser of evils (and in many ways, it is), "clean coal" is more of an economic challenge than a technological challenge, unless you want PERFECTLY clean coal, which is not possible. Is coal's worst real price the carbon in the atmosphere or the coal miners and others who die digging the stuff? Or live, digging the stuff?

Biomass: It's not just Ethanol

Do you know the biggest problem with ethanol?

It's that 37,000 children a day are dying of hunger, and ethanol is made from corn. Nuclear power will not feed the hungry. Other forms of biomass (such as hemp) are available, which do not take away from the food supply. The author utilizes hemp extensively. It wears better than cotton and is far safer in a fire than nylon. It's more comfortable, too. Our founding fathers grew hemp. Simply wearing hemp *could* close a few nukes!

Solar Energy Pays Off

Did you know you can use solar power beyond Saturn? Safe, reliable, simple technology is available for all sorts of places: Rooftops, car tops, parking lot shade covers, and even the very roadways we drive on can all be turned into solar collectors.

So why aren't they? This author cannot answer *that* question!

Conservation is STILL in its infancy!

If you just go by the numbers, you could close ALL the current operating nuclear power plants simply by getting Americans to do a really serious job of conserving energy. And you CAN just go by the numbers. It would work, we just have to want to equate the events closely. Otherwise, once we've done everything we can to conserve energy, we'll still be producing nuclear waste every day, with no safe way to store it.

Geothermal -- it's worked for centuries

Geothermal power includes the simple idea of running a few pipes into the ground for more efficient building heating and cooling, which can be done virtually everywhere in America. If we really want to cut our energy usage, this is EASY. Geothermal also includes far more complex technological marvels which can provide many thousands of megawatts of power for the nation.

Tide Power is wasted twice a day

Tide comes in, tide goes out. Tide comes in, tide goes out. You can't get much more reliable than that, if you REALLY are worried about providing the citizens with so-called "baseline power."

Space-Based Mirrors are a safe use of Low Earth Orbit

The mirrors can be manufactured in space of extremely thin polymers, then aimed progressively at various places around the globe to provide a few extra hours of evening or morning light. Properly designed, it would be very cost-effective.

America CAN choose "all of the above"

HOW MUCH DOES ALL THIS COST?

Plenty.

Everywhere you look, the costs are out of control.

Government subsidies are "needed" because the costs of nuclear power are simply outrageous. And when government pays, we all pay.

In 2005, Thomas E. Capps, CEO of Dominion Resources, which operates four nuclear power plants, said a new 1400 megawatt power plant would cost $2.6 billion and take 6.5 years to build. He stated Dominion was "not going to build under those financial conditions" without massive government subsidies. But regardless, his price estimate was probably off by triple, or quadruple, or even more, when he made it.

From 1971 to 1986, Northeast Utilities experienced a 22-fold increase in the cost of constructing their nuclear power plants.

In 2005, Capps and other rich CEOs were promised loan guarantees for up to 80% of the cost of the first six new nuclear power plants. And they were given $3 billion in research and development funding. So far, it still hasn't been enough to get a new nuclear power plant started since Three Mile Island. And costs will surely skyrocket even more in the post-Bush economy.

By 1981, building a nuclear power plant took as long as 20 years. And if anything delays it, it will cost more than a million dollars a day while the problem is sorted out. The industry wants to be guaranteed income during this period, no matter how long it lasts, no matter what the reason for the delay -- even if it's negligence on their part!

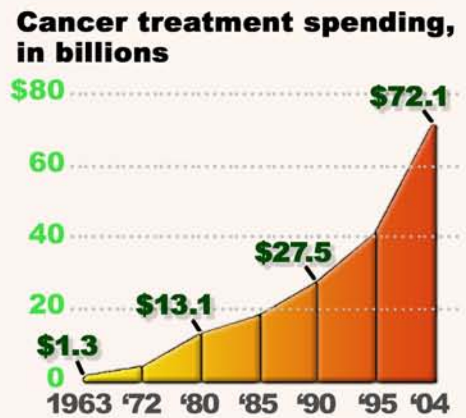
The initial cost estimate for many commercial nuclear power plants turned out to be a third or less of the actual final cost. Even then, the first units of each type were usually sold at a terrible financial loss to the manufacturer.

And there are lots of upcoming bills, too.

The estimated cost of Yucca Mountain has risen by $38.7 billion since 2001, a 67% increase. *Source: USA Today, August 2008*

The amount committed to the nuclear waste fund is $31.4 billion dollars, of which $9.5 billion has already been spent. *Source: Nuclear Energy Institute, 2008*

The only "bargain" in any of this is the deal we are making with the devil. He's gotten a great bargain!



Original Source: National Cancer Institute

$1,600: The average cost of a one-month supply of a typical cancer drug.
Source: Managed Care, Aug 2007

Colon cancer drugs over a 10 period went from $500 to $250,000. The average life expectancy went from 11 months to a little over two years.
Source: Dr. Leonard Saltz of Sloan-Kettering (published in Business Week)

. . . and that's just the cost of treatment.

There's also lost productivity, lost great people, and lost great ideas:

2005: Total cost of cancer care [including lost productivity] in the U.S.: $209.9 billion. *Source: NIH*

Has cancer cost you someone you loved? *Me too.*

Maybe radiation was responsible.

...and radiation causes many other illnesses besides cancer...

Digging Deeper

This book has only scratched the surface.

Dr. Richard Webb points out (right) that the radioactive releases from Three Mile Island went OFF THE CHART for a period of time (even though these are logarithmic scales!), and the strip chart "stops" for two critical hours. The NRC and the President's Commission misrepresented this monitor, claiming it was "onscale" when in fact it wasn't.

Dr. Webb has also done some calculations on the hazards of a spent fuel accident:

"160,000 sq. miles rendered uninhabitable due to Cs-137 alone; 338,000 sq. miles of land ruined agriculturally due to Sr-90 fallout; 200,000 sq. miles ruined by plutonium contamination alone -- a lung cancer dust hazard." Since performing those calculations, he has also concluded that radiation is a lot more harmful than he had assumed, and that in the first two days after a reactor accident, 30 to 100 million people would be seriously damaged (or killed) by radiation fallout.

