A Critique of
“Radioactive Wastes and the Global Nuclear Energy Partnership”*

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*The Institute for Policy Studies, Washington, DC, published “Radioactive Wastes and the Global Nuclear Energy Partnership” in early 2007.

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1. Executive Summary

A group of academics and professionals who have dedicated much of their personal time throughout the course of their careers to communicating with the public and policy makers undertook a critique of the recently released report titled “Radioactive Wastes and the Global Nuclear Energy Partnership” (Institute for Policy Studies, Washington, DC, 2007, henceforth referred to as the RW & GNEP report). We did so because we believe this report is highly biased, slanted, filled with prejudicial, emotion-charged terminology, lacking in scientific rigor, and lacking in context. It was written by an unknown cadre of writers with unknown credentials; we were unable to determine whether this is the work of a single disgruntled former federal or nuclear industry employee, a team of career anti-nuclear bureaucrats, or respected scientists, engineers, and policy makers. As proponents of nuclear science, technology, medicine and energy, the review group felt that it not only damaged the potential for expansion of global use of nuclear energy, but that it could exacerbate unreasonable fears of nuclear technologies and materials that have benefited mankind for more than a century.

In addition, the report ignored three major, key points:

1) The global environmental impacts of energy use must first and foremost be addressed;
2) A massive expansion of nuclear energy, which is globally recognized as necessary to meet the energy challenges of the future, will result in an exponential increase in the number of permanent nuclear waste repositories—unless nuclear fuel is recycled and subsequent wastes are treated; and
3) GNEP is a global program, intended to unite major nuclear-power nations in development of new nuclear technologies that can be deployed to all nations without increasing the risk of proliferation of nuclear weapons.

As a collective body, we find the report to be counterproductive in terms of its portrayal of the nuclear reactor waste issue and the Department of Energy’s GNEP program. Thus, we have chosen to point out the omissions, errors, and distortions in the report in order to provide perspective on its negative impacts. The following are the group’s major criticisms of the RW & GNEP report.

Major Criticisms of RW & GNEP

GNEP is Not Portrayed as a Global Initiative

The arguments presented in this report focus solely on the United States, when in fact GNEP is a global initiative. Failing to address the issue of recycling used nuclear fuel will not only hurt the standard of living for future generations of Americans, but also billions of people in developing countries that cannot afford to grow their economies in light of the cost of expensive fossil fuels. Evidence of this conundrum is apparent in China which has one of the most dynamically growing economies on the planet but is struggling to deal with its energy shortfalls. Affordable and sustainable energy is required for humans to exist on earth while maintaining a reasonable standard of living. Suspending funding on R&D projects such as GNEP now will only place a greater burden on future generations as they will have to deal with the issue of used nuclear fuel and limited uranium supplies.

The Consequences of Ignoring Used Nuclear Fuel are Not Discussed

The RW & GNEP report focuses on nuclear waste and GNEP, without considering the consequences of not using this potential used fuel avenue. There is no comparison to other energy sources like fossil fuels that would have to be used if nuclear power plants did not have the fuel or waste disposition needed for expansion. There are environmental impacts from the use of fossil fuels, but environmental advantages should not be the only reason for using nuclear power. Exploration for and mining of fossil fuels result in a significant impact on the environment, while recycling used nuclear fuel would reduce the need to mine for uranium. As a general statement nuclear power can reduce pollution and other environmental effects; and unlike finite resources like oil, coal and natural gas, uranium can be recycled. Additionally, the resource and national security issues associated with a dependence on fossil fuels must be considered. Clearly omitted from the conclusions of the report, these issues pose a serious threat to the future of both U.S. and international security. The supply of oil is limited to only a handful of nations. These nations often seek to gain both politically and economically from using their inherent resources as a weapon against the rest of the world. The future is replete with the potential for nations to use energy statecraft against both enemies and allies alike. Evidence of this is clear as was the case between Russia and Belarus last winter. The fact that this type of analysis was omitted from the report is a grave concern.

