

## CHAIRMAN Resource

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**From:** Ace Hoffman <rhoffman@animatedsoftware.com>  
**Sent:** Saturday, October 07, 2017 1:03 AM  
**Subject:** [External\_Sender] Nuclear Waste Management: The view through the years...

Dear Readers,

There is a long -- if often shallow -- history of looking at the nuclear waste problem. But it's still a problem. Below is a list of books in my collection (there are undoubtedly many others) on the subject of nuclear waste, or with significant sections about nuclear waste, with dates of publication and several quotes from each one. Many other books in my collection have some mention of the problem, going back to the 1940s (most that old simply deny it's a problem, saying we'll rocket nuclear waste to the sun, drop it under the polar ice caps, bury it in deep sea trenches, or reuse it in other reactors).

These quotes show the immense difficulty of attempting to isolate radionuclides, of transporting nuclear waste, and of finding a permanent repository or even interim storage. Again and again over the decades, people were sure all these problems would be solved "soon." Yet as of today, none of them have been solved. The problems remain intractable, and the solutions are still as elusive as ever.

Note: In a few cases, I have added some comments to the quotes, which are clearly delineated.

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'Population Control' Through Nuclear Pollution (1970, Tamplin & Gofman, forward by Paul Ehrlich (Chapter 8))

Quotes:

"We are producing waste products that must be maintained in isolation from the environment for a thousand years or more. Guarding this radioactive garbage is one of the prices that future generations will have to pay, in addition to the genetic consequences they will suffer from the radioactivity which we are presently introducing into the environment, either deliberately or under the guise of waste disposal" (pg 170)

"A large nuclear electric plant producing 1000 megawatts of electrical power uses the same amount of uranium in one year as a 25 megaton uranium-fission bomb. And this means the production of strontium-90 and cesium-137 and other radioisotopes equivalent to that produced in such a 25-megaton bomb." (pg 171)

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Everyone's Trash Problem: Nuclear Wastes (1979, Hyde & Hyde)

Quotes:

"There is no way of hurrying the decay from radioactive to non-radioactive; final disposal must be by natural decay." (pg 79)

"The search for places to store high-level radioactive wastes is not new. As long ago as 1957 permanent disposal was recommended by a special committee of the National Academy of Science -- National Research Council. Since then many ideas have been explored. A well-known one is to shoot long-lived wastes into space via rocket." (pgs 80-81)

Regarding deep sea burial: "Canisters would be buried in claylike ooze that covers the ocean floor in regions that are geologically quiet. They would be dropped from winch-equipped ships and would force their way 30 meters below the floor before coming to rest." (pg87) "One area being studied is 600 miles north of Hawaii." (pg 88)

Plutonium, Power, and Politics: International Arrangements for the Disposition of Spent Nuclear Fuel (1979, Gene I. Rochlin)

Quotes:

"There is no doubt that throughout the twenty-plus-year history of commercial nuclear power...it has been the assumption of nuclear industry and nuclear agencies alike that spent reactor fuel would be reprocessed." (pg 79)  
Note: That is undoubtedly why they currently prefer monitored, RETRIEVABLE storage solutions. But: "By early 1974...[d]ifficulties were reported from all quarters from reprocessing of higher burn oxide fuels." (pg 79)

"Fresh fuel charged to [a Light Water Reactor] is made up of about 3 percent U-235 and 97 percent U-238. After its full residence in the core (about three years for a PWR, four for a BWR), the spent fuel consists (by mass) of about 95 percent U-238, 1 percent plutonium, 1 percent residual U-235, and about 3 percent light elements produced by fission of uranium and plutonium. There are also small amounts of other heavy elements, particularly neptunium, americium, and curium..." (pg 83) Note: "High Burn-up fuel contains up to 5% U-235, and after use in a reactor, contains correspondingly more fission products, plutonium, etc..

