

**Recommendations Related to
U.S. Fission and Fusion Energy R&D Policy**

by

Thomas B. Cochran, Ph.D.

presented

to the

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Natural Resources Defense Council, Inc.
1200 New York Ave, NW, Suite 400
Washington, D.C. 20005
Voice: 202-289-2372
Fax: 202-289-1060
E-Mail: TCochran@nrdc.org

Fission Energy

The U.S. nuclear power industry has benefited from massive public funding subsidies and a regulatory system under the Nuclear Regulatory Commission (NRC) and its predecessor, the Atomic Energy Commission (AEC), that was, and still is, overwhelmingly biased in support of the development of nuclear power. As a consequence over 100 power reactors have been constructed and licensed for operation in the United States. Conventional light water reactor (LWR) types—pressurized water reactors (PWRs) and boiling water reactors (BWRs)—now represent mature technologies in the United States and abroad for generating electricity. However, neither the U.S. Government (USG) nor the nuclear industry could assure nuclear power's economic competitiveness, and now nuclear power generation represents an uneconomic and failing industry in the United States with no new domestic reactor orders during the past 20 years. Many observers, including this one, believe that the nuclear power industry has had more than its share of public subsidies, and its turn at the public feeding trough is over. Government subsidies to U.S. reactor vendors and public assistance furthering their efforts to market U.S. reactors abroad should be halted.

At the same time USG policy, and industry and government actions, have made a complete mess of the back end of the nuclear fuel cycle. Now, some 53 years after the first nuclear high level waste (HLW) was generated, we are still decades away from having a permanent geologic repository. The USG long ago assumed the responsibility for geologic disposal of commercial as well as defense HLW, but has managed the job abysmally. The Department of Energy (DOE) made a mockery of the HLW repository siting process after which Congress forced the choice of Yucca Mountain from among the DOE candidate sites. Despite having been tasked to prepare HLW licensing criteria in the late-1970s, the Environmental Protection Agency (EPA) has yet to issue a final rule. Congress in 1992 diluted EPA's authority to establish a final rule and further delayed the promulgation of a final rule by forcing EPA to adopt disposal criteria that were consistent with recommendations of the National Academy of Sciences (NAS).¹ On an annual basis since 1992 the nuclear industry has tried without success to get Congress to further erode HLW licensing requirements. Now the Yucca Mountain licensing process has become so politicized that it may never be viewed as a safe disposal site even if it is licensed for operation. If Yucca Mountain is abandoned it will likely have a severe repercussions on U.S. nonproliferation policy. Yucca Mountain is a tar baby from which the USG cannot extricate itself. At a minimum it is important that EPA standard setting authority be preserved and a final HLW rule be promulgated.

By far the greatest long-term risks associated with nuclear power use are nuclear weapon-related. The continued support of commercial use of plutonium by some countries and the resulting huge stockpiles of separated plutonium that have been, and are being, created, for example in Japan, will surely act as a barrier to very deep reductions and eventual elimination of nuclear weapons. Also, the potential illicit use of separated plutonium associated with closed

¹ See National Research Council, *Technical Basis for Yucca Mountain Standards* (Washington, D.C.: National Academy Press, 1994).

fuel cycle economies and the failure to adequately dispose of plutonium laden spent fuel represent serious long-term proliferation risks.

There are also detrimental societal impacts that can be alleviated to some extent through the use of nuclear power--the impact of regional wars involving fossil fuel suppliers, air pollution, and global warming. However, the contribution that nuclear power can or should play in alleviating these risks over the short and long term is debatable and contentious.

In the short term the extent to which nuclear power will continue to be used in the United States will be dictated by economic condition that are outside the policy purview of the USG. In the longer term if nuclear power is to become a significant alleviator of non-nuclear risks, such as global warming, either widespread public acceptance will be necessary, or alternatively, the United States will have to follow its past practice of biasing the regulatory processes or move closer to the Japanese or French model whereby the public is essentially excluded from construction and licensing decisions.

Wider public acceptance of nuclear energy will require a major shift in the public perception of the risks associated with it. This will require that the nuclear industry first put its own house in order, which is unrealistic in the near term because of the poor economic prospect for nuclear power plant sales in the United States and the polarization of the public debate over nuclear issues. If it is to occur at all it will probably require bold changes in USG policy regarding the conditions under which nuclear power use is considered acceptable. PCAST must decide whether it is prepared to recommend bold, as opposed to evolutionary, changes in nuclear policy.