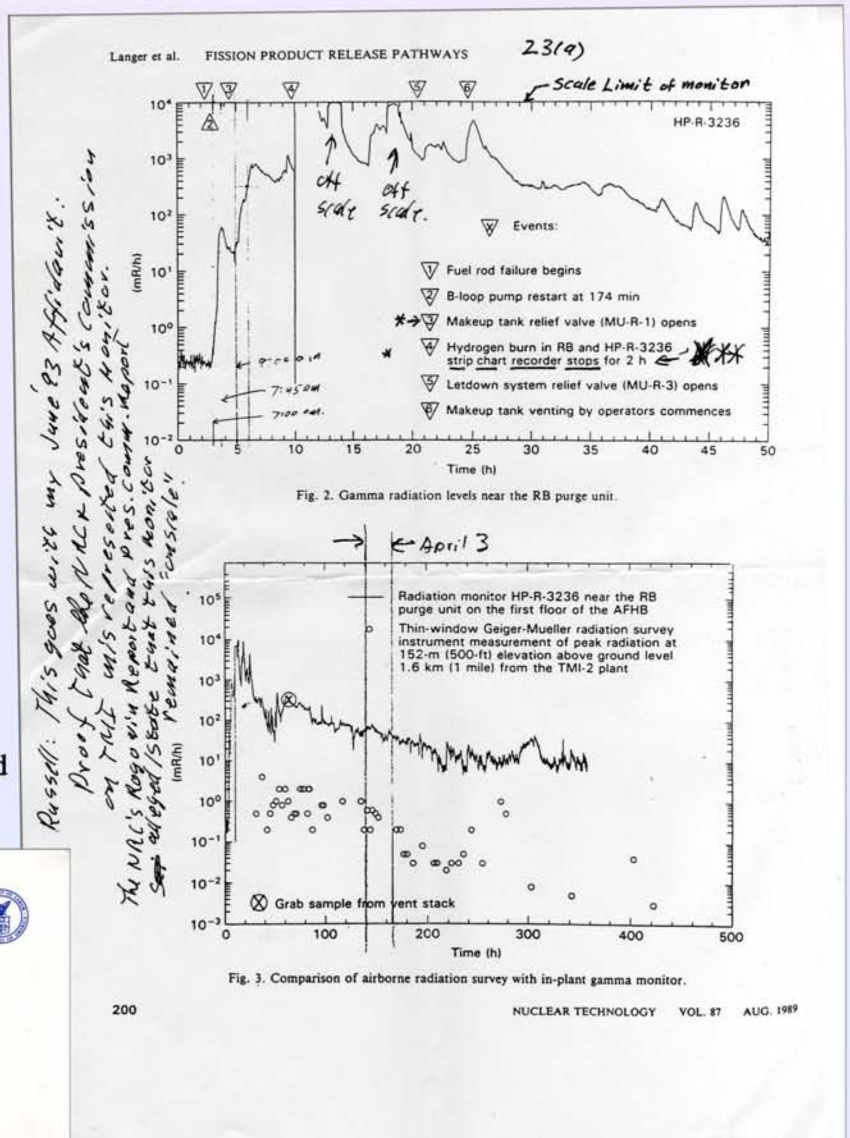
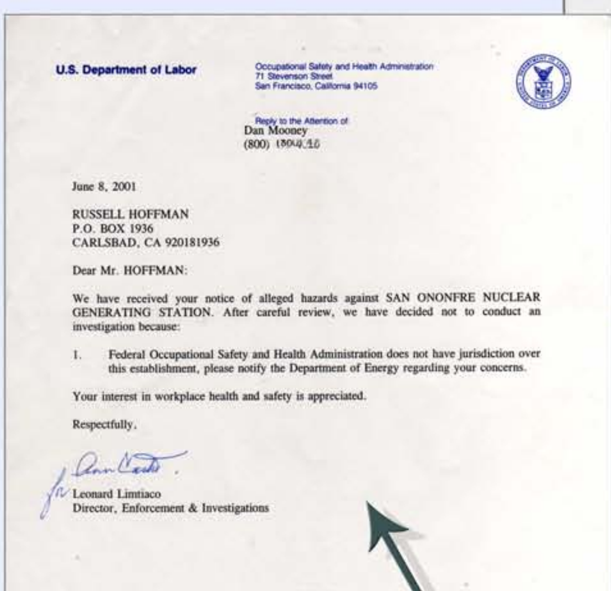

Langer et al. FISSION PRODUCT RELEASE PATHWAYS 23(a)

Fig. 2. Gamma radiation levels near the RB purge unit.

Fig. 3. Comparison of airborne radiation survey with in-plant gamma monitor.

200 NUCLEAR TECHNOLOGY VOL. 87 AUG. 1989


U.S. Department of Labor

Occupational Safety and Health Administration
71 Stevenson Street
San Francisco, California 94105

Reply to the Attention of
Dan Mooney
(800) 1804/16

June 8, 2001

RUSSELL HOFFMAN
P.O. BOX 1936
CARLSBAD, CA 920181936

Dear Mr. HOFFMAN:

We have received your notice of alleged hazards against SAN ONONFRE NUCLEAR GENERATING STATION. After careful review, we have decided not to conduct an investigation because:

1. Federal Occupational Safety and Health Administration does not have jurisdiction over this establishment, please notify the Department of Energy regarding your concerns.

Your interest in workplace health and safety is appreciated.

Respectfully,

for Leonard Limtiaco
Director, Enforcement & Investigations

Letter to author from the Department of Labor, pointing out OSHA's lack of jurisdiction at nuclear facilities.

This glow has mesmerized many...

Cerenkov Radiation

(Also called Cherenkov Radiation.)

"The Blue Glow"

Light produced by electrons rushing through the water at "greater than the speed of light in water." Seen in the Purdue University Reactor. (1-kilowatt; LEU as of Sept. 2007; known as PUR-1).

Source: Purdue University Post Card; DOE

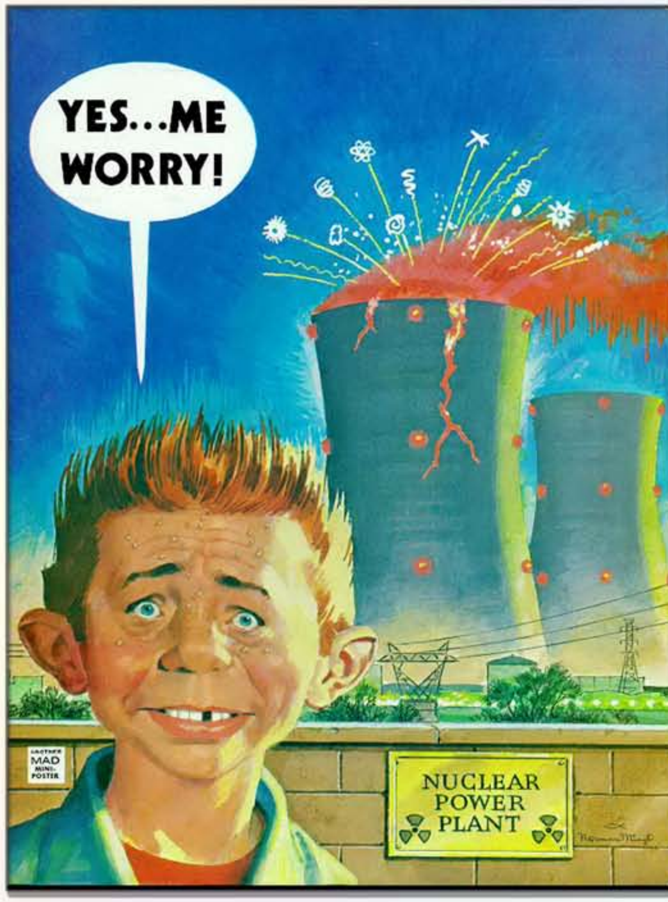
CONCLUSION

Renewables give us all the energy we need, and waiting to switch is deadly.