"There are in principle three options for dealing with the spent fuel. It could be treated as a waste for ultimate disposal. It could be stored offsite, in surface or subsurface facilities, for an interim period ranging from one to several decades pending a decision as to whether it should then be disposed of or reprocessed to recover the fissile content. Or it could be stored for a period ranging from a few months to perhaps a decade and then reprocessed." (pg 81)

"The safety of a mined geologic repository can be analyzed in terms of three different time periods: 1) The operational period, when the repository is open; 2) The 'thermal' period, that is, the first few hundred years after closure, during which time the radioactivity and the heat production of the wastes are dominated by the fission products; 3) The actinide decay period, which extends to several hundreds of thousands of years. (pg 99)

"The back end of the nuclear fuel cycle is clearly in disarray." (pg 100)

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Unpaid Costs of Electrical Energy (1979, William Ramsey (Chapter 5))

Quotes:

"...spent fuel is presently being stored temporarily at each reactor site, with the fuel rods immersed in pools of water. This present system is perhaps inelegant, but it would be surprising if this kind of local storage could not be continued safely over the next decades, or at least until such time as a permanent solution has been found to the waste problem." (pg 61)

"Critics of nuclear power...say that if the strontium 90 produced in one year of spent fuel were to be dispersed into river basins all over the country, it would be enough to contaminate the annual freshwater runoff of the United States to several times the acceptable limits." (pg 63)

"Storage in salt beds is not the only possibility; rock formations, ice caps, and the ocean floor have all been proposed as storage areas. Even shooting off the wastes somewhere into outer space has had its proponents." (pg 92)

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Too Hot To Handle? (1983, 3 editors)

Quotes:

"Much of the concern about plutonium arises from the facts that chemical separation of plutonium from uranium is conceptually simple and pure plutonium can be handled rather easily because of its low level of radioactivity. The separation could be carried out without appreciable difficulty were it not for the fact that plutonium discharged from light-water reactors is mixed with actinides and highly radioactive fission products." (pg 52)

"Among the possibilities for disposal sites for radioactive wastes are continental geologic formations, the sea bed, ice sheets, and space beyond the earth's atmosphere." (pgs 53-54)

"The...radioactive waste management program is now widely considered to have been seriously deficient. President Carter acknowledged that 'past governmental efforts to manage radioactive wastes have not been technically adequate. Moreover they have failed to involve successfully the States, local governments or the public in policy or program decisions.'" (pg 165)

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#### Management of Tritium at Nuclear Facilities (1984, IAEA)

Note: Tritium is a radioactive form of hydrogen. It is highly toxic.

#### Quotes:

"In BWRs the proportion of the [tritium] activity released with off-gases is 10 to 50%...[i]n PWRs 99% of the moderator and coolant activity [of tritium] is present in liquid phase, and 1% is in gaseous phase. Because of their low concentration, both gaseous and liquid tritiated effluents are released to the air after proper dilution, so the releases are much below the release levels permitted." (pg 5)

"In a gas container filled initially with T2 [(tritium gas)] the pressure increases with time from radioactive decay to He3, with the pressure ultimately reaching twice the filling pressure...the disadvantage of gas storage is the potential for [leakage] through valves. The advantage is that the tritium is easily recoverable for use at any time." (pg 28) Note: One of the main "uses" of tritium is as a trigger in nuclear weapons. It is also used in emergency exit signs, gratings for rifle scopes, etc..

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#### Nuclear Power in Crisis (1987, Edited by Andrew Blowers and David Pepper)

#### Quotes:

"As early as 1952 James Conant, the President of the American Chemical Society, asserted that nuclear energy would founder because the problem of radioactive waste disposal was insoluble. It is not surprising that a man of Conant's eminence -- a former President of Harvard University and a member of the wartime US National Defense Research Committee that was intimately involved with the Manhattan Atomic Bomb Project -- should make such a sombre and prophetic assessment, as he had direct access to the key atomic researchers of the era...Another skeptic was Professor George L. Weil who wrote in 1955: 'The beneficial prospects associated with the development of nuclear energy have been widely publicized. On the other hand, discussions of the unpleasant aspects have been limited almost exclusively to the technical meetings and publications.' (Weil, 1955). It was Weil who extracted the first fuel rod from the first atomic reactor in Chicago, December, 1942." (pg 132; this chapter was written by Andrew Blowers and David Lowry)

