EDO Principal Correspondence Control

FROM: DUE: / / EDO CONTROL: G20040405
DOC DT: 05/21/04
FINAL REPLY:

Clinton Bastin
US Department of Energy

TO:

Clinton Bastin

FOR SIGNATURE OF : ** GRN ** CRC NO: 04-0366

DESC:

Energy Policies, Programs, Plans, Exports and
Relted Activities

ROUTING:

Reyes
Virgilio
Kane
Norry
Collins
Dean
Burns/Cyr

DATE: 06/18/04

ASSIGNED TO: NMSS

CONTACT: Strosnider

SPECIAL INSTRUCTIONS OR REMARKS:

Appropriate Action.

Template: SECY-017

E-RIDS- SECY-01

**OFFICE OF THE SECRETARY**
**CORRESPONDENCE CONTROL TICKET**

*Date Printed: Jun 17, 2004 16:22*

---

| | | | |
|---|---|---|---|
| **PAPER NUMBER:** | LTR-04-0366 | **LOGGING DATE:** | 06/15/2004 |
| **ACTION OFFICE:** | EDO | | |
| **AUTHOR:** | Clinton Bastin | | |
| **AFFILIATION:** | GA | | |
| **ADDRESSEE:** | Nils Diaz | | |
| **SUBJECT:** | Energy policies, programs, plans, exports and related activities | | |
| **ACTION:** | Appropriate | | |
| **DISTRIBUTION:** | Chairman, Comrs, OPA | | |
| **LETTER DATE:** | 05/21/2004 | | |
| **ACKNOWLEDGED** | No | | |
| **SPECIAL HANDLING:** | Made publicly available in ADAMS via SECY/EDO/DPC | | |
| **NOTES:** | | | |
| **FILE LOCATION:** | ADAMS | | |
| **DATE DUE:** | | **DATE SIGNED:** | |

EDO --G20040405

**Clinton Bastin** (Chemical Engineer, US Department of Energy, Retired)
987 Viscount Court, Avondale Estates, Georgia 30002
Telephone 404 297 2005; E-Mail clintonbastin@msn.com

May 31, 2004

Honorable Nils Diaz, Chairman
US Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

Dear Dr. Diaz:

The attached letter to the Director of the Central Intelligence Agency forwards a copy of my May 20 letter to The President (enclosed) which describes a major flaw in the organization of the US Department of Energy and predecessor agencies - national laboratory scientists who report to Federal program managers - that is similar to that of the former Soviet Union.

The letter to the Director of CIA also provides further explanation for the statement in Enclosure 1 of my letter to The President "Estimates by the Central Intelligence Agency of the number of nuclear weapons in North Korea are based on DOE laboratory estimates of plutonium produced in North Korea's graphite moderated nuclear power plant and are probably high."

A postscript points out that if the US Atomic Energy Commission had evaluated and applied lessons learned from successes and failures for disposition of used nuclear fuel, as explained in Enclosure 3 of my letter to The President, many formidable problems would have been avoided. Leaders of the United States should support criteria outlined in Enclosure 3 for disposition of used fuel from nuclear power plants throughout the world.

I hope that you will encourage The President to consider a "New Approach" for nuclear technology in the U.S. that will help resolve many problems and lead to better information for Americans about the great benefits of nuclear technology and how its dangers are best avoided.

I would be pleased to discuss this with you or provide further information. Best wishes!

Sincerely

Clinton Bastin

Clinton Bastin

**Clinton Bastin** (Chemical Engineer, US Department of Energy, Retired)
987 Viscount Court, Avondale Estates, Georgia 30002
Telephone 404 297 2005; E-Mail clintonbastin@msn.com

May 31, 2004

Honorable George Tenet, Director
Central Intelligence Agency
Washington, DC 20505

Dear Mr. Tenet:

The attached letter to The President describes a major flaw in the organization of the US Department of Energy and predecessor agencies - national laboratory scientists who report to Federal program managers - that is similar to that of the former Soviet Union. Since America works by free enterprise of competent corporations, this structure works against America's interests, often through misinformation that leads to misdirection.

Enclosure 1 describes problems resulting from this misinformation and misdirection. Item 19 points out that "U.S. intelligence and national security agencies rely on the DOE and its national laboratories for assistance in analyzing nuclear information for proliferation threat assessment and nonproliferation initiatives. Such assistance was flawed for the U.S. nonproliferation initiative with India from 1975 until late-1977, and for the proliferation threat assessment of Pakistan in 1982. Estimates by the Central Intelligence Agency of the number of nuclear weapons in North Korea are based on DOE laboratory estimates of plutonium produced in North Korea's graphite moderated nuclear power plant and are probably high." Following is an explanation of this issue:

1. I was the participant from the Savannah River Plant in 1959 and 1960 for preparation of master nuclear weapons production schedules for the United States. The activity consisted of AEC site representatives providing capability for production of nuclear and non nuclear materials and components, which determined the schedules that could be achieved for producing weapons. I provided the capability for the SRP to produce plutonium, tritium and tritium-deuterium weapons components. I was aware of power levels of Hanford graphite moderated reactors and was surprised at the low amount of plutonium produced per megawatt day (MWD) there, compared to that produced at the SRP. The amount produced in SRP reactors was 1 gram/MWD; that at Hanford, as I recall was 0.5 to 0.6 grams/MWD.

2. During the late 1960s, the Pacific Northwest National Laboratory developed a program to produce tritium in the "N" graphite-moderated reactor at Hanford and calculated the amount of tritium that would be produced. The tritium was recovered in SRP facilities. The amount recovered was about one-half of that calculated by PNNL. Special calorimetry analyses were made to ensure that no tritium had remained in target residues; none was found.

3. During several productivity runs for recovery in SRP reprocessing plants of plutonium produced in newly designed reactor charges, the amount of plutonium found was almost always at least 20% less than that calculated by reactor scientists.

4. The DOE did not consider the difference in productivity of heavy water vs. graphite moderated reactors in its design effort for a new production reactor during the Administration of President George H. W. Bush, and thus the significant difference in environmental impact. Energy Secretary James Watkins ended the program with a "No Decision" because of failure to address these differences in the environmental impact statement.

5. The DOE and its predecessors seldom evaluated successes and failures for lessons learned. When they did, lessons learned were usually later discarded.

6. If data provided to the CIA by DOE laboratory scientists indicate the amount of plutonium produced in the North Korean reactor is as much as 0.7 or 0.8 grams per megawatt day, it is almost certainly too high. Considering the limited nuclear experience in North Korea and the fact that this reactor also produces electricity, 0.4 to 0.5 grams per megawatt day is a more realistic estimate of the production of plutonium in this reactor. Content of weapons grade plutonium in used fuel would be about 0.5 grams per ton of uranium.

The threat to U.S. and global security from unsafeguarded nuclear programs in North Korean cannot be overemphasized, but best estimates of weapons capability should be used in assessing the threat and resolving challenge posed by nuclear programs in North Korea and elsewhere. I hope that you will encourage The President to consider a "New Approach" for nuclear technology in the U.S. that will lead to better information for Americans, their leaders and the intelligence community about the great benefits of nuclear technology and how its dangers are best avoided. I would be pleased to discuss this with you or provide further information.

Best wishes!

Sincerely

Clinton Bastin

PS: Note also that if the USAEC had evaluated and applied lessons learned from successes and failures for disposition of used nuclear fuel, as explained in Enclosure 3, many formidable problems would have been avoided. Leaders of the United States should support these criteria for disposition of used fuel from nuclear power plants throughout the world.

cc: The President
Honorable Colin Powell, The Secretary of State
Honorable Donald Rumsfeld, The Secretary of Defense
Honorable Spencer Abraham, The Secretary of Energy
Honorable Nils Diaz, Chairman, US Nuclear Regulatory Commission
Honorable Saxby Chambliss, United States Senate

**Clinton Bastin** (Chemical Engineer, US Department of Energy, Retired)
987 Viscount Court, Avondale Estates, Georgia 30002
Telephone 404 297 2005; E-Mail clintonbastin@msn.com

May 20, 2004

The President
The White House
Washington, DC 20500

Dear Mr. President:

Your letter of November 5, 2003, points out that America's energy issues have been long-neglected. My response describes a major flaw in the organizational structure of the US Department of Energy and predecessor agencies - national laboratory scientists who report to Federal program managers - that is similar to that of the former Soviet Union. Since America works by free enterprise of competent corporations, this structure works against America's interests, often through misinformation and misdirection.