Some say "politics" is stopping Yucca Mountain, or stopping an expansion of nuclear power, or stopping reprocessing from restarting, or stopping "mini-nukes," nuclear airplanes, etc. etc..

But actually, politics is stopping the CLOSING of the nukes. Politicians prevent the proper public debates. Politicians pontificate from their oval offices and microphone-bedecked speaking platforms, declaring "it's politics that's prevents solutions to our energy problems."

Don't fall for yesterday's lies about nuclear power, spewed now by some politician who has never explored the issues half so much as you have by simply reading this book. The decision to use nuclear power was wrong, and MUST be rescinded. Otherwise, our species (and all the others) will die. Our DNA will be invaded, changed, destroyed. Nuclear power is useless as an energy source or as a weapon -- whether we're talking about D.U. or atomic bombs. Radiation is very dangerous and virtually useless, a few medical uses of very tiny amounts notwithstanding.



Global warming is real. It has been known for many decades, but nuclear power is no more a solution now than it was at any other time. There IS a solution: Renewable energy. Fossil fuels and nuclear power are economic disasters and then ecological disasters, each in their own way.

But pound-for-pound, nuclear power is about 100 million times worse for the planet than fossil fuels. It is not an alternative power source.

After Three Mile Island, Mad Magazine expressed the world's opinion -- the world's fears -- with the cartoon shown above. Since then, Chernobyl, Davis-Besse, and Kashiwazaki-Kariwa -- to name just three blatant examples -- have further shown that nuclear power is going to bite us very badly one day, unless . . . unless we shut down the plants and begin the long, slow process towards reducing the dangers of the waste. The author does not advocate "phaseouts." The author advocates immediate and permanent shut-down.

In a 1979 publication (included in the list that follows), a highly-honored pro-nuker called the nuclear waste problem "trivial." Right now (2008), Yucca Mountain, the only proposed solution, is deeply flawed, and expected to cost about $100,000,000,000.00. It will probably cost far more -- if it ever opens -- even if there are no accidents. This is *not* a trivial problem.

3H	Tritium.
3He	Light Helium.
6Li	A stable isotope of Lithium.

ABCC	Atomic Bomb Casualty Committee. Established in 1948 (too late!) and renamed RERF (Radiation Effects Research Foundation) in 1975.
absorbed dose	An amount of radiation, given in terms of joules per kilogram, which is the same as a gray.
AEC	Atomic Energy Commission. Forerunner of the DOE and the NRC; as inept as either.
ALARA	As Low As Reasonably Achievable. This really stands for As Low As Is Still Profitable for the corporations involved, or as low as will allow the operation to move forward as planned.
alpha particle	Two protons and two neutrons ejected together from the nucleus of an atom at very high speed. When an alpha particle slows down it will grab two electrons and be a (stable) helium atom. Alpha particles are about 7,345 times more massive than beta particles. Symbolized by the greek letter α.
AMU	Atomic Mass Unit. One 1/12th the mass of a C^{12} atom.
ARS	Acute Radiation Syndrome. The health effects which show up after a large dose of radiation has been given, accidentally or on purpose. Often extremely painful and can last weeks or even months (or minutes).
atom	For any chemical element, an atom is the minimum amount of that element that retains its chemical properties. An atom contains a nucleus, made of at least one proton and perhaps one or more neutrons. Normally it also has as many electrons as protons. The electrons can be thought of as orbiting the nucleus, and those orbits occupy most of the space of the atom.
atomic bomb	Another name for a nuclear bomb or nuclear device.
atomic number	The number of protons in the nucleus of an atom gives it its atomic number.
atomic mass	The number of protons plus the number of neutrons gives an atom its approximate atomic mass in AMUs.
atomic weight	On earth, in layman's language, the same as the atomic mass, but professionals speak almost exclusively in units of "mass" instead, so that if they're on another planet or lost in space (as many of them seem to be), or operating under different accelerations than the rest of us couch potatoes, they won't get confused.

background radiation	Typical 1940s estimate: About 100 mrem per year. Today: 360 mrem. Reason for the increase? Some say it's just due to better measuring devices and more careful observation. Most just won't mention the increase at all.
Becquerel	One Becquerel is exactly one radioactive decay per second. Abbreviated Bq.
BEIR VII Committee	Biological Effects of Ionizing Radiation #7 Committee.
beta particle	A type of ionizing radiation. Symbolized by the greek letter β. Beta particles have an electrical charge of either **-1** or **+1** and as they slow down, this charge causes most of the damage to biological systems. Because of this fact, so-called "soft" or "low-energy" beta emissions can be just as damaging as high-energy beta emissions. Once they slow down, β^- emissions become normal electrons.
bioaccumulation	The increase over time of a toxic substance in living tissue, especially when the substance (whether chemical or radioactive) concentrates in a particular part of the body. A related term, which is sometimes used interchangeably, is biomagnification. However, biomagnification is usually defined as the concentration of toxic materials via the food chain, leading to animals that eat higher in the food chain (such as humans) getting a disproportionate dose of the toxin -- another good reason to be a vegetarian. Bioconcentration is another, less commonly used, term for the overall phenomenon of an organism absorbing something toxic faster than it can eliminate that substance.
biological half-life	The average amount of time it takes for the first half of a substance to leave the body. Does not always asymptote at zero like a radiological half-life.
breeder reactor	Any reactor which produces enough Pu^{239} from the U^{238} in its core to be profitably reprocessed later for a future reactor. Usually uses "fast" neutrons.
BWR	Boiling Water Reactor. Typical BWRs in the United States are older, smaller, and less efficient than PWRs.

