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July 4, 2007

Honorable Dale Klein, Chairman
Honorable Pete Lyons, Commissioner
US Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

Dear Chairman Klein and Commissioner Lyons:

The attached letter to The President discusses the importance of good management of used nuclear fuel. But it also describes problems with reprocessing concepts from scientists who do not fully understand the complexities of this technology.

As part of its "Global Nuclear Energy Partnerships" plan for management of used fuel, the Department of Energy is proposing "advanced fuel cycles" that are neither advanced nor appropriate. Presumably these proposals would be submitted to the NRC for licensing.

The NRC and its predecessor have experience with licensing and regulation of "problem" reprocessing plants. For example:

- The March 16, 1972, letter to R. N. Miller, President, Nuclear Fuel Services, incorporated from Dave Low, Director, Division of Compliance, U.S. Atomic Energy Commission, describes some of the problems with reprocessing at West Valley, NY.
- The July 5, 1974 *Midwest Fuel Recovery Plant Technical Study Report*, by C. E. Reed, Senior Vice President, General Electric Corporate Studies and Programs, and others, describes problems at Morris, IL
- Allied-General Nuclear Services officials decided not to operate the Barnwell Nuclear Fuel Plant after I told them that production at the Idaho Chemical Processing Plant that they had relied on for a determination of economic feasibility had been overstated by a factor of five, and that there were other problems.

Good NRC criteria for licensing of reprocessing plants could avoid problems. Enclosure 1 describes informal use of criteria for evaluation of an earlier DOE proposal for fuel reprocessing. Special features of the fuel recycle complex designs of DuPont based on lessons learned from experiences at the Savannah River Plant (See page 3 of the attached letter) are good criteria that would help avoid problems.

I hope that the NRC will develop and use good criteria to license reprocessing and recycle facilities and would be pleased to help. Best wishes!

Sincerely

Clinton Bastin

Clinton Bastin

cc: Dan Tedder, US Nuclear Regulatory Commission

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July 4, 2007

The President
The White House
Washington, DC 20500

Dear Mr. President

The "advanced fuel cycle technologies" proposed by the Department of Energy for Global Nuclear Energy Partnerships are neither advanced nor appropriate for reprocessing of nuclear power plant used fuels. But the plan for GNEP - nations with enrichment capability supplying fuel and receiving and reprocessing used fuel - is identical to the initial program of the US Atomic Energy Commission[1]. It should be pursued, but with best reprocessing technology.

One of the "technologies" proposed by the DOE, called "UREX +," would extract uranium from used fuel but leave plutonium with the waste. This was done for highly enriched uranium fuels in "H" Canyon at the Savannah River Plant for many years, but the small amount of plutonium in these fuels was not usable for weapons. Moreover, the plutonium remaining in used nuclear power plant fuels could be easily recovered following removal of the uranium during reprocessing, as was done for low-grade plutonium-238 on an experimental basis in H Canyon. Indefinite safeguards would be required for nuclear waste from UREX +[2].

The other "technology" proposed by the DOE is called "pyroprocessing," a process similar to that used for recovering and refining metals. Pyroprocessing would be very difficult in the remote environment needed for reprocessing, results in large losses of nuclear materials, and is virtually impossible to measure for weapons material safeguards[3].

The initial program for disposition of used fuel from nuclear plants in the US and those in other nations of US origin was to receive and store fuels in the Receiving Basin for Off-site Fuels at the Savannah River Plant and reprocess them in H Canyon. Major ports authorities in the U.S. provided clearance for import of the used fuel.

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1 I had lead responsibility for the AEC program to receive and reprocess used fuels.

2 Used nuclear fuel planned for permanent disposal at Yucca Mountain would also require indefinite safeguards, which cannot be assured. This concern has never been addressed by the DOE. The response to my comment on the Waste Repository Environmental Impact Statement was a telephone call from the Yucca Mountain Repository Office saying that my concern would not be addressed.

3 Enclosure 1 provides more information about pyroprocessing problems

Unfortunately, AEC officials had already compromised the program to receive used fuel from other nations when they published in 1957 a major report falsely claiming successful operation of the Idaho Chemical Processing Plant, invited nuclear program officials from other nations to learn about that technology and encouraged its use to reprocess used nuclear fuel.

The program for receipt and reprocessing of used fuels from U.S. nuclear power plants was cancelled in 1962 when nuclear power plant operators accepted the misinformation about the success of pilot plant technology at the ICPP and supported its use for commercial fuel reprocessing.

The failure of the ICPP had resulted in need to modify H Canyon at the SRP to reprocess highly enriched uranium fuels used for production of tritium, thus AEC officials at the SRP knew that the technology planned for commercial use was not appropriate. But we were not aware that AEC officials had encouraged other nations to use ICPP reprocessing technology. Actual reprocessing performance at the ICPP was classified, thus commercial reprocessors did not have access to accurate information.