Enclosure 1 discusses sixty years of misinformation and misdirection of national energy policies, programs, plans, exports and related activities. Enclosure 2 discusses fundamental energy issues, with emphasis on viability or non viability of energy options. Both conclude with recommendations for correction that would help avoid problems. Please note:

1. The US Department of Defense relies on corporations for its aircraft, electronics, nuclear propulsion systems for Navy ships and submarines, and other facilities, equipment and systems.

2. Nuclear power, America's safest, least polluting and potentially most abundant energy resource, was provided by corporations that built Navy nuclear propulsion systems. Improved safety and performance of these plants have been achieved by plant operators through coordinating efforts of the Institute of Nuclear Power Operations. However, there has been a de facto moratorium on new nuclear power plants in the U.S. since 1974. Major reasons for the moratorium are the lack of a responsible policy, program or plan for disposal of nuclear wastes and partitioning and transmutation of by-product fissionable (weapons-usable) materials in used nuclear fuel, and Americans that have not been fully informed about the safety and importance of well-managed nuclear power.

3. The safest and most successful program of the US Atomic Energy Commission, that for production of nuclear materials for space exploration, defense, research, and other important national programs, was managed by DuPont and directed by former US Army Corps of Engineers officers. If the initial US program for disposition of used fuel from commercial nuclear power plants had remained under DuPont management, major problems would have been avoided. During its final years, the AEC reassigned this program to DuPont. After AEC programs were transferred to the Energy Research and Development Administration, new leaders transferred programs back to laboratory management. Most leaders of successful AEC programs were set aside.

4. Most national laboratory scientists and most Federal program managers do not understand the challenges of safe, sustained operations with complex technology, lack incentives for success inherent in free enterprise, and do not carefully review successes and failures for lessons learned.

5. The used nuclear fuel planned by the DOE for permanent disposal at Yucca Mountain will contain enough plutonium to produce 100,000 nuclear weapons. This plutonium must be removed so that it can be destroyed by use in existing and advanced nuclear power plants. Permanent disposal of the fuel without removal of plutonium would be irresponsible because safeguards cannot be assured for the hundreds of thousands of years needed for full decay. The DOE has never addressed this issue.

6. The DOE has dismissed virtually all corporations that were responsible for earlier successes and has lost capability for many important activities. Loss of capability to produce tritium necessitated production of this material in commercial nuclear power plants, a serious violation of long-standing nonproliferation policies and/or practices of America and other nations.

7. The total cost to America's economy resulting from misinformation and misdirection has been many times the hundreds of billions of dollars misspent by the DOE, its predecessors and corporations relying on the misinformation. Other adverse impacts include:

- Proliferation by India and proliferation threats and problems in other nations.
- Loss of credibility of nuclear power and nuclear technology with most Americans.
- Americans that are misinformed about energy and nuclear technology issues.

8. Former Senate Energy Chairman Frank Murkowski and present Chairman Pete Domenici expressed support for my ideas for a "New Approach" that could avoid problems inherent in the DOE structure. An independent, Presidential-appointed and Senate-confirmed U.S. Energy and Nuclear Technology Board, selected to reflect different views based on substantial knowledge and expertise and who would function in an open manner, was an important recommendation. This board would ensure that Americans and their leaders are provided full and accurate information about energy and nuclear technology issues and their environmental, economic and national security consequences. Appropriate partitioning and transmutation of plutonium and disposition of highly radioactive wastes in used nuclear fuel were another important recommendation. Criteria for these are in Enclosure 3.

Mr. President, your Energy Task Force under the leadership of The Vice President was an important first step. But more is needed to overcome sixty years of misinformation and misdirection of national energy policies, programs, plans and related issues; assure continuity of success-based efforts; and avoid failures, wasteful expenditures and other problems of the past. I hope that you will support a new approach for national energy and nuclear technology programs, particularly a U.S. Energy and Nuclear Technology Board. I would be pleased to help or provide further information. Enclosure 4 is a biographical sketch.

Best wishes!

Sincerely

Clinton Bastin

Clinton Bastin

List of Recipients of Copies: See next page

**List of Recipients of Copies of Letter to the President about Long-neglected Energy Issues and Misdirected Energy Policies, Programs, Plans, Exports and Related Activities:**

The Vice President, The White House
Honorable Spencer Abraham, The Secretary of Energy
Honorable Colin Powell, The Secretary of State
Honorable Donald Rumsfeld, The Secretary of Defense
Honorable George Tenet, Director, Central Intelligence Agency
Honorable Nils Diaz, Chairman, Nuclear Regulatory Commission
Honorable William H. Frist, Senate Majority Leader
Honorable Tom Daschle, Senate Minority Leader
Honorable J. Dennis Hastert, Speaker of The House
Honorable Nancy Pelosi, House Minority Leader
Honorable Pete Domenici, Chairman, Senate Committee on Energy and Natural Resources
Honorable Joe Barton, Chairman, House Energy and Commerce Committee
Honorable Zell Miller, United States Senate
Honorable Saxby Chambliss, United States Senate
Honorable Denise Majette, United States House of Representatives
Mr. Larry Foulke, President, American Nuclear Society
Mr. Joe Colvin, President, Nuclear Energy Institute
Mr. Don Hoffman, President, and Board of Directors, Eagle Alliance
Dr. G Wayne Clough, President, Georgia Institute of Technology
President Jimmy Carter, The Carter Center

Enclosure 1

## Sixty Years of Misinformation and Misdirection of America's Energy Policies, Programs, Plans, Exports and Related Activities
by Clinton Bastin, May 20, 2004

## PROLOGUE

*The New World, 1939/1946* (Volume I of the history of the US Atomic Energy Commission), by Richard G. Hewlett and Oscar E. Anderson, Jr.(1962), describes one of the greatest technological achievements ever, the Manhattan Project of the US Army Corps of Engineers during World War II. Success of this project was made possible by an understanding by project directors of the need for competent corporations to build and operate nuclear facilities; partnership type interactions among US Army Corps of Engineers officers, the corporations and laboratory scientists; and the fact that the first use of nuclear technology was by DuPont. DuPont's core values of safety, health and the environment, ethics and respect for people have been exceptional constants since the Company was formed more than 200 years ago. Its ability to select, adapt and develop ideas from scientists for first of a kind complex technology are unequaled. But this book also describes the disappointments of Manhattan Project scientists who believed that their accomplishments had earned them the right to carry the project through to completion and that they were capable of doing so.

*History of DuPont at the Savannah River Plant*, by William P. Bebbington (1990), describes the outstanding program for production of nuclear materials for strategic nuclear deterrence, space exploration, research and other important national programs for the US Atomic Energy Commission. DuPont at SRP also achieved best-ever safety for the AEC. Critical to the success at SRP were full corporate management by DuPont, identical to that provided for its commercial plants, and former Army Corps of Engineers officers who stayed with the US Atomic Energy Commission to direct nuclear materials production programs. They explained to President Harry S. Truman the outstanding achievement by DuPont for the Manhattan Project and critical need for DuPont for the expanded effort for the AEC. DuPont responded to President Truman's personal request because of its recognition of the national importance of the effort. Partnership type interactions among officials and staff of AEC Production Division, AEC Savannah River Office and DuPont, and among officials and staff of DuPont, Los Alamos Scientific Laboratory and AEC SRO for weapons programs, were also critical for success of the effort. Full corporate management by DuPont for SRP programs was unique for AEC activities.

General Electric Company and Westinghouse Electric Company carried out research at laboratories for US Navy Nuclear Programs, built nuclear propulsion plants for Navy ships and submarines, and built the first commercial nuclear power plants, which incorporated important design features of Navy nuclear propulsion plants. GE, Westinghouse and other US corporations built additional - and successively larger - nuclear power plants in the US and many other nations. The Institute of Nuclear Power Operations, formed by nuclear power plant operators in response to the accident at Three Mile Island, has been coordinating efforts by nuclear power plant operators in the U.S. for improved safety and performance through commitment to excellence - with great success. The World Association of Nuclear Operators, formed after the accident at Chernobyl, has been coordinating similar efforts for nuclear power plants throughout the world - with similar success.

Well-managed nuclear power is humankind's safest, least polluting and potentially most abundant energy resource. But a by-product of nuclear power, used nuclear fuel, contains significant quantities of weapons usable plutonium and highly radioactive fission products. Safeguards cannot be assured for the time period needed for full decay of plutonium. Thus, it must be separated from the fission products and transmuted into non-weapons usable fission products by use as fuel in existing and advanced nuclear power plants. The fission products require long-term isolation from the biosphere.