The principal problems with nuclear power today in order of importance are: 1) the nonproliferation risks associated with separated plutonium and the impact commercial use of plutonium will have on efforts to eliminate nuclear weapons; 2) the safety of existing commercial power reactor types, but particularly those of Russian design that do not have secondary containment structures; and 3) the lack of an adequate method of disposing of spent fuel/high level waste. The general public perception of the relative priority of these risks is probably the reverse of order assigned by NRDC and given here.

Turning first to the nuclear weapon-related issues, there is unlikely to be widespread acceptance of nuclear power, or deep reductions in strategic reserves of fissile materials for weapons as long as the community of nations assume that separated plutonium and highly-enriched uranium are acceptable materials of commerce for civil use. Moreover, if some weapon states hold on to military stocks of fissile material as a hedge against breakout by countries with large stocks of civil plutonium, then other weapon states may reserve larger numbers of weapons as a hedge against breakout by states retaining large military stocks of plutonium.

Separated plutonium and other weapon-usable materials should be treated in the same manner that the medical profession treats smallpox--as a disease to be eradicated. The current U.S. policy is ambiguous and ineffective. On the one hand the U.S. professes to be opposed to commercial use of weapon-usable materials; on the other hand the USG refuses to criticize the

commercial use of plutonium in countries with good nonproliferation credentials, e.g., U.K., France and other EURATOM countries, Japan, and Russia; the U.S. provides assistance to closed fuel cycle activities in some states, e.g., Japan; and the U.S. has refused to phase out the F and H chemical separation facilities at the Savannah River Site or the pyroprocessing (i.e., electrometallurgical spent fuel treatment) activities at Idaho National Engineering Laboratory (INEL).

The nuclear industry is unwilling to design and license something close to an "inherently safe" nuclear power plant because it would further drive up the cost of what are already uneconomical plant designs, and it might imply that existing reactors, or the newer evolutionary designs, such as the Westinghouse AP 600, are not sufficiently safe. At last year's Moscow Safety Summit, Russian Ministry of Atomic Energy's claim that Chernobyl-type RBMKs, which have no secondary containment structures, could be made safe with a little Western financial assistance, went unchallenged by the G-7 participants. DOE is currently subsidizing safety improvements at RBMKs without criticizing the continued reliance on unsafe reactors of Russian design. We would support a small DOE funded research effort into reactor concepts that rely on a once-through fuel cycle and are designed to minimize the residual plutonium left in the spent fuel. Alvin Radkowsky's Thorium Reactor, which incorporates a uranium/plutonium seed-fuel driven thorium blanket, is such a concept.²

The U.S. fission energy R&D program, embodied in DOE's Office of Nuclear Energy, Science and Technology (DOE/NE), is a collection of disparate programs, most of dubious value. One of these is the "Nuclear Energy Security." FY 1997 represents the final year of funding for R&D subsidies to certify new advanced LWR designs under the Light Water Reactor subprogram. Instead of gracefully retiring from the field, DOE/NE has created a new subprogram, "Nuclear Energy Security," at virtually the same level of funding (\$40 m requested for FY 1998) to subsidize the continued operation of existing nuclear reactors beyond their current licensing period. For reasons already indicated this subprogram should be terminated except for a small effort to extended fuel burnup, which has useful nonproliferation value. The Senate Appropriations Committee has denied the FY 1998 budget request for Nuclear Energy Security. We are unsure what action the House will take on this matter.

The DOE/NE FY 1998 budget request includes \$47 m for the Advanced Radioisotope Power System subprogram. The objective of this subprogram is primarily to supply several radioisotope thermoelectric generators (RTGs) over the next decade to "the Departments national security customers." It appears that over one-half this budget represents a hidden source of funding to the intelligence community in the form of RTGs. The program continues to purchase Pu-238 from Russia, which provides Chelyabinsk-65 with U.S. hard currency to maintain its tritium production reactors and reprocessing programs which are not in the national security interest of the United States.

² Alvin Radkowsky, "The Nonproliferative Light Water Thorium Nuclear Reactor," Work sponsored by the Raytheon Corporation UE&C Nuclear, Philadelphia (Undated); "TRR, Radkowsky Thorium Reactor," Radkowsky Thorium Power Corporation, 1994.