General Electric Company built a commercial reprocessing plant at Morris, IL, with technology that was very complex. Cold testing revealed that the plant could not be operated successfully, and GE decided to cancel plans for operation[4].

Allied Chemical Company and General Atomics Company built a commercial reprocessing plant at Barnwell, S.C. based on ICPP reprocessing technology. They had relied on annual reports from Idaho that overstated ICPP productivity by a factor of five. After learning that claims of ICPP productivity had been exaggerated, ACC and GAC notified the AEC that they would not operate the plant except as a government demonstration.

General Atomics Company planned to commercialize High Temperature Gas-cooled Reactors based on a uranium-thorium fuel cycle that required reprocessing. GAC relied on cost estimates from ICPP for reprocessing that were at least a factor of ten low. When GAC learned that reprocessing would cost more, plans for HTGR commercialization were cancelled.

India detonated a nuclear explosive in 1974 with plutonium produced in the CIRUS (Canadian Isotope Reactor - United States) and recovered in a reprocessing plant built with ICPP technology. The model for CIRUS was NRX, which Canada used to produce plutonium for U.S. nuclear weapons under a mutual security agreement. The U.S. provided heavy water to moderate CIRUS as an initial supply of "U.S. Atoms for Peace."[5]

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4 Details about problems are described in *Midwest Fuel Recovery Plant Technical Study Report*, July 5, 1974, by C. E. Reed, Senior Vice President, General Electric Corporate Studies and Programs, et al.

5 My letter of June 12, 1998 to Naresh Chandra, India's Ambassador to the United States, and my letter in the May 2007 issue of *Nuclear News* provides further information.

Nuclear program leaders in Britain, France, Germany, India, Japan and the Soviet Union were aware of problems with the ICPP pilot plant reprocessing technology and the success of DuPont technology. In 1970, French reprocessors visited the U.S. with a promise of access to DuPont technology, but after their arrival, the AEC denied access. The Soviet Union gained an understanding of DuPont technology through intelligence efforts, but did not provide adequate containment. Britain had access to DuPont technology through a classified cooperative agreement, but relied on its "no maintenance" philosophy until a severe accident in 1973.

France attempted management of reprocessing by its Atomic Energy Commission and encountered serious problems. Its technology was based largely on the ICPP pilot plant reprocessing concept, with provision for rapid removal of certain more sensitive process equipment. Since creation of a corporation, COGEMA, France has improved reprocessing, and, in the absence of DuPont reprocessing technology, dominated world reprocessing activities. However, the high cost and other features of the most recent French-built reprocessing plant, that of Japan at Rokkasho Mura, raise serious questions about French technology.

After review of reprocessing successes and failures, and particularly the failures and other problems with commercial reprocessing[6], the AEC in 1974 reassigned responsibility for direction of commercial fuel reprocessing support from its Division of Reactor Development to its Division of Production, whose officials understood reprocessing. With strong support by the Edison Electric Institute Nuclear Fuel Cycle Committee, DuPont was asked and agreed to manage this program.

DuPont carried out and supported research and development by others focused on conceptual design studies for a licensed fuel recycle complex. The design studies were completed and reports provided to the DOE in November 1978. Estimated costs of the 3000 tons/year integrated fuel reprocessing/fabrication facility was $3.7 billion. Special features of this facility included:

- no access to or accumulation of separated plutonium
- rapid, remote removal and replacement of failed equipment - usually less than one day
- remote decontamination of failed equipment and repair for reuse
- rapid approach to full productivity after start of operations - a few minutes, compared to eight days at Hanford PUREX and thirty days at the ICPP
- total loss of plutonium to waste from fuel reprocessing and refabrication about 5% of that from U.S. commercial nuclear fuel reprocessing and refabrication
- nuclear wastes prepared for long-term isolation in a permanent repository; no storage of liquid wastes in underground tanks
- indefinite (hundreds of years) life of facility
- flexibility for major changes, including other types of fuels (thorium-uranium, fast reactor)
- costs for reprocessing about one-fourth of that of current reprocessing prices
- containment of radioactivity under all conditions, including credible accidents
- other features based on successful reprocessing experiences at the SRP.

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6 I provided technical leadership for this review.

Construction and operation of this facility by DuPont and sharing the technology with other nations with large nuclear power programs and the International Atomic Energy Agency would have resolved many problems and concerns.

Programs of the AEC were transferred to the Energy Research and Development Administration in January 1975. Nuclear program leaders in ERDA did not understand the complexities of reprocessing, set aside those who did, and transferred program responsibilities back to the Office of Nuclear Energy, successor to the AEC Division of Reactor Development.