In 1957, DuPont was assigned responsibility for disposition of used fuel from nuclear power plants in the US and those in other nations supplied by US vendors. Facilities were built to receive and store used fuel, research and design effort was carried out to modify SRP facilities to permit partitioning of plutonium from fission products so that it could be transmuted in existing and advanced nuclear power plants, negotiations were carried out with nuclear power plant operators in the US and other nations for terms and conditions for acceptance of used fuel, and approvals were obtained from major ports on the US East Coast for import of used fuel.

Unfortunately, based on misinformation and misdirection, the AEC in 1962 supported use, licensing and export of a laboratory concept for reprocessing of used nuclear fuel. This led to failure of commercial reprocessing in the US, proliferation in India, proliferation threats and problems in other nations, loss of the success-based program for disposition of used fuel, and loss of credibility for nuclear power.

During its final year, the AEC reassigned responsibility to DuPont for commercial nuclear fuel cycle programs. Facilities were designed to meet best criteria for safe, well-safeguarded and proliferation resistant management of potentially weapons usable materials and disposal of nuclear wastes.

Unfortunately, when AEC programs were transferred to the Energy Research and Development Administration, new leaders transferred responsibility back to laboratories and set aside most former Army Corps of Engineers officers experienced in direction of successful nuclear programs.

The DOE determined that used fuel should be disposed of without reprocessing, but did not address the issue that this would create geologic deposits of weapons usable material that would be accessible for use or diversion by future populations or terrorists and thus would not be a responsible action.

A moratorium on new nuclear power plants has existed in the US since 1974 because of lack of responsible programs for disposition of used fuel, transmutation of by-product weapons usable material, and permanent disposal of radioactive wastes. Yucca Mountain in Nevada is appropriate for isolation of radioactive wastes, but does not address the issue of partitioning and transmutation of plutonium and other potentially weapons usable materials, or the need for more efficient use of nuclear energy resources.

## MISINFORMATION AND MISDIRECTION BY THE DEPARTMENT OF ENERGY AND PREDECESSOR AGENCIES

Following are examples of misinformation and misdirection by the DOE and predecessor agencies, and recommendation for corrective actions:

1. In 1944, after completion of experiments by DuPont in the Clinton Reactor and Reprocessing Pilot Plant at Oak Ridge, TN, Manhattan Project Director Leslie Groves approved a "productivity" run in this facility to be operated by these scientists. According to Oak Ridge National Laboratory officials documented in the 1995 history of the ORNL Chemical Technology Division, the "first kilograms of plutonium for atom bombs were produced in the year long run in the pilot plant." This showed, as Director Alvin Weinberg would later explain to those at ORNL, "national laboratories could carry out projects that were beyond the capability of US corporations." The amount actually recovered based on accountability data was not several kilograms but about 300 grams.

2. Based on claimed high productivity of the pilot plant, the AEC selected ORNL to build and direct startup operation of the Idaho Chemical Processing Plant to reprocess all highly enriched uranium, including that for production of tritium for nuclear deterrence. ICPP failure threatened completion of nuclear deterrence, but successful modification and operation of a reprocessing plant by DuPont at the Savannah River Plant to reprocess HEU fuels resolved the problem.

The proper role of laboratories is research, not selection of research to be used or projects for use of that research in safe, sustained operations. DOE and predecessor agencies' reliance on laboratories for activities beyond their proper role is a major reason for failures, weapons proliferation, wasteful expenditures, adverse impact on America's economy and other problems.

3. Statements that commercial used fuels could be reprocessed for $17.30 per KgHM were made in the report WASH 743, issued in 1957 by the AEC Division of Civilian Applications. The report was prepared by ORNL Chemical Technology Division; costs were based on stated "successful experience at 80% productivity in the ORNL built Idaho Chemical Processing Plant." Actual ICPP productivity was about 3% and there were other problems.

Acceptance of misinformation in this report led not only to cancellation of the AEC success-based program for receipt, storage and reprocessing of used nuclear power plant fuels and support for the destined-to-failure reprocessing venture of NFS; but also to the supply of reprocessing technology for the production of unsafeguarded weapons grade plutonium in India and similar capability in other nations. These actions were also a model for subsequent actions of France for Israel, Italy for Iraq, etc., and most recently that of Dr. Kahn and his colleagues in Pakistan for Iran, Libya and North Korea.

4. The WASH 743 report addressed all of the reactor types that were being built or planned by the AEC Division of Reactor Development during the late 1950s and early 1960s, described in an article several months ago in *Nuclear News*. What this article did not explain was that these reactors were of essentially no value for nuclear power. Some failed only a few days after startup, giving nuclear power its first loss of credibility.

5. In 1954, USAEC Chairman Lewis Strauss made a prediction that electricity would be available from nuclear fusion that would be too cheap to meter. India AEC Chairman Homi Bhaba made a prediction that energy from fusion would be commercially available within twenty years. More recently, US scientists have predicted that fusion energy would be available with fifty years.

Nuclear fusion, the energy source for stars and thermonuclear weapons, occurs on a continuing basis only at the center of stars, at temperatures of many millions of degrees. This energy is contained - most of the time - by the enormous forces of gravity of stars. Comparable forces are not attainable on Earth. There is no scientific basis for a conclusion that fusion energy on Earth will ever supply energy needs.

6. In 1967 the US General Accounting Office conducted a review of nuclear waste management practices at USAEC sites. Staff of the Atlanta GAO office spent all summer at the Savannah River Plant in a thorough review, found and reported to SR AEC officials some minor problems that were corrected, and in a closeout meeting made several remarks commending SRP nuclear waste management practices.

However, the report issued by the GAO headquarters office described several dangers associated with SRP practices that did not exist. The false information in the report had been provided by AEC headquarters personnel. The Director of the GAO Atlanta office called the AEC Manager of the SR office to apologize. SR AEC and DuPont staff attempted to make corrections in the AEC report, but were only partially successful. The false information has led to wasteful expenditures to protect against dangers that do not exist, and Americans that are misinformed about dangers of nuclear wastes.

7. The AEC report and statements in 1968 that High Temperature Gas-cooled Reactor fuel could be reprocessed commercially in a facility costing about $100 million, and that an AEC demonstration of HTGR fuel reprocessing would be done at ICPP with modifications that would cost $1 million resulted in an investment of $500 million by Gulf and Shell Oil Companies (then major owners of General Atomics) for commercializing HTGRs. All of the investment was lost when careful assessments led to recognition that cost for facility modifications for demonstration would be not $1 million but $300 million, and cost of a commercial HTGR fuel reprocessing facility would be not $100 million but at least $800 million.

During this same time period, exaggerations by AEC Idaho Operations Office staff of ICPP productivity by a factor of five led to investments by Gulf and Shell Oil Companies and Allied Chemical Company of $240 million for the Barnwell reprocessing plant, which was based largely on the ORNL/ICPP design. A credible accident mentioned in the Barnwell Safety Analysis Report would have released more than a hundred times as much cesium as released at Chernobyl, from radioactive wastes stored at concentrations hundreds of times those at DOE facilities.

This misinformation led not only to problems as indicated, but also to loss of credibility of nuclear power with Gulf and Shell Oil Companies. Atlantic Richfield, Exxon, Getty, Phillips Petroleum, and other competent American corporations had similar experiences, and their earlier enthusiasm for nuclear fission technology has disappeared. Shell's brochures emphasize no involvement in nuclear.

8. Maximum allowable radiation exposure to workers is 5 REM per year, which is one-fifth of 25 REM, the threshold amount between beneficial effects from radiation and possible adverse health effects. In 1962, AEC policies were changed to require "radiation exposures as low as reasonably achievable." AEC managers and staff were told that there was no technical basis for this, that the standard of 5 REM per year would remain, and that operations and programs would not be changed. This action led to acceptance of false information that low levels of radiation were dangerous.

9. In 1975, ERDA officials cancelled the nuclear fuel cycle program developed by the AEC during its final year based on lessons learned from successes and failures, in order to support development and planned demonstration by ORNL of a reprocessing concept using a research-type maintenance system used by ANL at Idaho. The ORNL development was cancelled after expenditure of several hundred million dollars. The DOE then decided to support development and planned demonstration by ANL of its research-type maintenance system of an alternative fuel cycle process that was claimed to be proliferation resistant but was not.

10. The Oak Ridge Gaseous Diffusion Plant spent billions of dollars for gas centrifuge development for uranium enrichment, Boeing spent more for commercialization, but then DOE said no, let's develop lasers for uranium enrichment. Other nations have deployed centrifuges which have much greater energy efficiency than gaseous diffusion, and the U.S. will too some day, thirty to forty years late.