cancer	A type of disease that develops due to DNA damage and causes abnormal cells to proliferate uncontrollably. According to the American Cancer Society, "Cancer is the general name for a group of more than 100 diseases in which cells in a part of the body begin to grow out of control. Although there are many kinds of cancer, they all start because abnormal cells grow out of control." Note that "out of control" does not necessarily mean faster. They may die slower than normal and that can be a problem, too, for instance.
CANDU	A type of Canadian reactor which releases about 10 times more tritium into the environment than most other reactors, and produces about 30 times more.
carcinogen	Any substance or energizing ray which causes cancer.
Cassini	A space probe launched by NASA in Oct. 1997, containing a record 72.3 pounds of Pu^{238} (in dioxide form) and used as a cover for a military program of launching similar plutonium power packs into earth orbit. Russia is even worse, having launched dozens of nuclear reactors, and China is the worst of all, launching hundreds of thousands of projectiles into earth orbit, which will destroy the casings of the various radioactive power packs when they inevitably collide, since none are anywhere near strong enough to resist such impacts.
cerium-144	A beta-emitting isotope with a half-life of 285 days, ***abundantly manufactured*** in LWRs: About 60 X 10^{12} Bq/MW year of electrical power (source: JSTOR). A significant hazard in any spent fuel or reactor accident, mainly from inhalation.
cesium-137	A beta-emitting isotope with a half-life of 30.23 years. One of the most dangerous fission products of nuclear reactors.
chain reaction	A situation possible only with fissile isotopes such as U^{235} and Pu^{239}, which sustains itself, usually by neutron bombardment of other fissile atoms in the mixture. A bomb if very fast, a nuclear power plant if very slow. The maximum speed is in part determined by the blend of uranium and / or plutonium isotopes. May require a trigger to get started, such as tritium. Can be controlled, sometimes.
Chernobyl	Site near Kiev, Ukraine, of the world's worst nuclear accident (so far), in **1986**. A meltdown and explosion spread radioactive debris globally.
CIA	Central Intelligence Agency. Investigates activists' friends abroad. Passes carefully selected information, or carefully crafted rumors (depending on the perceived need of the State at the time) to foreign entities. Known to have a huge clandestine budget as well as virtually unlimited access to corporate and private computer information networks. Can control most media. Also has a nearly complete lack of normal legislative and / or judicial oversight.
cold water accident	A meltdown caused by flooding the core of a light water reactor with too much cold water. Operators are told not to do this, which isn't much protection against it.
cosmic rays	A broad spectrum of radiation coming from a wide variety of sources deep in space. About 90% of cosmic rays are protons. 90% of the rest are alpha particles. Most of the rest (~1%) are beta particles.
committed dose	The quantity of radiation expected from a given absorbed dose over the life of the radioactive materials involved.
culture of cover-up	How any apparent "culture of safety" is achieved in the nuclear industry.
cumulative dose	The total radiation received in a given period of time, for example, a lifetime. Your risk probably goes up more or less proportional to your cumulative dose, and you've already had too much radiation.
criticality	For a pro-nuker intent on making a bomb or a nuclear reactor, the moment of success. For everyone else, the moment of failure. During criticality, more energy is released as time goes on, until the available supply of fissile material is used up or the build-up of fission products poisons the reaction.
CRS	Cutaneous Radiation Syndrome. Burns and other skin inflammations due to radiation exposure. Can lead to fatal infections and be extremely painful.
curie	An amount of radioactivity defined as **$3.7 * 10^{10}$** decays per second. Not officially used anywhere, but it's still actually used everywhere, and it's still about equal to the radioactivity of one gram of pure radium. Replaced by the Becquerel (Bq).

Glossary D - F

daughter products Also called decay products, they are the isotopes, usually radioactive, which result from the decay of a radioactive substance.

Davis-Besse A PWR in Ohio which nearly melted down in 2002. The incident was almost completely ignored by the news media.

depleted uranium A mixture of around 99.5% U^{238} and the rest all sorts of other things, usually U^{235} and U^{234}, but sometimes also fission products if the DU comes from reactors. Used by the military for the ballistic and pyrophoric military advantage it gives.

deuterium An isotope of hydrogen having one neutron and one proton. Not radioactive.

dirty bomb Any bomb using conventional (non-nuclear) methods to spread radiation. The DOE defines a radiological dirty bomb as having 1,000 Curies or more of radioactivity. Thus, one nuclear power plant equals about 100,000 dirty bombs in the reactor core alone. Typical U.S. reactors release one dirty bomb every five weeks of tritium -- plus many other substances. "ALARA" allows this crime by massive dilution.

DNA Deoxyribonucleic acid. A self-duplicating polymer which contains the genetic code of life uniquely defining you. DNA is found in the nucleus of nearly every cell in your body (red blood cells and a few others have no DNA).

DOE Department of Energy. AKA "Death of the Earth Squad" because they are responsible for poisoning the planet, but not responsible for protecting it.

dose equivalent A standardized radiation amount, so one can attempt to compare different isotopes and / or different elements.

dosimeter A device for measuring how badly you were irradiated. Some are hundreds of times more accurate than others.

downwinder Anyone who has to breath radioactive poison gasses: Everyone, in varying amounts.

dry casks Dry Cask Storage is a dangerous but relatively inexpensive way to hold nuclear spent fuel. Deaths will occur as much as 500 miles downwind from a dry cask fire.

$e = mc^2$ The equation expressing the conversion factor between mass and energy. First realized by Albert Einstein.

effective dose Another way to standardize the measurement of the dose received so that assessments (and conversations) can begin. Effective dose attempts to quantify how different parts of the body react to different types of radiation. Effective dose is measured in sieverts.

electron A beta particle after it has slowed down. Also the outer subatomic particle of an atom, having an electrical charge of **-1**.

enrichment The process of lowering the U^{238} concentration while raising the U^{235} concentration.

EPA Environmental Protection Agency. A toothless federal agency which permits the DOE and NRC to do whatever they want.

eV Electron Volt. Molecular bonds are about one eV. The "thermal bath" we all live in (and which is a part of us) is about 1/40th eV. Hydrogen can be ionized (its electron can be stripped off) at about 13.6 eV.

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fallout NOT just any repercussion. Fallout is a technical term for the radioactive poison that "falls out" of the sky for days, weeks, months, years, and decades after a radioactive release, whether from a bomb, a nuclear power plant, or an accident. Whenever you hear the phrase referring to anything else, just remember it really describes the ugliest horror bestowed on civilians by war or by industry, and should be prevented at all costs.

Fat-man The first (and only) plutonium bomb used on a civilian population. Its radioactivity still kills today, and will continue to kill for many millennia.

FBI Informants in activist groups often are Federal Bureau of Investigation agents or local police. The FBI charter says public corruption is one of their top investigative priorities. But, when this author contacted them about a clear violation of the law by one of their agents, which allowed a Congressman to go free after the attempted murder (by head-on collision) of *this citizen and his wife*, he was told -- as if it were law: "We police our own."

fission Splitting the atom. Smashing the atom. Harnessing the energy of the mighty atom.

fusion Combining two atoms to make one, while releasing energy at the same time. Usually done with tritium and deuterium. Although there has been much speculation about fusion reactors, so far only fusion bombs (hydrogen bombs) exist. Except in stars.

gamma ray — One of several types of ionizing radiation, comprised of high-energy photons. Symbolized by the greek letter γ. Just like an x-ray only stronger.
Geiger counter — A device to let you know how badly you'd rather be somewhere else. It counts decays, and indicates them by a clicking noise. A common problem in an emergency is that there are so many decays, the machine stops emitting any clicks (information) at all.
genetic effect — Injury to the sperm or egg.
ground zero — Another term stolen from the nuclear vocabulary. Used universally to mean the center of attention. The original meaning of the term was the point at which a nuclear burst -- a ground burst, to be more specific -- took place.
Gy — Gray. An amount of absorbed (by a living organism) ionizing radiation equivalent to one joule of energy per kilogram of body mass.