Presidents Gerald Ford and Jimmy Carter carried out major policy reviews of reprocessing with no input from persons who understood the technology and what had happened that led to successes, failures, proliferation and other problems. The indefinite deferral of efficient use of nuclear energy resources and responsible disposal of nuclear wastes resulting from these reviews was a major factor that resulted in the long moratorium on new nuclear power plants in the U.S.

DOE nuclear program leaders set aside information from DuPont about reprocessing that would have resolved problems and supported use and development of laboratory concepts that had no potential for success. No information about the success-based concepts was provided to Presidents Carter or Reagan.

President Reagan was elected on a platform to support reprocessing but was unwilling to support operation of the Allied-General plant at Barnwell.

The DOE funded development of an Oak Ridge National Laboratory concept for reprocessing with the conventional PUREX process but a very complex, laboratory-type, in-place maintenance system until a cost estimate based on detailed design indicated exceptionally high cost. The ORNL program continued as collaborative development with Japan, and the complex maintenance system was incorporated in the very expensive reprocessing plant at Rokkasho Mura.

In 1990, the ORNL program was phased out in order to support development of an Argonne National Laboratory reprocessing concept that used a pyrometallurgical process that was claimed to be proliferation-resistant. An evaluation by DOE staff knowledgeable of reprocessing revealed that the concept was neither proliferation-resistant nor appropriate for reprocessing. There was no disagreement with the evaluation by DOE or ANL officials, but DOE is now supporting the concept as advanced technology (See Enclosure 1)

Existing nuclear power plants in the US and other nations use less than 1% of the energy in uranium and do not use more abundant thorium. They also produce large amounts of weapons-usable plutonium mixed with nuclear waste in used nuclear fuel. Permanent disposal of nuclear waste mixed with plutonium would require safeguards until significant decay of the plutonium, some 250,000 to 500,000 years. Since safeguards for these time periods cannot be assured, the plutonium must be removed by reprocessing. This would permit responsible disposal of nuclear waste, transmutation of plutonium by its use to produce energy and full use of nuclear materials.

Manhattan Project Director Leslie Groves recognized in 1942 that a competent chemical engineering organization was needed to design, build and operate reprocessing plants. He asked DuPont to design, build and operate the pilot reprocessing plant at Oak Ridge, TN, and production scale facilities at Hanford, WA.

President Harry S. Truman was aware of the great success of DuPont for the Manhattan Project and in 1950 asked DuPont to design, build and operate the Savannah River Plant.

Aware of the success at the Savannah River Plant and problems with reprocessing at Hanford and Idaho, the AEC in 1959 asked DuPont to manage the program for receipt, storage and reprocessing of used fuel from nuclear power plants in the US and those in other nations of US origin.

After failure of commercial reprocessing, proliferation in India and other problems resulting from use and export of laboratory reprocessing technology, the AEC in 1974 asked DuPont to manage programs for reprocessing of nuclear power plant fuels.

Manhattan project scientists were disappointed with the decision of General Groves to use DuPont for reprocessing. They believed that they had earned the right to build and operate reprocessing plants and that they were capable of doing so. Support for this belief by nuclear reactor program managers of the AEC, ERDA and DOE, combined with false claims of successes of laboratory-type reprocessing activities, have plagued nuclear power since 1962.

America needs a competent chemical engineering organization to manage reprocessing and an organization such as a "U.S. Energy and Nuclear Technology Board" that will:

- implement and support policies and programs on the basis of need determined through careful, competent assessment based on lessons learned from experiences,
- provide full and accurate information to Americans about energy and nuclear technology,
- carry out collaborative research and development with other nations for use of best systems and technology for beneficial, efficient, and safe use of nuclear technology.

You, Mr. President, leaders of Congress and leaders of nuclear power programs should ask DuPont and others with extensive experience in successful reprocessing and related technology to help create organizations to resolve long-neglected energy and nuclear technology challenges. Recent French experience in certain reprocessing techniques will be important for U.S. programs, but French facility designs should be examined carefully by those with experience in best reprocessing technology.

Note that DuPont's exceptional core values of safety, health and the environment, ethics and respect for people were major factors in success and best-ever safety, radiation protection and criticality control of reprocessing and other nuclear programs for the Manhattan Project and AEC.

I would be pleased to discuss this with you and others, provide more information or clarification and help in any way.

Best wishes!