11. The August/September 1988 issue of *Technology Review*, publication of the Massachusetts Institute of Technology, contained the article "Radioactive Waste: Hidden Legacy of the Arms Race" by two anti-nuclear extremists, Robert Alvarez and Arjun Makhijani This article made false claims of great dangers, including a Chernobyl-scale accident from hydrogen in waste tanks at DOE sites. A similar article "Nuclear Waste: The $100-Billion Mess" by the same authors and with the same false and inflammatory allegations, was the entire first page of the "Outlook" section of the September 4, 1988, issue of *The Washington Post. The Post* article included the statement that it was an excerpt from the MIT publication, giving it special credibility.

The DOE had a comprehensive report from DuPont which refuted all allegations of dangers, and could have corrected the misinformation but did not. My letter to the editor of both publications with correcting information from the DuPont report and my own experiences was published in *Technology Review.* The Editor-in-Chief admitted at a meeting of the Washington, D.C. MIT Alumni Association that the article was a serious mistake. *The Washington Post* did not publish any correcting information.

Mr. Alvarez joined the staff of the Senate Governmental Affairs Committee in 1989, worked with staff of the Office of Technology Assessment to develop justification for spending hundreds of billions of dollars for "Cleanup of Nuclear Waste," and in 1993 joined the DOE as a Deputy Assistant Secretary for Environmental Restoration and National Security Policy. Shortly after Mr. Alvarez's arrival at DOE, the cost estimate for "Cleanup of nuclear waste" was raised to $400 Billion.

More than sixty billion dollars have been spent by DOE on "Nuclear Waste Cleanup" since publication of the false and misleading information in *Technology Review* and *The Washington Post* in 1988. Many billions of dollars have been spent on radioactive waste management and monitoring at Hanford since 1967. Some of the work has compromised the integrity of the stable waste configuration in old tanks and in the soil; little of value has been accomplished. All of the work has resulted in more radiation exposure and more dangers to humans than if the work were not done.

Former Energy Deputy Secretary Bill White started our initial partnership meeting in July 1994 by recalling a thought he had while on the speakers' platform for ceremonies of the completion of a multimillion dollar mill tailings removal project at Grand Junction, Colorado. He asked if the pile was a hazard where it had been, why was it not also at the new site - and if it was not a hazard, why was it moved? We both knew that the only justification for removal was jobs, promotion, power and prestige for DOE managers and staff, and profits for dirt moving companies.

12. The need for a new reactor for production of medical isotopes, plutonium-238 for space exploration and tritium to maintain the strategic nuclear deterrent has been recognized for more than twenty years. A major effort was lost during the Administration of President George H. Bush because DOE did not consider in its Environmental Impact Statement the difference in productivity and thus environmental impact of the different reactor types. The DOE then decided to use accelerators for tritium production and ignored other needs, and later decided that accelerators would not be efficient. The final decision to use commercial nuclear power plants to produce tritium was a major compromise of long-standing nonproliferation practice and/or policy of the US and other nations. There is no capability to produce plutonium-238, medical isotopes, and other nuclear materials for important national programs.

13. The Fast Flux Test Facility at Hanford, which was needed for a demonstration on an engineering scale of passive safety features of Argonne National Laboratory's Experimental Breeder Reactor-II, was shut down and scheduled for termination in order to support the ANL fuel cycle process that was claimed to be proliferation-resistant but was not.

14. The American Nuclear Society "Blue Ribbon Committee on Nonproliferation" of the Special Committee on Nonproliferation, recommended major emphasis on ANL's electrorefining process that was claimed to be proliferation resistant but was not. The electrorefining process was initially developed to recover very pure plutonium from scrap. One of the claims was that electrorefining could not be used to produce plutonium pure enough for a nuclear weapon.

15. The note of my telephone conversation with Glenn Seaborg in April 1997 discusses the success-based program for production and processing of transcalifornium elements at the Savannah River Plant while he was Chairman of the US Atomic Energy Commission, and the claims by scientists at Lawrence Berkeley National Laboratory of production of these elements by accelerators. The SRP program was subsequently cancelled by AEC Chairman James Schlesinger, and claims of LBNL scientists were later discovered to be false.

16. At the ANS meeting in New Orleans in November 2003, DOE-NE provided its report "Understanding Radiation," which says "the major effect (to humans of low level radiation) is a very slight increase in cancer risk." There is no scientific basis for this statement. Quite the contrary, there is a significant amount of scientific data indicating benefit to human health from exposure to low levels of radiation. For many years organizations within DOE and its predecessor agencies have supported false claims of dangers or problems in order to support programs that could lead to jobs, promotions, power and prestige - and increased cost and loss of credibility for virtually everything nuclear.

17. President Dwight D. Eisenhower's December 1953 vision of "U.S. Atoms for Peace" was magnificent. Its implementation by the AEC was not. Weapons grade plutonium production technology and facilities were supplied to India which resulted in weapons proliferation; laboratory-type reprocessing technology was supplied to many nations which led to proliferation threats and other problems; and weapons usable highly enriched uranium (HEU) was supplied to many nations and is a continuing problem. These actions provided a model that other nations followed and are continuing to follow that have resulted in further proliferation and proliferation threats. Recent articles by nuclear professionals to commemorate the 50th anniversary of President Eisenhower's speech imply that the AEC program was a success and resulted in reduced proliferation.

Many Americans are aware of the problems from AEC implementation of Atoms for Peace. But they are not aware that well designed and well-managed nuclear power plants that were provided to other nations by competent U.S. corporations form the basis for the international safeguards regime, which is essential to limit proliferation. They are also not aware that proper supply of US Atoms for Peace and those of other nations would have resulted in much less proliferation and proliferation threats than actually occurred. Proper supply would have limited exports to nuclear power plants; appropriate, well-conceived and well-safeguarded nuclear fuel cycle materials, services and technology to support those plants; carefully reviewed materials and technology for other important nuclear applications; and well-conceived cooperative efforts with other nations and with the International Atomic Energy Agency for multinational programs for nuclear fuel cycle support.

The Nuclear Non-Proliferation Act of 1978 limited U.S. supply of Atoms for Peace and precluded success of the U.S. nonproliferation initiative with the Government of India.

Thorough review of experiences with US Atoms for Peace for lessons learned, and application of those lessons for future policies, plans and programs, will help reduce future proliferation and proliferation threats. Unfocused research by DOE and its laboratories, who have little understanding of the challenges of nuclear fuel cycle technology needed for safe, sustained operations, will be of little value.

18. Responsible disposition of used nuclear fuel and disposal (long term isolation) of nuclear wastes are imperative for viable nuclear power, but there has been no responsible program, plan or policy for such effort since 1975. At the ANS Winter meeting in November 2003, there were three major proposals for disposition of used fuel: (1) The MIT Report, prepared by the architects of the policies of former President Jimmy Carter and which proposed creating geologic deposits of weapons usable material that would be accessible for use or diversion by future populations or terrorists; (2) The DOE proposal to follow a proven path to failure with another laboratory concept that has not been properly evaluated by those with experience in safe, sustained use of nuclear fuel cycle technology; and (3) The Georgia Tech paper to partition and transmute potentially weapons usable materials in used fuel to preclude their use for weapons, based on lessons learned from experiences. Leaders of ANS gave prominent publicity to the MIT and DOE proposals, but not to the Georgia Tech proposal.

19. U.S. intelligence and national security agencies rely on the DOE and its national laboratories for assistance in analyzing nuclear information for proliferation threat assessment and nonproliferation initiatives. Such assistance was flawed for the U.S. nonproliferation initiative with India from mid-1974 until late-1977, and for the proliferation threat assessment of Pakistan in 1982. Estimates by the CIA of the number of nuclear weapons (if any) in North Korea are based on DOE laboratory estimates of plutonium produced in North Korea's nuclear power plant and are probably high.

20. For fifty years, some nuclear program leaders have been promising that nuclear fusion - the energy of stars and thermonuclear weapons - would be producing clean, safe, renewable, commercially available energy from sea water within twenty years that would be "too cheap to meter." The twenty years was recently increased to fifty years. There is no scientific basis for these promises. It will not be possible to develop materials that will maintain strength at the energy levels of nuclear fusion. Forces comparable to gravity on stars are almost certainly not attainable on Earth. Virtually all fusion experiments and all thermonuclear weapons use tritium, which is not plentiful, not clean and difficult to contain. The only radiation overexposure to a worker at the Savannah River Plant was in a tritium facility. If controlled fusion is made to work, intense neutron bombardment, forces and temperatures would result in need for frequent replacement of equipment and structures - which would be highly radioactive.