H — Hydrogen. The lightest and most abundant element on earth, in our bodies, and in the universe.
H3 — Tritium. Also called 3H, T, H^3, H-3, etc.. Abundantly manufactured in nuclear reactors.
half-life — The average time it takes for half the atoms of a pure isotope to decay into something else.
He — Helium.
HP — Health Physics. A corrupt bunch of technicians who can calculate the effective dose, the accumulated dose, the LD50 dose, grays, rads, sieverts and so on, but cannot bear to study the effects in carefully-controlled situations to see if their founding father, Karl Z. Morgan, was correct when he denounced the then-current standards as utterly unsafe, and, of course, explained his reasons. HP has worn blinders ever since.
HEU — Highly Enriched Uranium. Generally considered to be any uranium with the U^{235} content enriched above 20%. Can be used for atomic bombs without further enrichment.
Hex — Uranium Hexafluoride (UF_6). UF_6, a hazardous substance, is concentrated to make bombs, or reactor fuel.
HLRW — High Level Radioactive Waste. Usually means spent nuclear fuel rods, but also less "hot" things like the reactor pressure vessels, and various military waste. A safe way to contain HLRW would defy the known laws of physics -- both Einstein's and Newton's.
HO — Hydrogen-Oxygen molecule. A potent free radical which is created in our bodies when tritium in a water molecule decays. Also symbolized as OH.
Hot Particle — A tiny, probably microscopic, particle made of radioactive isotopes, causing a small area of the body to experience local high doses of radiation. May lead to excess cancers.
HTO — Hydrogen-Tritium-Oxygen molecule. (Water (H_2O), but with a tritium atom for one of its hydrogen atoms.)

ICRP — International Committee on Radiological Protection.
inverse square law — A mathematical progression which describes (among other things) the proportional decline in intensity of something which is spreading out evenly in all directions from a point source. Pro-nukers always assume you don't know this. They also always assume (for the sake of arguing with you) that all actual dispersals actually follow this pattern exactly, when, in fact, none do.
ionization — The process of removing electrons from atoms (or adding electrons to atoms) with radiation or with some other energy.
ionizing radiation — Energetic emissions of light and / or high-speed particles, often emanating from the nucleus of atoms, and having enough energy to break chemical and other bonds.
isomer — Molecules having the same number of atoms in the same proportions, but different structures, are called isomers. Ionizing radiation can create different isomers of proteins and other molecules, which may be poisonous or, at best, useless. The term can also refer to similar nuclides in different states of excitation.
isotope — Atoms with the same number of protons but different numbers of neutrons are called isotopes. Some isotopes of all elements are radioactive, and some elements have no stable isotopes. Prior to the nuclear age, many of the elements on earth had no radioactive isotopes.

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jellyfish The cause of many shutdowns of coastal reactors over the years, including again today, as I create this glossary, at the Diablo Canyon plants, where one reactor's coolant system was clogged and had to be shut down, and the other was cut to half power "just in case." This is what they keep telling us is reliable baseline power!

joule A unit of measure for energy. One joule is the energy required to exert a force of one Newton through a distance of 1 meter. One joule per second equals one watt.

K40 A naturally-occurring radioactive form of potassium.

KeV Kilo-electron Volts (pronounced kay-ee-vee).

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latent period The time after a radiation exposure when you still feel fine, before a cancer or other health effect sets in. Could be decades, or seconds.

LBL Lawrence Berkeley Labs (aka LBNL).

LBNL Lawrence Berkeley National Laboratories (aka LBL).

LD50 Lethal Dose 50. When determining how toxic something is, scientists have concluded that the amount that kills everyone (every dog, every guinea pig, every cockroach) is less useful, and more difficult to establish with certainty, than the amount that will kill half of the exposed group.

LEU Low Enriched Uranium. Uranium enriched somewhat, but not above 20% U^{235} content.

Little-boy The bomb used against Hiroshima. The first intentional atomic attack on civilians.

LLNL Lawrence Livermore National Laboratories, Livermore, California.

LLW So-called Low-Level Waste. There used to be three classifications, and before that, four. Now there are just two levels of dilution: Extremely diluted waste which is still hazardous (LLW) and everything else (HLRW). LLW is also called LLRW. HLRW is also called HLW.

LOCA Loss of Coolant Accident. When the water drains out of a nuclear reactor. Presumably quickly becomes a meltdown, if it lasts very long. How long depends on such factors as: How hot the water was, how much (if any) water is left, how cold the replacement water is (if any is available), how old the fuel is, and whether the control rods insert properly.

LOFA Loss of Flow Accident. Due, for example, to pump failure. Can quickly lead to a meltdown if the right combination of other things goes wrong, too.

LRI Local Radiation Injury. What you get when you are too close to something too much like a point source.

LWR Light Water Reactor. Any reactor using water which has not had the concentration of deuterium and / or tritium increased above normal isotopic percentages.

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meltdown An overused expression which actually refers to something far worse than anything we've ever seen on Wall Street. When referring to nuclear reactors (the only proper use of the term) a meltdown is a terrible accident in which the reactor core melts and vast amounts of radioactivity are released. Chernobyl is usually described as a meltdown, while TMI is usually described as a partial meltdown. An older term for meltdown is "rapid disassembly."

MeV Million electron Volts (pronounced emm-ee-vee).

mitochondrial DNA One of two forms of DNA passed on from generation to generation. MDNA does not undergo joining of the sperm DNA with the egg DNA. Virtually all MDNA comes directly from the female. It is easily damaged by radiation.

moderator (1) A substance -- water in LWRs -- which slows neutrons in a reactor core.
(2) Someone at a meeting or hearing, usually an employee of the government, who slows down information flow and prevents free discussion.

MPC Maximum Permissible Concentration.

N	Denotes a neutron. In relation to the number of protons in a nucleus (Z), N denotes the number of neutrons in a nucleus. Different Ns for the same Z are known as different isotopes of that element.
NCRP	National Committee on Radiological Protection and Measurements.
neutron	One of the two sub-atomic particles found in the nucleus of an atom. Has a net electrical charge of zero.
neutron activation	The process of increasing the number of neutrons in the nucleus of an atom by bombarding the nucleus with neutrons.
non-stochastic effects	A health effect whose severity is related to dose, but that typically only occurs above a certain dose threshold. An example is the acute radiation sickness experienced by many people after the Hiroshima and Nagasaki bombs.
NPP	Nuclear Power Plant.
NRC	Nuclear Regulatory Commission. The federal organization which permits nuclear waste to be created and dispersed but has virtually no responsibility for human health consequences.
NTLF	National Tritium Labeling Facility, a defunct division of LBNL.
nuclear energy	An expensive, dirty, and dangerous way to boil water (sometimes sodium, etc.).
nuclear fuel cycle	All the many steps in the fuel-intensive, dangerous, and dirty process of splitting atoms to boil water.
nuclear reactor	A weapon of mass destruction which creates mountains of fission products then releases them in varying amounts and at various times.
nuclei	When talking about more than one atomic nucleus, you can say "nuclei."
nucleus	The center of an atom, made of protons and neutrons.

OH	A potent free radical, sometimes created when tritium decays, if the tritium atom was taking the place of a normal (nonradioactive) hydrogen atom in a water molecule at the time of decay.
ostrich	pro-nuker's choice of animal to imitate concerning the facts in this book.