"The Department of Energy (DOE) is investigating potential sites in the south and west for siting a deep underground repository, which it is hoped will be operating by the end of the [20th] century. The investigation poses the question of whether the earth, 1000 to 3000 feet underground, can contain radioactivity for one million years or so without releasing it, and highlights the problem of transporting high level waste over large distances, affecting many communities en route." (pgs 178-179; this chapter was written by Marvin Resnikoff)

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#### Understanding Radioactive Waste (1989, Raymond L. Murray)

#### Quotes:

"The fuel is no longer suitable for operation in a reactor, but precautions must still be taken to avoid accidental criticality." (pg 67) "Of special interest [in designing dry storage] are the ability to remove decay heat with a safe cladding temperature and to protect the cladding against corrosion by use of an inert cover gas such as helium or nitrogen." (pg 69) "One concept is the Monitored Retrievable Storage (MRS), a large facility located geographically between the generating companies and the fuel disposal site. The fuel would be repackaged at the MRS for disposal." (pg 69) This book also describes some of the tests that transportation cask designs are supposed to survive: "...a 30-foot fall on a flat, unyielding surface...a 40-in. fall onto a metal pin 6 in. in diameter...a 30-min. exposure to a fire at a temperature of 1475 degrees F." (pg 95). (The book does not note, but it SHOULD be noted, that jet fuel burns up to 1500 degrees F., hot enough to significantly weaken steel containers. Gasoline burns at 1880 degrees F., LNG burns even hotter.)

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Site Unseen: The Politics of Siting a Nuclear Waste Repository (1990, Gerald Jacob)

Quotes:

"...efforts in the early 1970s to site a repository at Lyons, Kansas, failed -- when state geologists revealed serious problems with the site. (pg 45) "Problems at temporary storage facilities, such as the leaking Hanford tanks, gave temporary storage a bad reputation." (pg 134) "While the [Nuclear Waste Policy Act] was meant to restore public confidence in Congress and the nuclear establishment, lack of confidence in existing and future institutions was used to justify permanent disposal in a geologic repository...The poor record of nuclear management over the past thirty years left little reason to assume it would be more effective in the future." (pg 135)

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Trashing The Planet (1990, Dixie Lee Ray & Lou Guzzo (DLR signed copy))

Quotes:

"In 1968, the General Accounting Office recommended a vigorous long-term waste management program..." (pg 145)  
"...we have reached an impasse with the plan to put spent fuel into deep geological repositories. State after state has adopted the not-in-my-backyard attitude..." (pg 152)

Note: Ray believed the waste should be reprocessed to extract the "useful" fissile and industrial isotopes, and the remaining waste "should be disposed of in the ocean."(pg 153) Ray also claimed there are vast dead zones ("deserts in the sea") (pg153) and that the current natural burden of radionuclides in the oceans overwhelm anything mankind could add. Ray opposed land-based solutions including Yucca Mountain, Hanford, etc..

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The Nuclear Energy Option: An Alternative for the 90s (1983 - 1992, Bernard L. Cohen)

Cohen was sure that any and all nuclear waste solutions would be safe and feasible, at least compared to handling arsenic, and that terrorists would be more likely to bust a large dam, release a poison gas into a building's ventilation system, napalm a sports arena, or poison a city's water supply, than attack a nuclear facility (pgs 245 - 246).

Quotes:

"[w]e may eventually expect about 2 million cancers for each pound of plutonium inhaled by people." (pg 247)

"It...seems unlikely that an operating solar power plant can ever cost less than \$1,000 per peak kilowatt. Since their power output over day and night is only about 20% of the peak, this corresponds to a cost of \$5,000 per average kilowatt. The cost estimate for a new generation of nuclear power plants is under \$2,000 per average kilowatt." (pg 261). Note: In August, 2016 the average cost of PV (photovoltaic)-generated electricity was estimated to be about 15 - 20% LESS than "advanced nuclear" (source: US Energy Information Administration). The price difference is expected to continue to expand in favor of PV.