Sincerely

Clinton Bastin

cc:
The Vice President, The White House
Honorable Sam Bodman, The Secretary of Energy
Honorable Dennis Spurgeon, Assistant Secretary for Nuclear Energy, DOE
Mr. Edward Sproat, Director, Office of Civilian Radioactive Waste Management, DOE
Honorable Nancy Pelosi, Speaker of the House of Representatives
Honorable Harry Reid, Senate Majority Leader
Honorable Jeff Bingaman, Chair, Senate Energy and Natural Resources Committee
Honorable Pete Domenici, Ranking, Senate Energy and Natural Resources Committee
Honorable John Dingell, Chair, House Energy and Commerce Committee
Honorable Joe Barton, Ranking, House Energy and Commerce Committee
Honorable Saxby Chambliss, United States Senate
Honorable John Isakson, United States Senate
Honorable Dale Klein, Chairman, US Nuclear Regulatory Commission
Honorable Pete Lyons, Commissioner, US Nuclear Regulatory Commission
Dr. Dan Tedder, US Nuclear Regulatory Commission
Honorable Sonny Purdue, Governor of Georgia
Dr. G. Wayne Clough, President, Georgia Institute of Technology
Mr. Joe Irvin, Vice President and Executive Director, Georgia Tech Alumni Association
Dr. Don Giddens, Dean, College of Engineering, Georgia Tech
Dr. Ron Rousseau, Chair, School of Chemical and Biomolecular Engineering, Georgia Tech
Dr. Nolan Hertel, Professor of Nuclear Engineering, Georgia Tech
President Jimmy Carter, The Carter Center
Mr. Charles O. Holliday, Jr., Chairman of the Board and Chief Executive Officer, DuPont
Mr. Frank L. (Skip) Bowman, President and CEO, Nuclear Energy Institute
Mr. J. Barnie Beasley, Jr., President, Southern Nuclear Company

Enclosure 1

Concerns about Pyroprocessing - a Major Nuclear Fuel Cycle Initiative of the U.S. Department of Energy

by Clinton Bastin, July 4, 2007

In 1991 I was assigned by DOE's Office of Nuclear Energy to develop criteria for evaluation of a planned demonstration of DOE's pyroprocessing fuel cycle. I visited DOE sites in Chicago and Idaho to inspect process equipment and details of the planned demonstration, and learned that plans were for a demonstration of process, not technology, and that questions of operability, maintainability, safeguardability, and containment of radioactivity - major problems with commercial reprocessing - would not have been resolved. Of greatest concern were great difficulties for material balance measurements and high plutonium losses. These findings led to a conclusion that the safeguards challenge would be difficult and the process as planned would not be proliferation-resistant nor viable for commercial nuclear fuel reprocessing and recycle. Concerns about the planned demonstration were reviewed with DOE and DOE laboratory management and technical staff without significant disagreement and are summarized below:

1. Processes to be used were similar to those used for plutonium metal processing in Atomic Energy Commission weapons programs. Much greater difficulty was experienced in plutonium metal processing than in properly designed aqueous reprocessing. Large accumulations of scrap were normal at all plutonium metal plants except for those at the Savannah River Plant where scrap was immediately redissolved and returned to reprocessing. In earlier fuel cycle experiments with pyroprocessing at Idaho, large amounts of scrap were shipped to the Idaho Chemical Processing Plant for recovery.
2. Equipment proposed for DOE pyroprocessing was much more complex than that used in aqueous reprocessing and would have been very difficult to maintain for reasonable on-stream time. In-situ manipulator type maintenance would be needed. The rapid, remote equipment replacement system used in successful reprocessing would not be appropriate.
3. Material measurement in process equipment was extremely difficult under cold, development conditions and was performed only about every year or two in the development facility. Measurement of fully irradiated fuel in a remote environment would be far more difficult, thus material accountability and safeguards would be virtually impossible.
4. High process losses (10-20%) were experienced in research equipment, particularly in the fuel fabrication step, and high process losses would have been likely elsewhere. This, combined with measurement difficulties, would make diversion of significant amounts of weapons material impossible to detect.
5. Operations in a remote environment are about three times as difficult as operations in glove boxes; operations in an inert environment are similarly more difficult. The combination contemplated for pyroprocessing might be ten times as difficult as those in aqueous reprocessing, without consideration of the more complex equipment planned for pyroprocessing. High temperatures would further increase difficulties.
6. Pyroprocessing requires use of exotic materials that are not available in forms/shapes needed. Research for materials was underway, but there is no experience base for use of these materials.
7. Inter-process transfer of nuclear materials for pyroprocessing requires physical movement of containers of nuclear material as opposed to transfer through piping in reprocessing plants that have operated successfully. The containers are not fully sealed. Thus, there is significant potential for release of contamination into the cell atmosphere.
8. Fissile plutonium is in weapons usable form and in concentrations usable for a significant nuclear explosive. Some argued that in-process materials may not be directly usable for weapons suitable for military stockpiles, but clever operators of process equipment could produce pure plutonium metal directly usable for military type nuclear explosives.