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pCi	picoCurie, a trillionth of a curie.
photon	A discrete and measurable amount of energy emanating from ... more energy. Light. Photons have no electrical charge and no rest mass, but they do have momentum.
plume	Any deviation from a 100% even dispersal is a plume. Being inside the plume of a radiation release increases the risk for downwinders.
Po-210	Polonium-210. An alpha emitter with a half-life of about 138 days.
Price-Anderson Act	A notorious piece of legislation which negates virtually all legal right to compensation after a nuclear accident at a power reactor. Also used by NASA for space missions launched over foreign countries, and probably by the CIA (in secret) for domestic spy satellites containing plutonium.
proton	One of two components of the nucleus of an atom. Neutrons are the other. The number of protons determines the type of element each atom is.
Pu-238	An isotope of plutonium having a half-life of about 87.75 years. An alpha emitter. Used by NASA (and presumably the CIA) as a heat source for power generation; it is extremely hazardous and the containers NASA (and presumably the CIA) uses are utterly inadequate. About 280 times ***more*** carcinogenic than Pu^{239}.
Pu-239	The well-known form of plutonium, used in bombs and some reactors. An alpha emitter with a half-life of ~24,100 years. Lethal down to millionths of a gram.
PWR	Pressurized Water Reactor. About 2/3rds of all U.S. reactors are PWRs. The rest are BWRs (Boiling Water Reactors).

Q	Quality Factor. A series of assigned values estimating the radiation effect by considering which isotopes and which organs are involved. The Radiation Weighting Factor is a more modern and more accurate method.
QC	Quality Control. As far as the author can tell, this term does not appear anywhere in the nuclear industry's lexicon. Usually replaced with "Cover-up" and intimidation of workers who might think about registering complaints.

rad — Radiation Absorbed Dose. A measure of radiation equal to 0.01 Joule per kilogram, or 100 ergs per gram.

radiation — Any emission; but for this book, specifically ionizing emissions.

radiation sickness — Anything that shows after an exposure to radiation. Otherwise, pro-nukers believe you are not harmed in any way.

radiation weighting factor — This is more current (2008) than Q, and more accurate because it more carefully accounts for different exposures from different isotopes to different organs of the body. Works better with computers, too.

radioactivity — The emission of high-energy, high-speed particles and / or waves, usually from the nucleus of atoms.

radon — A noble gas emitted by uranium mine tailings and many kinds of rock. Considered especially hazardous because of its short half-life and inhalation risk.

RBE — Relative Biological Effect. Similar to Q. The mathematical relationship between the effect of a reference dose (for example, 1 rad to the whole body) and the same effect of a dose in question (for example, a piece of DU stuck in the gut). What it has most in common with Q is inexactness.

REM — Roentgen Equivalent Man. Rads times a Q factor of some sort. Inexact.

Roentgen — A measure of radioactivity named after a man named Roentgen, who was greatly admired, and still is, for discovering x-rays (and then irradiating his wife's hand). One Roentgen of beta or gamma emissions delivers a dose of one Rad, which is equivalent to 1 Rem. Old-fashioned and largely unused; replaced by the gray (gy).

RPV — Reactor Pressure Vessel. Usually about eight inches thick with a stainless steel liner.

RPVH — RPV Head -- the top of the RPV. Dr. Richard Webb has calculated that a core melt and steam explosion could blow an RPVH half a mile into the air, right through the containment dome. Weighs about 20,000 pounds and is heavily bolted down. In PWRs, the control rods come down into the reactor core through the RPVH. Rusts easily due to the extremely corrosive environment, the radiation, the heat, etc.

rubblize — To turn the reactor core into minute particles of intense heat and reactivity. Inevitably will result in a massive radiation leak and global fatalities in excess of most wars. Depending on the winds at the time, of course.

Shippingport — The United States' first "commercial" or "civilian" power reactor, came online a year after Russia's first civilian reactor, and was based on naval propulsion units. It was inefficient and prone to outages, and was used unofficially mainly for nuclear weapons production. It was finally mothballed in 1982. Neither the waste from Shippingport, nor the reactor pressure vessel, nor anything else from it has been safely disposed of, yet somehow it is presented as a shining example of a "successful" decommissioning!

SI — Systeme Internationale units, used mainly by the IAEA for additional confusion.

sievert — A unit of measure of energy absorbed by a body, equal to 100 rems. One Sv is the energy equivalent to one rad, or one gray (Gy), of x-rays. One chest x-ray is 0.1 millisieverts or less; a chest CT-scan is about 8 millisieverts (according to one British news source). CT-scans can lead to measurable increases in cancer later, especially for younger patients. When equipment is poorly maintained, it can deliver a much higher dose. The most modern dental x-ray equipment uses digital cameras and delivers less than 1/5th the typical film x-ray dose. Find doctors and dentists who care about these issues for their patients.

specific activity — The amount of radiation eminating from a given amount of a substance in a given amount of time. Usually expressed in curies per gram.

spent fuel pool — Where used nuclear reactor cores are placed after use in a reactor. Most SFPs in America are overcrowded and therefore more susceptible to fires following a loss of water. The amount of spent fuel in the pool is usually dozens of times more than is in the reactor itself, yet the SFPs have relatively little protection from jet crashes and other dangers. Somewhat safer, in this author's opinion, than Dry Cask Storage (also known as Dry Storage Casks).

SRP — Savannah River Project (now known as the SRS).

SRS — Savannah River Site (formerly known as the SRP).

stability curve — As you go up the Periodic Table of the Elements, the number of neutrons needed for stability (non-radioactivity) goes up disproportionately to the number of protons in the atom. When viewed on a chart, a gentle curve is seen.

Strontium-90 — Sr^{90} is a radioactive fission product from reactors and bombs, with a half-life of **29.1** years. Decays by beta emission into yttrium-90 (Y^{90}), which decays by beta and gamma emission with a half-life of **64** hours.

T — Tritium.

T2 — Tritium Gas.

tailings — Uranium mining waste. Releases enormous amounts of radon gas and other daughter products -- may be the main source of radon gas poisoning for many people. Large piles endanger nearby rivers with radioactive debris inundation. The Colorado River is one such threatened river.

thyroid — A gland in the neck of vertebrates (including humans) which produces hormones that primarily help to control metabolism.

TMI — Three Mile Island. Unit II was permanently damaged in 1979 during a partial core melt.

transuranic — Another fancy term to keep beginners on their toes, it just refers to elements which have more protons than uranium (which has 92 protons).

Trinity — The first atomic explosion, in Alamogordo, New Mexico. Turned desert sand to glass, night into day, and democracy on its ear.

tritium — A radioactive isotope of hydrogen having two neutrons. H^3 has a half-life of about 12.3 years. It decays by beta emission into helium. Created with wild abandon in all NPPs.

UNSCEAR — United Nations Scientific Committee on the Effects of Atomic Radiation.

U-238 — So-called "Depleted Uranium" has a half-life of 4,500,000,000 years, but will still emit a million decays per day (of alpha particles) per milligram.