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Atomic Harvest: Hanford and the Lethal Toll of America's Nuclear Arsenal (1993, Michael D'Antonio, forward by Stewart Udall)

Quotes:

"Called the Basalt Waste Isolation Project, the dump would be the final resting place for nearly all the nation's high-level radioactive waste." (pg 31) The project was cancelled in 1987, causing the loss of 1200 jobs in the area. (pg 211)

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The Nuclear Waste Primer (League of Women Voters Education Fund, 1993 Revised Edition)

Quotes:

"In 1970, the Atomic Energy Commission tentatively selected a full-scale repository site in the salt deposits near Lyons, Kansas. The site was chosen without a formal search...the Lyons site was abandoned two years later...in 1974 the federal government again began a search for possible permanent repository sites, beginning with a survey of underground rock formations in 36 states...In February, 1983...DOE formally identified nine potentially acceptable sites located in Louisiana, Mississippi, Nevada, Texas, Utah, and Washington...in December 1984, the department

recommended further study of sites at Yucca Mountain, Nevada; Deaf Smith County, Texas; and Hanford, Washington...all three state governments opposed the study of sites within their states." (pg 49) "The Nuclear Waste Policy Act of 1982 also required DOE to identify a site for a second high-level waste repository...the search for a second site centered on granite formations in 17 eastern, southern, and midwestern states...Most of the hearings were contentious..." (pgs 49-50)

"The 1987 Nuclear Waste Policy Amendments Act did authorize DOE to site and construct a monitored retrievable storage facility, with strong restrictions. The department cannot select an MRS site until a permanent repository site has been recommended, and construction cannot begin until the NRC has issued a construction license for a repository. Only a limited amount of spent fuel can be stored at any time -- spent fuel equivalent to 10,000 metric tons of heavy metal before a repository is operating and 15,000 metric tons of heavy metal when a repository is operating." (pg 54)

"As of 1992, four counties and 16 Indian tribes had applied for grants to study the feasibility of locating a storage facility within their jurisdictions; three counties and seven tribes were awarded grants. However, one county and four tribe subsequently withdrew from the process. DOE initially decided not to conduct a siting process of its own but to rely on the voluntary process...to identify a site for an MRS in time for a facility to be operating by January 1998." (pg 54)

The Primer has a table, courtesy Worldwatch Institute, December, 1991, listing sixteen countries' target dates for their high-level waste burial programs. The earliest date given was Germany, 2008, followed by the U.S. and France, 2010 (two, Russia and China, did not provide estimates). (pg 63)

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Environmental and Ethical Aspects of Long-Lived Radioactive Waste Disposal (Proceedings of an International Workshop organized by the Nuclear Energy Agency in co-operation with the Environmental Directorate, OECD, Paris, September, 1994)

Quotes:

"...it is inappropriate to use traditional discounting techniques over long periods of time...One reason the technique does not work is simple mathematics: since the present value of future benefits declines the farther out into the future they occur, even with a very low discount rate a health benefit saving thousands of lives 10,000 years from now would have a negligible present value." (pg 130)

"[D]iscounting can lead to inequitable distribution of health benefits: 'When using a 10 percent discount rate, for example, we value 100 lives saved 30 years in the future the same as 6 lives saved in the present.'" (pg 131)

"...it is difficult to see how we can decide on a method of final disposal which is 'irreversible', irrevocable, in the sense that the need for reparability is not met to any reasonable extent. Then too, it also becomes clear that the demands for safety in operation and reparability are, in part, in conflict with each other. Safety in operation requires, at least in a certain sense, a sealed repository. Reparability requires, in a somewhat different sense, an accessible repository. The technical question of how both these requirements can be met simultaneously is still insufficiently explored." (pg 291)

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Not In My Back Yard (1994, Jane Anne Morris, published in San Diego, California)

Quotes:

"Today, the U.S. government in general, and the military branches in particular, are regarded as the perpetrators of the worst toxic cleanup mess in the nation: The problem of radioactive wastes. For a half century, the government has handled its nuclear-weapons-related projects without much interference...Public participation (except for paying for it) was next to nil." (pg 226)

"Even when national security was not an issue, Congress was often no help at all, as when it exempted the Department of Energy from OSHA (Occupational Safety and Health Administration) regulations." (pg 227) Note: DOE is still exempted.