It appears that the cost of Pu-238 RTGs is several tens of millions of dollars each. We question whether this program is cost effective on purely economic grounds. The program deserves a careful independent review.

Nuclear program enrollment at U.S. universities has been declining and these programs are relying heavily on the influx of foreign students and USG subsidies to stay in business. Consequently, the \$6 million FY 1998 budget request for University Nuclear Science and Reactor Support may in the long run provide a greater subsidy to foreign nuclear programs than those of the United States. This program should be investigated.

The \$25.17 million FY 1998 budget request for electrometallurgical technology is foremost a jobs program in response to heavy lobbying by the Illinois and Idaho congressional delegations. This program should be terminated.

The Fast Flux Test Facility (FFTF), part of the old Liquid Metal Fast Breeder Reactor (LMFBR) program, was shut down in 1993 and was to be dismantled. Under DOE/NE's Termination Cost subprogram FFTF is being maintained in a hot standby condition as a possible future source of tritium for weapons. Sodium cooled reactors, such as FFTF, represent an unreliable option for tritium production, and at the very least FFTF funding should fall under Defense Programs' responsibility.

Magnetic Confinement Fusion

As a consequence of severe Congressional mandated budget cuts driven by a perceived lack of progress in magnetic confinement fusion, the Department's Fusion Energy subprogram of the Office of Energy Research has been forced to restructure the magnetic fusion energy program. The program focus has shifted away from a near-term goal of constructing a U.S.-based demonstration reactor to a focus on basic fusion science. The new program mission is to advance plasma science, fusion science and fusion technology through basic research.

The U.S. program is trying to maintain a role in the development of the International Thermonuclear Experimental Reactor (ITER). However, none of the four ITER partners--the European Union, Japan, Russia and the United States, which together have invested about \$1 billion in engineering design--are prepared to pay the higher cost share to host the construction and operation of ITER, or to collectively figure out how to pay for its construction, currently estimated to be on the order of \$11 billion. The ITER construction decision is likely to be delayed for two years until 2000, which will surely be its death knell.

Some fusion energy experts question whether ITER will achieve a sustained D-T burning. Others argue--and we share this view--that fusion reactors on the scale of ITER are not commercially viable, and a commitment to ITER will claim such a large share of U.S. fusion energy research funds that it will essentially preclude significant exploration of other concepts

for at least a decade.³ In our view, the magnetic fusion community indeed needs to step back and focus on basic science. The prospects for commercial magnetic fusion at present appear so dim that further reductions in the magnetic fusion budget are unlikely to have detrimental impact on U.S. energy security in the long term.

Inertial Confinement Fusion

DOE's inertial confinement fusion (ICF) program now overshadows the magnetic confinement fusion program in terms of funding. ICF R&D is funded primarily through the Department's Defense Programs, and it is primarily justified as being essential for nuclear weapons stockpile stewardship. The current focus of the program is on the construction of the National Ignition Facility (NIF). NIF construction began at the Lawrence Livermore National Laboratory (LLNL) the first of this month. While the official construction cost estimate is \$1.2 billion, when all program costs directly tied to NIF are included, it ultimately will cost about \$3.5 billion to construct and operate.

There is no consensus within the ICF and nuclear weapon design communities that NIF will achieve its design objective of demonstrating fusion ignition in the laboratory.⁴ There has been no recent review of the ICF program, including whether to construct NIF, that was independent and unbiased. In response to a suit brought by NRDC and two local organizations, the District Court in Washington, D.C. enjoined DOE from relying on the report or any other product of the National Research Council's Committee for the Review of DOE's ICF Program, because DOE and the Academy had likely violated the Federal Advisory Committee Act (FACA). The case was brought by NRDC primarily because the committee was not balanced with respect to points of view as to whether NIF construction should proceed. In our view because there is not high confidence that NIF will achieve ignition and because there is considerable more research that could be done to better determine whether NIF is likely to achieve ignition, construction of this facility is premature.