U-235 — So-called "Fissile Uranium" is used for atomic bombs and reactors. All reactors except CANDU reactors use "enriched" uranium, which has a higher percentage of U^{235} than natural uranium (natural uranium is about ~**0.7%** U^{235}, **99.3%** U^{238}, and a little U^{234}).

Windscale — The worst nuclear accident on British soil; it caused a name change to Sellafield. Attempts by scientists to study the environmental damage have been consistently thwarted by the British government and the nuclear industry.

whole body exposure — Generally taken to mean exposure from something big. That is, not a point source.

Glossary X - Z

x-ray   A lower-powered energy ray than a gamma-ray, but still a strong ionizing radiation. Used by doctors to look at bones and other structures. Often over-used since they are very profitable.

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yellowcake   Uranium which has been mined, milled, and chemically processed. Usually comprised of **70%** to **90%** U_3O_8. Also called urania. “Hex” is made from yellowcake.

Yucca Mountain   A place where all the radioactive waste in America will safely and conveniently be transported, then stored at very low cost and with essentially no risk to the environment. Actually, none of the above.

Z   Often used to denote the number of protons in a nucleus when comparing the number of neutrons (denoted as N) to the number of protons. As depicted in the “stability curve,” as Z goes up, N goes up even faster, and then faster still. Above a certain Z (83), there are no known stable isotopes, though pro-nukers dream of an “island of stability” high above the highest known element. The search has yielded only jobs for those searching.

Zirconium   A pyrophoric (ignites spontaneously in air) metal used as a cladding for nuclear reactor fuel, which may contain nearly two dozen tons of this dangerous metal. Once burning, cannot be easily extinguished because water, for example, will only make things worse.

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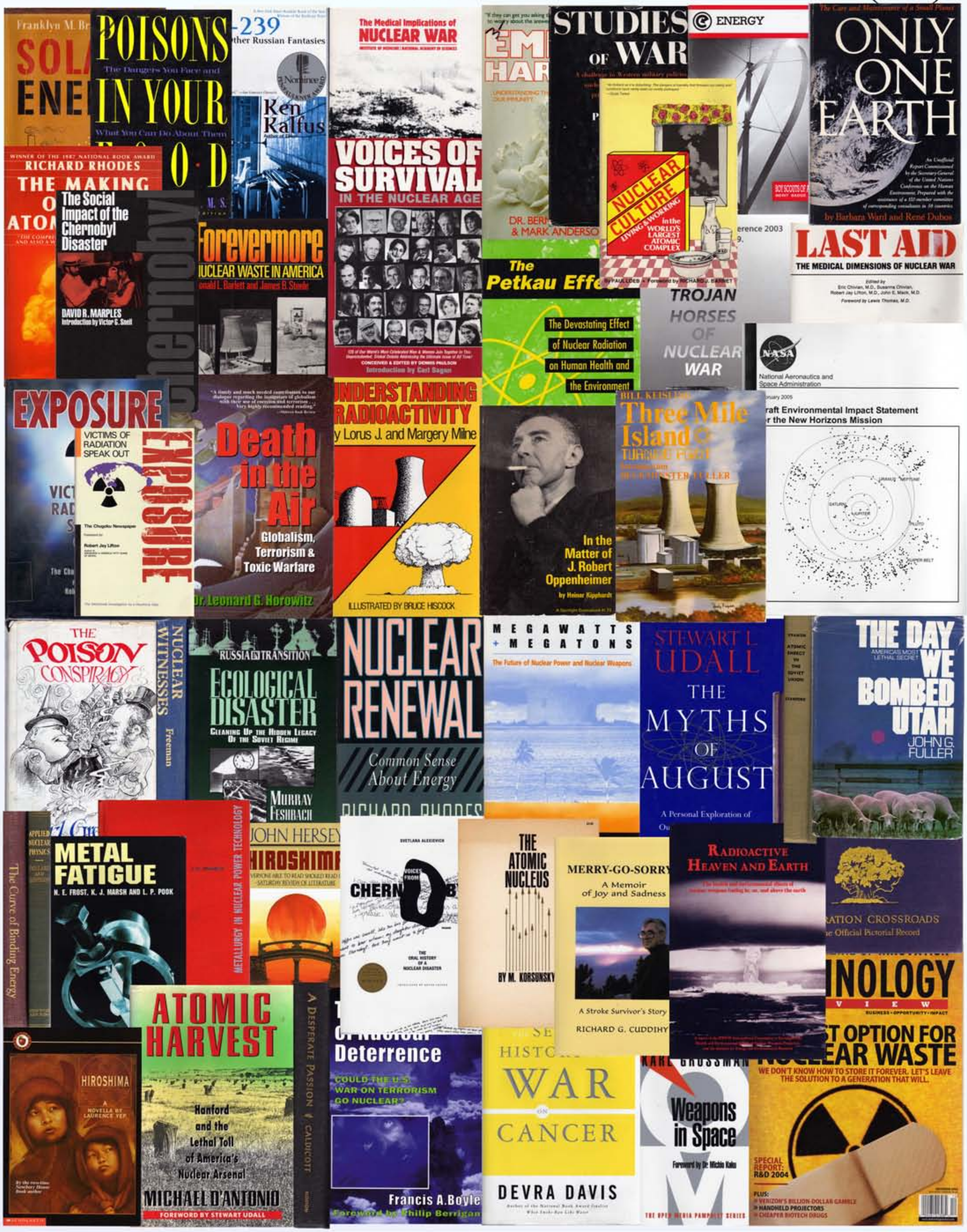