Quotes:

"Ceramic Coatings. A thin coating (1.5 millimeters (0.06 inch) or more) of a ceramic oxide on the outer surface of the waste package could increase the life of the waste package by slowing the rate at which the waste package will corrode." (pg E-3) Note: Despite plans to leave waste in thin (5/8ths inch) stainless steel canisters for decades at reactor sites and interim storage locations, there are no plans to coat the dry casks with ceramics.

"The probability of a criticality event would be very low. This is based on the Nuclear Regulatory Commission design requirement (10 CFR Part 60) that specifies that two independent low-probability events must occur for criticality to be possible and that this requirement will be part of the licensing basis for the repository." (pg H-3)

"[A]ircraft crashes on the vulnerable area of the repository are not credible because the probability would be below  $1 \times 10^{-7}$  per year, which is the credible limit specified by DOE." (pg H-11) Note: This statement and the calculations that accompany it were written BEFORE 9-11.

"Meteorite Impact. This event would not be credible based on a strike frequency of  $2 \times 10^{-8}$  per year for a damaging meteorite...This estimate accounts for the actual area of the Waste Handling Building roof given previously..." (pg H-13)

"Sabotage...The repository would not represent an attractive target to potential saboteurs due to its remote location and low population density in the area...DOE expects that both the likelihood and consequences of sabotage events would be greater during transportation of the material to the repository..." (pg H-16) Note: What does this opinion suggest about current waste storage policies?

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Information Digest (2002, 2003 editions, Nuclear Regulatory Commission)

Quotes:

(2002 Edition): Currently, there are 20 operating independent spent fuel storage installation sites (ISFSIs) in the U.S." (pg 86)

(2003 Edition): Currently, there are 27 operating independent spent fuel storage installation sites (ISFSIs) in the U.S." (pg 86)

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The Best Option for Nuclear Waste: We Don't Know How to Store it Forever. Let's Leave the Solution to a Generation That Will (2004, Technology Review Magazine Cover Story (M.I.T.'s Magazine of Innovation))

Quotes:

"Once the fuel was underground at Yucca, it would be hot enough to boil ground water into steam. Steam could corrode the containers or break up surrounding rock, raising uncertainty about secure burial." (pg 40)

"The Nuclear Regulatory Commission has determined that an F-16's crashing into the casks...is a 'credible accident.'" (pg 44) Note: An F-16 is a relatively small aircraft.

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Too Hot To Touch (2013, Alley & Alley)

Quotes:

"The [Blue Ribbon Commission] report discussed at length the underlying reasons why the US nuclear waste program is in complete disarray..." (pg 317)

"In late 1975, the newly formed ERDA [Energy Research and Development Administration] announced a reinvigorated plan to address disposal of high-level radioactive waste. The Nuclear Waste Terminal Storage Project...was ambitious.

Six repositories were to be identified...The first two...would start operating at a pilot scale by 1985...All six would be operating by the mid 1990s." (pg 178)

"On December 20, 1982...the House and Senate passed the Nuclear Waste Policy Act (NWPA)...President Reagan declared mission accomplished. 'The Act,' he proclaimed, 'provides the long overdue assurance that we now have a safe and effective solution to the nuclear waste problem.'" (pg 191)

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Decommissioning Nuclear Power Plants (2014, NRC Pamphlet)

Quotes:

"Several nuclear power plants completed decommissioning in the 1990s without a viable option for disposing of their spent nuclear fuel because the Federal Government did not construct a geologic repository as planned." Also: "After cleanup...dry cask safely stored and monitored until disposal." The pamphlet claims decommissioning fund ranging from "\$300 million to \$400 million" are adequate, but does NOT note that that amount does not cover monitoring the spent nuclear fuel "until disposal."

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The author, an independent researcher and computer programmer, has a collection of approximately 500 books and videos on nuclear issues, and has studied the problem for more than 40 years.

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