The great concern is that promises by nuclear program leaders of unlimited energy from fusion energy are likely to be accepted by political leaders, and insufficient effort will be given to viable energy technologies - such as well managed nuclear fission technology and efficient use of nuclear materials.

21. The DOE's National Renewable Energy Laboratory does not provide full and accurate information to Americans and their political leaders about the limitations of some renewable energy technologies. For example, time operating efficiency of solar electricity generation is limited to 10 to 20%; wind energy is available at only certain locations and is limited to about 30% to 40%.

22. During the administration of President George H. Bush, Energy Secretary James Watkins wanted to support nuclear power. But the DOE National Energy Plan submitted to the White House proposed expanded use of hydropower, the most ecologically damaging of any energy resource. The proposal was rejected by the White House.

23. The editorial in the March issue of *Nuclear News* reflects strong support of ANS leaders for a renaissance of nuclear power in order to produce hydrogen. Hydrogen is difficult to handle, has a low energy density and is unlikely to become a significant energy resource.

## CONCLUSIONS AND RECOMMENDATIONS

1. The great benefits of nuclear technology have been provided to Americans by competent, experienced corporations. Scientists at AEC laboratories made important contributions for achieving these benefits when their research was carried out with full involvement of engineering managers of the competent, experienced corporations who would select specific results for use.

2. Failures, proliferation and other problems resulted from (a) laboratories attempting to manage major projects based on their own or other laboratories' research; (b) AEC and successor agency officials attempting to manage projects based on laboratory research, and (c) corporations inexperienced in the technology accepting research results or other information from laboratories or the AEC without review by corporations experienced with the technology.

3. ERDA and DOE were created thirty years ago to address major energy, environmental, economic and national security challenges to the US resulting from overuse of fossil fuels and overdependence on fuels from other nations. Approximately one-half trillion dollars have been spent by ERDA and DOE since that time; virtually nothing has been accomplished that addresses the challenges. The negative impact on the US economy may be many times the amount of money spent by the ERDA and DOE.

4. DOE policies, programs and plans often support ideas and proposals of managers and staff of DOE and its laboratories in order to provide jobs, promotions, power and prestige for these individuals. Most other nations have separate commissions or boards who ensure that policies, programs and plans are based on national need and sound science, technology and management principles.

5. An independent, Presidential-appointed and Senate-confirmed US Energy and Nuclear Technology Board, carefully selected to reflect different views based on substantial knowledge and expertise and who would function in an open manner, could help avoid these and other problems, and ensure that Americans and their leaders are provided full and accurate information about energy and nuclear technology issues and their environmental, economic and national and global security consequences.

6. Appropriate partitioning and transmutation of weapons usable material in used nuclear fuel is a nuclear imperative. Partitioning (reprocessing), integrated with fuel refabrication should be done only in well-safeguarded, well-designed and well-managed fuel cycle centers in nations with large nuclear power programs or in regional (multinational) fuel cycle centers. Enclosure 3 provides criteria for these activities.

Clinton Bastin - May 20, 2004
987 Viscount Court - Avondale Estates, GA 30002
404 297 2005 - clintonbastin@msn.com

Enclosure 2

# FUNDAMENTALS OF ENERGY

by Clinton Bastin

Planet Earth is kept warm by the heat from radioactive decay of nuclear materials in the earth. Heat from the Sun during the day partially offsets heat lost at night. Nuclear materials within the earth are our most abundant resource for supplemental energy.

The U.S. lost ability to produce enough oil to meet demands in 1970. With about 5% of the world's population, the U.S. uses about 25% of world oil production. Most of this oil is imported, which at current prices adds about $160 billion each year to U.S. trade deficits. There have been no major discoveries of oil in thirty years and future major discoveries are unlikely. At present rates of use, world oil reserves would be fully depleted during the first half of this century. The world will lose ability to meet world demands long before oil is fully depleted. Some U.S. energy officials believe that it will occur less than five years from now. The recent cutback in production by OPEC with resultant price increases of oil is a harbinger for a challenging future. The recent announcement by Shell Oil Company of a reduction in proven reserves is another harbinger.

Well-managed nuclear power is safe, nonpolluting, reliable, cost effective, proliferation-resistant and an abundant resource for indefinite supply of energy. Existing nuclear power plants in the U.S. provide more than 70% of the emission-free generation of electricity.

Natural gas is our most precious - and limited - energy resource. It is particularly valuable for home heating. Its use for generation of electricity is inefficient and wasteful and has resulted in doubling and tripling the cost for home heating - and increasing imports of liquid natural gas, which present safety and other challenges. Natural gas became the resource of choice for electricity generation largely because of lack of sound U.S. programs for disposition of used fuel and disposal of radioactive wastes from nuclear power plants.

Permanent disposal of nuclear wastes, i.e., isolation of unwanted, highly radioactive fission products from the biosphere until full decay of the highly radioactive materials, is straightforward and achievable. However, used nuclear fuel contains significant amounts of plutonium and other weapons usable material, which require safeguards. Safeguards for the time period to permit full decay of weapons materials - hundreds of thousands to millions of years - cannot be assured. Weapons materials must be partitioned from the highly radioactive fission products by reprocessing, and transmuted through beneficial use for production of energy, to preclude their use for weapons. Well-managed, well-safeguarded reprocessing in nations with large nuclear power programs or in multinational, regional fuel cycle centers, is essential not only for responsible disposal of radioactive wastes and efficient use of nuclear resources, but also to limit nuclear weapons proliferation.

Radiation is a form of energy. Like other forms of energy, high levels of radiation burn and can be dangerous; low levels warm and are beneficial. Carefully directed high level radiation is very effective in destroying cancer. Many scientific studies show that human exposure to modest amounts of radiation - up to about 25 REM - is beneficial to health. Assumptions that low levels of radiation are dangerous are based on linear extrapolation from dangers at high levels. This type of extrapolation is invalid. A good analogy is comparison of the effects of drinking a lethal amount of alcohol to that from drinking a glass of wine each day.

Nuclear fusion, the energy source for stars and thermonuclear weapons, occurs at temperatures of many millions of degrees. This energy is contained in stars - most of the time - by the enormous forces of gravity of stars. Comparable forces are not attainable on Earth. There is no scientific basis for a conclusion that fusion energy on Earth will ever supply energy needs.

Productivity (time operating efficiency) for solar generation of electricity is limited to 10 to 20%, that for wind generation 5 to 40%, depending on location. Also, solar energy is received on Earth at only a few degrees above ambient temperatures, and, based on laws of thermodynamics, will always be inefficient when converted to other energy forms. The adverse environmental impact from production, use, maintenance and disposition of systems for electricity generation from solar and wind may exceed the environmental benefit from their use. Thus, any application should be carefully evaluated prior to decisions for their deployment and use. Reliable supply of electricity can be obtained from solar and wind systems in combination with hydropower systems, but hydropower results in greater ecological damage per unit of energy produced than any other energy source.

California leads the United States in installation of solar electric systems and windmills. It also leads the nation in economic problems resulting from shortages of electricity. The shortages were less than the electric generating capability of the Rancho Seco Nuclear Power Plant, which was shut down by California energy authorities.

Life energy systems are based on the hydrocarbon fuel cycle. Fossil fuels produced by past life are being used at rates up to millions of times the rates they were produced. Challenges to the environment and climate result from overuse of fossil fuels, but the greatest danger will be from shortages caused by delays in transition to use of more viable energy resources.

Elemental hydrogen is not a component of life energy systems, is not an energy resource and is essentially nonexistent in our biosphere. It can be produced using other energy resources and used in fuel cells to produce electricity. But hydrogen has a low energy density and is difficult to handle. Hybrid, not hydrogen-fueled automobiles, will be valuable in our transition from overdependence on imported, diminishing supplies of oil. Methyl alcohol may be an important fuel for automobiles and other transportation systems.

Coal is our most abundant fossil fuel resource, and will be needed - together with biomass fuels and with appropriate systems for environmental protection - for future production of fluid fuels needed for transportation. Oil shale and methane hydrate may be abundant, but their use as fuels may require more energy and result in greater adverse environmental impact than is achieved from their use. Geothermal heat will become increasingly useful as time goes by and fuel prices increase.

Conservation and more efficient use of all energy resources are critical needs. Americans must be fully informed of these needs, and in particular the need to end our addiction to overuse of oil.