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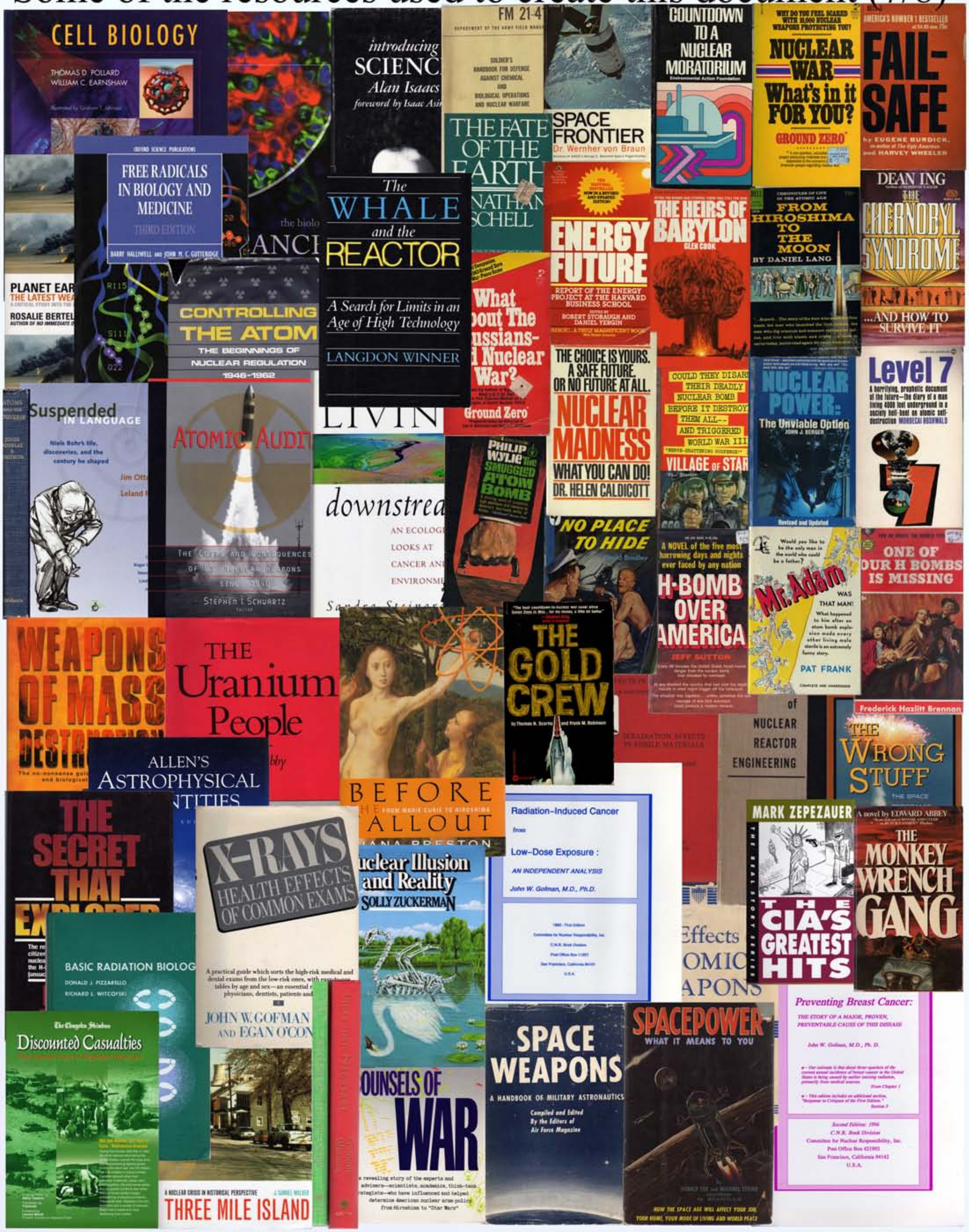

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About the Author

Ace Hoffman, b. August 14th, 1956, is a computer programmer. His educational software is used worldwide, in universities, hospitals, factories, military, EMT, nurse training, etc.. He has written software for statistics, mechanical pumps, the human heart, and his most recent program, released in 2006, is an award-winning animated interactive Periodic Table of the Elements. He is the owner of The Animated Software Co..

Hoffman is also a writer. His essays have been published by various media outlets in more than a dozen countries, plus over 100 "letters-to-the-editor." He or his work has also appeared in documentaries and on TV.

Hoffman has interviewed thousands of scientist on hundreds of topics. His free electronic newsletter, now over ten years old and almost exclusively about nuclear power, is read by scientists, lawyers, and activists, and has several hundred subscribers. The authors of more than two dozen books about nuclear issues have contributed to his newsletter and many of them are subscribers. He has interviewed -- and, more importantly, was educated by -- Karl Z. Morgan, John W. Gofman, and many other nuclear scientists from the "early days."

Hoffman has studied nuclear issues for over 35 years, and for nearly 25 years he has been a developer of educational software products. Hoffman has attended over 100 public hearings about nuclear power, and scores of other public hearings on a variety of topics. He nearly always speaks and presents documents for the officials. He has given over 100 presentations to computer user groups throughout the country. He has also created several comedy skits.

This document was created because the author recognized a need for a handy visual reference to the many complex issues involved in the debate over nuclear power. It is designed mainly to introduce new people to the issues, but also to help "old-timers" keep track of what's what, and to stop pointless arguments. Invariably, some pro-nukers will *still* challenge many of these points, but without any scientific basis. It will be just so much radioactive hot air.

The author does hope that some pro-nuke scientist will take on the task of answering this document, in its entirety, point for point, along with answering Hoffman's treatises on tritium (available at his web site: www.acehoffman.org).

Hoffman lives with his wife Sharon in Carlsbad, CA, way too close to San Onofre Nuclear Waste Generating Station.

Suggested next steps you can take today

Write your Congresspeople.

We've sent them over 150 copies of this book!

Write 'em again!

Demand they read this book!

and their staff-members, too!

Give copies of this book to friends and family.

(or tell them about the web site)

Seek reparations for radiation victims.

Join – or form – an organization.

Subscribe to the author's free electronic newsletter.

Write a letter to an editor!

Learn more.

Demand media divest itself from the mega-corporations.

Never give up!

Boycott nuclear corporations...

... and their mouthpieces.

Contacts:

Please note that there are hundreds of organizations around the world which are working on these issues. *(My apologies for not listing them all!)* Watch out for false friends, foolish goals, and fake organizations. The organizations listed here are well-known to the author.

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www.guacfund.org

CANE - Coalition Against Nuclear Energy South Africa
www.cane.org.za

Also please visit: **www.ratical.org**, where much of Dr. John W. Gofman's research has been made available online.

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(Please contact the author to have your organization added to this list. Thank you!)

Google: "**Davis Besse 2002**" ... "**Genpatsu-Shinsai**" ... etc....

Suggestions, comments, or corrections?
Please email the author: ace@acehoffman.org

This book may be downloaded (at no charge) from the author's web site. If you print it for others, you may charge enough to cover your printing costs, plus an appropriate donation for your organization.

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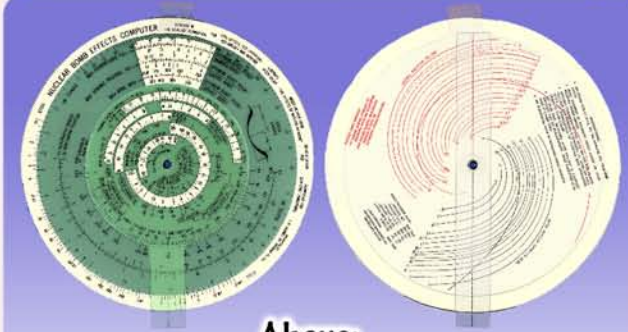
Back Cover:

Mayak was a plutonium extraction plant in Russia which blew up September 29, 1957. Estimates are that almost half a million people were poisoned with radiation; 10,000 were evacuated; and hundreds died. The area is now among the worst-polluted on earth. Yet Western authorities to this day claim they never noticed! Surely they DID notice -- but decided not to let the public know, lest it reject this terrible and dangerous technology. Mayak, appropriately enough, means "beacon."

The seeds of this project originally appeared as a booklet for California activists



Above:

Nuclear Bomb Effects Computer

These were available in the early 1960s and were used to calculate the damage that could be achieved from any given bomb size. For a digitized Nuclear Bomb Effects Computer and many other animated versions of images in this book, please go to the author's web site.

The more you know, the worse they look.

KNOW NUKES!

This document may be downloaded from the author's web site:

www.acehoffman.org