The ICF program management split between the Defense Programs and Fusion Energy under the Office of Energy Research is not conducive to the efficient development of ICF as a commercial energy source. The consensus view within the ICF community in recent years has been that a heavy ion driver offers the best prospect for achieving commercial energy through ICF. As a consequence, DOE's Office of Energy Research has been funding a heavy ion driver

³ Mark Crawford, "Fusion Experts Hit ITER, Call For Alternatives," *The Energy Daily*, July 1, 1997, pp. 1, 3.

⁴ See, for example, Lawrence Spohn, "Livermore's costly fusion laser won't fly, scientists say," *Albuquerque Tribune*, May 29, 1997, pp. A1,8.

program at the UC Berkeley Laboratory at a level of about \$5-10 million annually. The director of the KrF laser program at the Naval Research Laboratory believes the premise that a heavy ion driver offers the best prospect for commercial ICF needs to be reexamined. We agree.

**Answers to Questions from the Nuclear Task Force
of the Energy R&D Panel of the
President's Committee of Advisors on Science and Technology**

1. What will be the major issues associated with energy for the United States and the world for the next 50 years? Which of these issues are of particular importance to you or your organization, and what solutions do you advocate?

Answer: It is not possible to predict which issues associated with U.S. energy supply will be most important in the next 50 years. There may be: a) regional wars that affect oil supplies; b) another catastrophic nuclear accident; c) failure to achieve the elimination of nuclear weapons due to continued commercial use of weapon-usable nuclear materials in the energy sector; d) greater concern over greenhouse gases; e) theft of plutonium from the commercial energy sector; f) development of nuclear weapons in Iran with Russian assistance under the pretext of peaceful uses; and g) the widespread dissemination of thermonuclear weapon design information as a consequence of expanded research on inertial confinement fusion.

NRDC has promoted: a wide variety of energy conservation measures, least-cost energy planning, control of greenhouse gases, reductions in air pollutants emitted by fossil fuel technologies, protection of sensitive habitats from oil and gas exploration and development, a more balanced Federal energy R&D portfolio which has historically been tilted too heavily in favor of nuclear power, shut down of RBMK and VVER-440 reactors that have no secondary containment structures and the elimination of the commercial use of nuclear weapon-usable materials.

2. What is your view of the prospects, benefits, and risks of fission energy from today through 2025, domestically and globally? In what ways is federal support for nuclear energy adverse or beneficial to U.S. domestic and international interests?

Answer: Nuclear energy has benefited from massive U.S. government subsidies over the past forty or so years and is now a mature, uneconomic and failing industry in the United States with no new domestic reactor orders during the past 20 years. The U.S. nuclear power industry deserves no further U.S. government subsidies to prolong the operation of existing plants in the U.S., or to subsidize the export by U.S. vendors of evolutionary designed reactors and other nuclear technology.

Nuclear energy offers little prospect for meeting energy requirements in most countries. It is a growth industry in a few Asian countries such as China and Korea that are characterized by rapidly growing economies, dense populations/electricity markets, and authoritarian governments that have a history of suppressing or ignoring public opposition. The China National Nuclear Corporation currently has one of the world's worst nonproliferation records. Korea will likely emulate Japan and seek plutonium processing experience a separated plutonium stockpile based on a preference for a closed fuel cycle.

In a July 7, 1997 announcement that Dr. Clyde Frank will assume responsibility for managing activities related to international nuclear energy research and development in DOE/NE, DOE's Assistant Secretary of Energy for Environmental Management stated, "Dr. Frank will be exploring and developing opportunities for increasing DOE support for U.S. nuclear vendors in nuclear power markets in Asia and Europe."⁵ In our view, DOE should not be devoting public funds to subsidizing U.S. reactor vendor sales abroad.

3. What are the proliferation risks associated with nuclear (fission) power? What approaches should be pursued by the U.S. government to ensure maximum decoupling between weapons development and electricity generation?

Answer: The continued support of commercial use of plutonium by some countries and the resulting huge stockpiles of separated plutonium that are being created, for example in Japan Russia, France and the U.K., will act as a barrier to very deep reductions and eventual elimination of nuclear weapons. Also, the potential misuse of separated plutonium associated with closed fuel cycle economies and the failure to adequately dispose of plutonium laden wastes represent serious long-term proliferation risks.