The Department of Energy was created in 1977 to address critical energy issues resulting from diminishing supplies of oil, but its programs have been inconsistent and often ill-conceived. Despite expenditure of hundreds of billions of dollars, little of value has been accomplished. Most experienced, competent U.S. corporations that were responsible for successful programs of the U.S. Atomic Energy Commission have been dismissed by the DOE. Managers and staff of the DOE and its National Laboratories often lack appreciation of the challenges of complex technology needed for safe, sustained operations. Conclusions based on experiments in laboratory facilities are often not applicable for systems needed to produce reliable energy or support energy systems. DOE and laboratory managers and staffs also lack the discipline derived from participation in free markets. An independent, Presidential-appointed and Senate-confirmed U.S. Energy and Nuclear Technology Board, carefully selected to reflect different views based on substantial knowledge and expertise and who would function in an open manner, could help avoid these and other problems, and ensure that Americans are provided full and accurate information about energy and nuclear technology issues.

Clinton Bastin 987 Viscount Court - Avondale Estates, GA 30002
404 297 2005 - clintonbastin@msn.com
May 20, 2004

# Criteria for Partitioning and Transmutation of the Fissionable Material Byproducts of Nuclear Power

C. Bastin, Chemical Engineer, US Department of Energy (Retired),
987 Viscount Ct, Avondale Estates, GA 30002, clintonbastin@msn.com

D. W. Tedder, School of Chemical Engineering, Georgia Institute of Technology,
Atlanta, GA 30332-0100, daniel.tedder@che.gatech.edu

September 5, 2003

## INTRODUCTION

Light water reactors recover less than one percent of the available energy from nuclear resources. Their use for generation of electricity began in the United States and other nations with full expectation that long-lived fissionable materials in used fuel would be partitioned from unwanted fission products[1] and transmuted by their use as fuel in existing and advanced nuclear power plants[2]. This approach would preclude the use of these materials for nuclear weapons and permit more efficient use of nuclear energy resources. Partitioning and transmuting fissionable materials also permits their permanent disposal as fission products in nuclear wastes without the perpetual need for safeguards against diversion.

Successful partitioning in large, versatile, remotely operated, modular, heavily shielded reinforced concrete canyons by the DuPont Company for the Manhattan Project at Hanford during World War II[3] and the Atomic Energy Commission at the Savannah River Plant during the Cold War[4] gave full assurances that partitioning would be successful. President Dwight D. Eisenhower's vision of Atoms for Peace gave promise that appropriate export of nuclear technology would provide a base for international safeguards to limit threats of nuclear proliferation.

The promise of successful partitioning and transmutation of fissile materials in used nuclear power plant fuels was not realized, and U.S. exports resulted in nuclear proliferation in India and proliferation threats and problems in other nations. This paper discusses partitioning successes, failures and reasons for failures; institutional, organizational, technical and economic criteria that will assure successful partitioning and transmutation in the future; features needed to meet the criteria; and reasons that some features or systems were not or are not likely be successful.

## SUCCESSES AND FAILURES

Initial implementation of the AEC commercial used fuel partitioning policy[5] reflected full understanding of lessons learned from the successful experiences and the importance of President Eisenhower's vision of Atoms for Peace. Return of used fuel from other nations to DuPont-operated facilities at the SRP would have eliminated not only the proliferation threat from partitioning in other nations, but also that from indefinite accumulations of plutonium in used fuel in those nations. With expanding global use of nuclear energy - under good international safeguards – the U.S. could have shared its technology for successful and well-safeguarded partitioning with nations having large nuclear power programs, and necessary partitioning for all nations could have been carried out without significant threat of proliferation from peaceful uses of nuclear technology and materials. Well-managed, well-safeguarded partitioning in nations with large nuclear programs or in multinational nuclear fuel cycle centers[6] would have been recognized as an essential component of best nonproliferation practice and policy.

Unfortunately, the fledgling nuclear power industry accepted gross exaggerations from the AEC about productivity[7] and success of a small, laboratory type, contact maintained fuel partitioning facility[8] that had failed[9], and supported construction and operation of commercial partitioning facilities based on that concept. The AEC also exported the laboratory-type partitioning technology to other nations, with no requirement for international safeguards. These actions led to failure of commercial partitioning in the US, proliferation in India[10], and proliferation threats and problems in other nations.

Beginning in 1972, the AEC addressed problems that resulted from earlier actions by

- stopping export of laboratory-type partitioning technology with its denial to Iran;

- ordering halt of operations of the commercial partitioning plant at West Valley, NY[11], and indefinitely suspending operation of its PUREX partitioning plant at Hanford[12];
- identifying and attempting corrective actions for problems at the Idaho Chemical Processing Plant, the model for failed commercial partitioning at West Valley and the Barnwell Nuclear Fuel Plant in South Carolina;
- identifying problems at commercial partitioning plants at Morris, IL, and Barnwell, SC;
- initiating staff reviews of the commercial nuclear fuel cycle;
- canceling plans for demonstration of technology for partitioning of used fuel from High Temperature, Gas-cooled Reactors at the Idaho Chemical Processing Plant; and
- proposing to the International Atomic Energy Agency a comprehensive study of regional (multinational) fuel recycle centers.

Following the General Electric announcement in 1974 of problems with the Midwest Fuel Recovery Plant at Morris, IL[13], and statements of Allied General Nuclear Services officials that its Barnwell Nuclear Fuel Plant would not be operated without support from the U.S. Government[14], the AEC initiated actions to resolve problems of the commercial nuclear fuel cycle. Fuel cycle staff of the AEC Division of Production, who had supported successful partitioning programs of DuPont and knew about failures with laboratory-type facilities, provided technical leadership for these actions. The Joint Committee on Atomic Energy of the US Congress strongly supported the AEC action, and identified major funding needs for nuclear fuel partitioning.

Discussions were held with industrial organizations, including an important meeting with the Nuclear Fuel Cycle Committee of the Edison Electric Institute at its headquarters in New York in July 1974. Bill Lee, Chairman of the Committee and President of Duke Power Company, knew about successes and failures in partitioning and proposed that the AEC accept used fuel from nuclear power plants for partitioning at the Savannah River Plant. AEC staff pointed out that SRP facilities did not have sufficient excess capacity to meet then existing demands for LWR fuel partitioning.

Atomic Energy Commission responsibilities for the nuclear fuel cycle were transferred from the Division of Reactor Development, who had supported laboratory type partitioning, to the Division of Production, and DuPont was asked to carry out actions that would lead to successful partitioning.

DuPont identified problems, evaluated technologies, defined programs for work on identified deficiencies, and initiated conceptual design efforts and a program for integrating technology developments into the design. These efforts culminated in 1978 in a conceptual design for a spent LWR Fuel Recycle Complex[15] based on integrated partitioning, uranium-plutonium fuel refabrication and preparation of nuclear wastes for permanent disposal. The design was based on criteria to assure safe, cost effective operations; precise accountability for and protection against theft of nuclear materials; inaccessibility of plutonium; maintenance of process equipment and piping by remote, rapid removal and replacement by overhead cranes in a large, canyon structure; high integrity protection against environmental conditions, seismic events and missiles; and confinement of radioactivity by high-integrity buildings and ventilation systems. The facility was designed to partition 3000 tons of used nuclear fuel per year. Sand filters were included for high-efficiency, accident-resistant stages to withstand fires, explosions and other extreme events inside the facilities. This facility design, if built and licensed at an estimated cost of $3.7 billion, could have been used to avoid accumulations of used fuel and transmute potentially weapons usable materials by their use in existing and advanced nuclear power plants. This would have permitted efficient use of nuclear resources and permanent disposal of nuclear wastes without need for indefinite safeguards. The facility would also have provided a model for successful, well-safeguarded partitioning, fuel refabrication and preparation of nuclear wastes for disposal in other nations with large nuclear power programs and in regional fuel cycle centers, and thus would have been a major nonproliferation initiative.

Unfortunately, when programs of the AEC were transferred to the Energy Research and Development Administration and later the Department of Energy, responsibilities for nuclear fuel cycle programs were transferred back to offices whose staff did not appreciate the difference between laboratory type partitioning facilities that were appropriate for research, and those suitable for safe, sustained, well-safeguarded operations. Senior officials of ERDA and DOE rejected the success-based, proliferation-resistant design concepts and supported partitioning in facilities whose designs had been demonstrated as flawed, and research on other laboratory concepts. Neither President Reagan nor the nuclear power industry was willing to support the flawed concepts, and opportunities were lost. Lack of understanding of the differences between success-based, proliferation-resistant designs and those that had resulted in failures and proliferation led to the myth in the U.S. that partitioning was a proliferation threat, and flawed U.S. policies based on that myth.

Lessons learned from these and related experiences form the basis for the institutional, organizational, and technological/economical criteria that will be needed to ensure safe, well-safeguarded (proliferation resistant), successful, environmentally acceptable, cost effective partitioning and transmutation, and to avoid problems of the past.

## INSTITUTIONAL

Success of the Manhattan Project during World War II was possible because there was a national commitment to carry out the effort. A similar national commitment was important for successful partitioning of irradiated materials for space exploration and defense during the Cold War.

With increased recognition of the need for transition from over dependence on increasingly scarce oil and natural gas and limitations of alternative energy resources, increased and more efficient use of nuclear power will become essential. The national debate about plans for shipment of used nuclear fuel to Yucca Mountain in Nevada should lead to more awareness of a commitment to more viable concepts for disposition of used nuclear fuel and other byproducts of nuclear power and more efficient use of energy resources.

Full recognition by Americans and their leaders of future energy challenges and need for consistent, well conceived policies should lead to the establishment of the United States Energy and Nuclear Technology Board whose members are appointed by the President with the advice and consent of the Senate and would serve overlapping terms. The board would meet periodically to recommend long-range energy and nuclear technology policies and ensure that such policies were based on sound principles. The members would have good understanding of energy and nuclear technology issues and complex energy technology. The board would ensure that full and accurate information was provided to Americans and their leaders on all energy and nuclear technology activities and issues, and that misinformation was immediately corrected.

President Dwight D. Eisenhower's vision of "Atoms for Peace" was an important concept for limiting nuclear weapons proliferation, but its implementation was flawed. Cooperation among nations with nuclear technology is needed to limit nuclear weapons proliferation and to reduce global security challenges resulting from inadequate energy supplies. The United States Energy and Nuclear Technology Board would ensure that appropriate cooperation for partitioning and transmuting fissile materials is carried out to meet these objectives.

## ORGANIZATIONAL

In October, 1942, Manhattan Project Director Leslie R. Groves recognized that partitioning of irradiated nuclear materials needed for production of plutonium for a nuclear deterrent would be a challenge even to the most experienced chemical engineering organization[16]. He asked Du Pont to design, build and control experimental operation of the Clinton pilot plant at Oak Ridge, Tennessee, and to design, build and operate production-scale nuclear materials production and partitioning plants at the Hanford Engineering Works in Washington. Former Manhattan Project engineers who managed U.S. Atomic Energy Commission materials production programs recognized the much greater challenges of nuclear materials production and partitioning needed to support the thermonuclear-based strategic nuclear deterrent, exploration of deep space and other important national programs. This view was reflected in President Harry Truman's July 25, 1950, letter requesting Du Pont to design, construct and operate the Savannah River Plant[17].

In both instances, DuPont accepted the assignment but insisted on full corporate management of all activities. This competent management by an organization with experience with complex technology was the major factor in the outstanding success of both efforts, including best ever safety records for the AEC. Many of the problems at other USAEC facilities such as Hanford, Idaho National Engineering and Environmental Laboratory and Rocky Flats occurred because corporate management was not fully involved.

The United States Navy, working with commercial nuclear power plant vendors, and U.S. nuclear power plant operators, through commitment to excellence coordinated by the Institute of Nuclear Power Operations, achieved great successes with nuclear propulsion for U.S. Navy ships and submarines, and nuclear power plants, respectively.

Westinghouse Electric Company, working with former Nuclear Navy managers, built and operated the Fast Flux Test Facility at Hanford. The FFTF was described by Former Energy Secretary James Watkins as "a facility of excellence."

General Electric has done design work and study for its PRISM (Power Reactor Inherently Safe Module) advanced nuclear power plant. This is a liquid metal cooled reactor with a fast neutron spectrum with passive safety features.

An essential criterion for successful partitioning and transmuting of fissionable materials in used nuclear power plant fuels is experienced, competent corporate management led by persons with strong commitments to good ethics and management principles.

## TECHNICAL/ECONOMIC

**I Partitioning.** The following technical and economic criteria for safe, sustained, cost effective partitioning, and features to meet those criteria, are based on lessons learned from experiences. Other features used or considered for use for partitioning, with explanation of their limitations, are also included.

1. **Criteria:** Fissionable material in all used fuel from all nuclear power plants must be partitioned in a manner that limits potential for nuclear weapons proliferation or theft or undetected diversion of weapons material.

   **Features Needed:**

   - Limited number of high-capacity, well-safeguarded partitioning facilities, located in nations with large nuclear power programs or in multinational, regional fuel cycle centers. Large economies of scale of well-conceived partitioning facilities also makes this much more cost effective.
   - Fissionable materials usable for weapons maintained as inaccessible, i.e., in used or fresh fuel assemblies or in-process within the remotely operated and maintained integrated partitioning-refabrication facility[18].
   - Good, remote systems for prompt sampling of all process solutions and precise analysis to ensure good accountability for safeguards and process control.
   - Personnel access to control rooms through hardened tunnels only with close control of entry/exit.
   - Overall recovery of fissionable materials 99.8% or better[19], so that indefinite safeguards will not be needed for nuclear wastes. This requires that scrap from conversion and fabrication processes be dissolved and returned for recovery in the partitioning plant, as was done in SRP partitioning.

   **Limitations of features in other facilities**

   - The AEC exports of technology for small, laboratory-type partitioning facilities with no requirement for appropriate safeguards led to proliferation and proliferation threats and many other problems.
   - Large numbers of small partitioning facilities would increase the difficulty of international safeguards.
   - Virtually all partitioning to date results in accumulations of large amounts of accessible plutonium.
   - Sampling and analysis of pyroprocessing partitioning is very difficult under development conditions and would be much more difficult during operations, thus good accountability for safeguards assurances would be virtually impossible.
   - Overall recovery of fissionable materials for commercial fuel recycle in the US was about 96%[20].

2. **Criteria:** *Containment of radioactive materials and shielding from radioactivity must be assured under all operating and credible accident conditions.*

   **Features Needed:**

   - Partition used fuel by remote operations in a well-designed structure with several-feet thick heavily *reinforced concrete* walls and roof;
   - No personnel entry into process space.
   - Ventilation exhaust through six feet thick sand filter, because of demonstrated high reliability, long life, high efficiency, high air permeability, inherent freedom from channeling, superior protection during fires, better performance in the presence of moisture, high chemical resistance, self-sealing after disturbances such as earth tremor, tornado or explosion, and ease of maintenance or repair[21].
   - Fluidic systems for transfer of process solutions in the canyon.

   **Limitations of features in other facilities**

   - Personnel entry into process space for operations, maintenance, sampling or other purposes results in much higher radiation exposure to workers. In 1971, radiation exposures to workers at the contact-maintained partitioning facility at West Valley, NY, averaged about 15 times that to workers at the SRP[22].

- Conventional filters on cells at the ICPP plugged during early operations and were removed. Deep-bed fiberglass filters for Hanford PUREX and the Barnwell Plant would not provide containment under accident conditions.
- Brick walls of the Tomsk, Russia, partitioning facility failed following a solvent explosion and released radioactivity to surrounding areas.
- Shielding at Hanford PUREX was by cell covers above process equipment, not by the roof. Under severe earthquake conditions, the heavy cell covers combined with a less rugged roof structure could result in collapse of structure, destruction of equipment and release of radioactivity[23].

3. **Criteria:** Assure safe, sustained, cost effective partitioning at high productivity (80%).

   Features Needed:

   - Process that has demonstrated or is capable of high productivity.
   - Repair or replacement of failed equipment with minimum interference to operation by rapid, remote replacement of failed equipment, with decontamination and repair of failed equipment in separate maintenance shops within the facility. Canyon structure for containment of process equipment, which would be installed and replaced remotely by overhead cranes, is most cost effective because it provides for maximum use of building space. No space is needed surrounding process equipment for maintenance by persons or manipulators. A mockup shop is needed to insure proper fit of replacement equipment, connecting piping and connectors.
   - Rapid startup and approach to full productivity after a shutdown by not close-coupling process equipment, and using centrifugal contactors for solvent extraction.
   - Canyon structure capable of indefinite safe operation for hundreds of years
   - Flexibility to permit partitioning of other types of irradiated fuels, such as fast reactor, thorium-uranium-233, high temperature gas cooled; and for changes, additions or upgrade of process equipment, flowsheets, instruments, etc.
   - Recover selected radioactive fission products such as technetium-99 for beneficial use and to reduce time needed for isolation of radioactive wastes.
   - Flexibility for installation of special equipment such as that for partitioning of neptunium-237 for production of plutonium-238, transcalifornium element partitioning, etc.
   - Co-location with geologic or engineered repository for permanent disposal/isolation of nuclear wastes

   Limitations of features in other facilities

   - Pyroprocessing and fluoride volatility are much more complex and require more sophisticated, in situ, maintenance[24]. This would limit operating time and increase cost.
   - Similarly, use of sophisticated, in situ "Remotec" maintenance for conventional solvent extraction partitioning would limit operating time and increase facility cost[25].
   - Hanford PUREX lacked mockup shop for equipment to be installed to replace failed equipment, which increased time of installation and resulted in leakage at connections.
   - Hanford PUREX required eight days to reach full productivity after a shutdown[26]; ICPP required 30 days[27]. GE's Morris Fuel Recovery Plant required extended time for startup[29]. (SRP F canyon required only a few minutes after installation of centrifugal contactors.)
   - Most nuclear materials partitioning facilities were built for limited life and without flexibility for changes without decontamination and major modifications to structure.