Current USG policy is to refrain from interfering with the nuclear fuel cycle policies of our allies. DOE and State have interpreted this to mean that the U.S. should not take a strong advocacy position against commercial use of weapon-usable materials. In our judgment the U.S. should be aggressive in articulating its opposition to the commercial use of weapon-usable materials. The fission energy program should cease its promotion of nuclear reactor exports to Asia and instead restrict its activities to those that clearly have the potential to reduce proliferation risks. This could include R&D funding for more proliferation resistant reactor concepts such as Alvin Radkowsky's light water thorium reactor.

4. What have been the principal causes of nuclear power's problems in the United States? Should anything be done to address these problems? If so, what?

Answer: The principal problems with nuclear power in order of importance are: 1) lack of economic competitiveness; 2) the nonproliferation risks associated with separated plutonium and the impact commercial use of plutonium will have on efforts to eliminate nuclear weapons; 3) the safety of operating reactors, particularly those of Russian design that do not have secondary containment; and 4) the lack of an adequate method of disposing of spent fuel/high level waste. The public perception of the relative priority of the last three risks is probably the reverse of the order here, but we disagree with the public's prioritization.

These risk issues, in our view, have little to do with the problems of nuclear power in terms of prevented the continued decline in the reliance on nuclear power in the United States. Nuclear power's principal problem in the United States is that it is uneconomical. It cannot compete, for example with natural gas fired turbines. The unit size of nuclear reactors is

⁵ Alvin L. Alm, Assistant Secretary for Environment, Memorandum to all EM-Headquarters personnel, July 7, 1997.

large; and their capital cost is too high and the construction period too long relative to other electricity generating alternatives. Consequently, there is no electricity generator interest in nuclear power in the United States at this time. The biggest "enemy" of nuclear power today is the drive to deregulate of the utility industry.

During the last decade the NRC working in concert with the reactor vendors, have gutted the NRC licensing process which was already stacked hopelessly against intervenors. Effective organized opposition to nuclear power plant construction within the public interest community has all but evaporated. Consequently, there is no effective licensing impediment to nuclear power. To use an election phrase, "It the economy, stupid."

In our view the U.S. Government role should be limited primarily to solving the proliferation problem on a global scale and solving the waste problem domestically.

5. Do any of the "advanced" reactor designs meet your objections to nuclear power? If not, are there characteristics of a reactor that would, in your view, lead to acceptance?

Answer: None of the new evolutionary vendor designs impact issues related to nonproliferation and waste disposal. These new designs are not perceived by us or the anti-nuclear community as offering significant improvements in the safety of nuclear power plants.

With respect to nonproliferation, something like the Radkowsky thorium reactor may represent a significant improvement, but one should not discount the difficulty of introducing any new design into the market. In the post TMI era, the vendors have demonstrated that for economic reasons they are not prepared to develop reactor designs that approach being "inherently safe."

6. Should nuclear power be supported as a major element in addressing international greenhouse gas emissions (e.g. CO₂)?

Answer: Not with existing reactor technologies.

7. What strategies do you recommend for solving the disposal of nuclear waste?

Answer: The USG should preserve what is left of EPA's authority over development of HLW licensing criteria. DOE and NRC should be stopped from interfering in EPA regulatory authority through an interagency review process conducted in secret meeting at OMB.

8. What should be the Federal role in energy R&D in general, and in R&D for nuclear energy in particular?

Answer: As indicated above the U.S. Government should not be in the business of subsidizing mature and failing technologies. The DOE nuclear energy role should be

- primarily restricted to solving the high-level waste problem and eliminating nuclear weaponusable materials from commerce.
9. What are your views of the prospects for fusion energy, of the appropriate Federal role in its development, and of the priorities and plans of the Department of Energy's restructured fusion energy sciences program?
- Answer: See discussion in general remarks above.
10. What is your organization's involvement in research, education, and public outreach on energy and on nuclear matters?
- Answer: NRDC's Nuclear Program focuses primarily on nuclear weapon proliferation issues. NRDC also have programs that address energy conservation and utility restructuring; air pollution from fossil-fueled plants; reduction of CO₂ and other greenhouse gases; and safety of Russian designed reactors.
11. What other facts, projections, issues, or views should the Nuclear Task Force consider in its deliberations about R&D for fission and fusion energy?
- Answer: See discussion in general remarks above.
12. From what other individuals or groups should we hear?
- Answer: Bob Pollard, formerly of UCS; Richard Garwin on thorium reactors; and Scott Denman, Safe Energy Communication Council.