**II Transmutation.** Initial transmutation of fissionable materials partitioned from used nuclear fuel would be in existing nuclear power plants within guidelines of the US Nuclear Regulatory Commission and criteria for excellence of the Institute of Nuclear Power Operations. Subsequent transmutation would be in advanced nuclear power plants which use nuclear resources more efficiently. These would be built and operated by competent, experienced corporations within similar guidelines and criteria of the USNRC and INPO, and those recommended by the United States

Energy and Nuclear Technology Board. An important technical criteria for these plants would be passive safety features such as those demonstrated in Experimental Breeder Reactor II of the Argonne National Laboratory and planned for demonstration on an engineering scale in the Fast Flux Test Facility at Hanford[29]. These features were also incorporated in General Electric Company's concept for its Power Reactor Inherently Safe Module (PRISM).

## CONCLUDING REMARKS

Delivery of used fuel from nuclear power plants to Yucca Mountain in Nevada will be an important step for final disposition of nuclear waste. But it is only a first step. Fissionable materials must be partitioned from unwanted fission products and transmuted so that they cannot be used for nuclear weapons. Unwanted fission products may then be placed in a permanent repository where they may be safely isolated from the biosphere without need for indefinite safeguards. Transmutation in advanced nuclear power plants with a fast neutron spectrum of all the byproducts from existing nuclear power plants in the US would produce an amount of electricity equivalent to that needed in the U.S. for twelve hundred years, at present rates of use.

## References and Notes


1. US Atomic Energy Commission announcement in the Federal Register of March 12, 1957, of its policy for the receipt and partitioning of used fuel from nuclear power plants in the US and those in other nations supplied by the US or containing fuel of US origin.

2. Transuranium isotopes such as plutonium-238 and curium-244 would provide power for electronic systems on space craft. Transcalifornium isotopes are very important for research and may have significant value for other uses. Special ion exchange systems for partitioning of these isotopes were installed in F and H canyons at the SRP during the 1960s.

3. Hewlett, Richard G, and Anderson, Oscar E., Jr., The New World - 1939/1946 (Volume I of a History of the United States Atomic Energy Commission)

4. Bebbington, W.P., History of DuPont at the Savannah River Plant (1990), pages 111-128.

5. Reference 1.

6. International Atomic Energy Agency, "Regional Fuel Cycle Centers: 1977 Report of the IAEA Study Project"

7. USAEC Division of Civilian Application Summary Report: AEC Reference Fuel-Processing Plant, WASH-743, October 1957, indicated productivity of 80%; AEC accountability reports showed that actual productivity from 1952 (completion of construction) through 1957 was about 2.3%.

8. The Idaho Chemical Processing Plant, which had been built under the direction of Oak Ridge National Laboratory. Model for the ICPP was the pilot partitioning plant built at Oak Ridge by DuPont during World War II prior to construction and operation of facilities at Hanford.

9. Reference 4, page 113, mentions that H Canyon at the Savannah River Plant was modified in 1959 to partition highly enriched uranium used fuels. This modification was necessary because of failure of the laboratory-type (ICPP) partitioning facility.

10. Bastin, Clinton, Letter to Naresh Chandra, Ambassador of India to the United States, June 12, 1988

11. Low, Lawrence D., Director, Division of Compliance, US Atomic Energy Commission, letter to R. N. Miller, President, Nuclear Fuel services, Incorporated, March 16, 1972

12. Hanford PUREX partitioning plant could not be operated effectively as built without continuous direct disposal of radioactive waste to the soil. Major problems were close coupling of process equipment which resulted in long time for restart of full productivity after shutdown (8 days compared to a few minutes for F canyon at the SRP), and lack of a mockup shop for replacement equipment which made remote maintenance difficult. PUREX also had a major seismic deficiency and did not have a sand filter to assure containment of radioactivity under accident conditions.

13. General Electric, "Midwest Fuel Recovery Plant Technical Study Report," July 5, 1974

14. These statements were documented in June 4, 1975 letter from Gene Schubert, President of AGNS to ERDA Administrator Robert Seamans.

15. DuPont Savannah River Laboratory Design Integration Study "Spent LWR Fuel Recycle Complex," (DP-CFP-78-121), November, 1978.

16. Reference 3, page 91
17. A copy of President Truman's letter is in reference 4.
18. The DuPont Spent LWR Fuel Recycle Complex met this criteria. See reference 15.
19. Reference 4, page 111.
20. Carter, Luther J. , Nuclear Imperatives and Public Trust - Dealing with Radioactive Waste (1987), page 28.
21. Reference 15, pages 6-325-6.
22. References 4 and 11
23. Information provided during discussions with Paul McMurray and Sam Beard, President and Vice-President, Exxon Nuclear Corporation in 1974. Mr. McMurray and Mr. Beard had been managers of Hanford chemical partitioning operations.
24. Reference 13
25. Conceptual design studies by Bechtel indicated that costs for the "Hot Experimental Facility," a facility for partitioning of one-half ton per day of fast reactor fuel incorporating the "Remotec" (in situ maintenance) concept would cost about $2.7 billion. There have been reports that the partitioning plant at Rokkasho Mura, Japan, incorporates "Remotec" type maintenance and is estimated to cost some $15 to 30 billion.
26. Discussions with Oscar Elgert, AEC director for partitioning programs at Hanford (1974).
27. Discussions with Neal Powell, AEC director for partitioning programs at Idaho (1974).
28. Reference 13
29. An engineering-scale demonstration of passive safety features would be very important for advanced nuclear power plants, and consideration should be given to restart of the FFTF to carry out this demonstration.

Enclosure 4

## Biographical Sketch of Clinton Bastin

Clinton Bastin writes and talks to community groups, students and faculty of universities and high schools, the news media, political leaders and others about energy, the environment, national and global security aspects of nuclear technology and materials, and improved interactions between humans through partnerships. He is Vice President for the United States of the World Council of Nuclear Workers; Vice Chair, Chair-elect and coordinator for citizens' awareness activities of the Atlanta Section of the American Nuclear Society; and President-elect for the Northlake Golden K Kiwanis Club in Decatur, GA. His work for the US Department of Energy and predecessor agencies for more than 40 years included manager for nuclear programs, technical leader for U.S. nonproliferation initiatives, US coordinator for collaborative nuclear research and technology exchange with other nations, and lead consultant to US national security agencies on nuclear proliferation threats. He was also a lead technical consultant to the International Atomic Energy Agency for its study of the U.S. initiative of Regional (multinational) Nuclear Fuel Cycle Centers to reduce threats of nuclear weapons proliferation from nuclear power activities. Prior to work in Federal programs, Mr. Bastin worked as a fire protection engineer in the insurance industry.

At retirement in March 1997 he received the DOE's Distinguished Career Service Award recognizing him as "the U.S. authority on reprocessing and an advocate and initiator of total quality management and partnering agreements." In a keynote address at an international conference on nuclear safety held in Moscow on April 26-27, 1996, to commemorate the tenth anniversary of the Chernobyl accident, he pointed out that the Chernobyl Nuclear Power Plant and Challenger Space Shuttle accidents would not have occurred if there had been good partnerships between workers and managers for resolution of safety issues. His ideas for improved safety for nuclear activities were adopted in April 1997 by the Russian Ministry for Atomic Energy and Russian Nuclear Workers Union for future nuclear work in Russia.

Clinton Bastin served in the US Marine Corps during World War II and graduated as a Chemical Engineer from the Georgia Institute of Technology in 1950. He lives in Avondale Estates, GA with his wife Barbara. They have two sons, two daughters, and one grandson.

May 20, 2004