The Long Term Nature of a Closed Nuclear Fuel Cycle is Ignored

Eventually the economics of mining less recoverable uranium resources will necessitate the recovery of used fuel for reprocessing. A once-through nuclear fuel cycle is like throwing away aluminum cans, glass bottles, plastics and other consumer goods to landfills, which have become so expensive that we now commonly recycle these products. In the same manner we should recycle the used fuel from commercial nuclear plants. There is also much discussion on the potential for these recycling technologies to fail or produce more waste in shallow burial, which is of course reserved for wastes with a shorter half-life. Present technologies may not be perfect or optimum, but this a long-term commitment and technologies always evolve in a forward manner, often in ways not conceived even a decade earlier. Many of these advances result in revolutionary changes in technology as well as safety. The Wright brothers did not build a Boeing 747 the first time they flew.

Report Data is Inconsistent and Predisposed

The report relies much too heavily on the experiences from military production of nuclear materials and on the very early attempt at commercial reprocessing in the U.S. at West Valley New York. In the defense case, shortcuts were taken in the interest of national security, with technology dating to the 1950s and 60s. The DOE is today cleaning up those legacy wastes and waste sites. The technology employed at West Valley was that of the 1960s vintage; modern experiences in reprocessing tell a considerably different story. Furthermore, the RW & GNEP report relies heavily upon the National Research Council’s 1996 review of nuclear waste management, cherry picking the few points in this 400-plus page report that are adverse to the GNEP program. However, the third paragraph of the summary states: “A reason for [NRC] supporting continued use of the once-through fuel cycle is that it is more economical under current conditions. Some analysts predict that future demand for uranium—and as a consequence its price—may increase to a point where recycling becomes economically competitive. Should this happen, the choice of once-through fuel cycle would have to be reexamined …….” This is in fact the situation today; in 2003 the price of uranium was ~$10 a pound, in 2006 it was ~$45, today it is more than $100 per pound—a ten-fold increase. Just based on the 1996 NRC report, the once through fuel cycle needs to be seriously reevaluated. This is another fact that the Alvarez report totally neglects. In addition, this NRC report, while it is critical of many of the past waste handling procedures, strongly encourages that R&D for new separations and transmutation technology be pursued as is projected for the long term R&D vision of GNEP.

New Reactor Types and Designs are Never Addressed

There is no mention of new types of reactors that could be used to make the GNEP a success. A near-term deployable class of new reactors includes small, 10 to 100 MW-electric nuclear plants that are specifically designed to be affordable, safe and highly proliferation resistant. These reactors, which are designed for global use and could fit the GNEP concept, might be deployed in remote towns, e.g. in Alaska or on small islands. These small reactors can be designed to use recycled fuel and to produce a significantly reduced waste stream, and applications include electrical production, desalination of water, hydrogen production, and district heating. This type of distributed power plant could be used globally to increase the living standards of billions of people who cannot presently afford to build large commercial reactors or pay for the ever increasing cost of fossil fuels and transportation.

Radiation and Radioactivity are Never Discussed in Context

The RW & GNEP Report is replete with statements about huge quantities of radioactive materials and long half lives, with no indication of the expected health or environmental effects of those quantities, and no context to which to compare them. The simple existence of very large quantities of radioactive materials, as measured by a large amount of radioactivity (expressed in curies) and long half lives, is not in itself dangerous. Radiation must reach people and the environment to cause effects, yet there are no statements in the report of how the radioactive material, which civilian nuclear power has demonstrated the ability to sequester for decades, is purported to escape and harm people or the environment. The report mentions historical instances of radioactive waste leakage, but again says nothing about any harm to people or the environment. In fact, tank leakages that occurred were detected by planned monitoring programs. The tanks were located in areas where potential leakage could be detected and intercepted before doing harm. A technology that provides the largest source of emission-free energy requirements for the health and well being of billions of people should be expected to produce large quantities of waste! However, if that waste can be and is easily controlled, it is harmless.

Radiation and radioactivity are never discussed in context in the report, even though they are both natural and manmade phenomena. The whole ecology of the Earth has evolved in a sea of radiation. Too much radiation is harmful, of course, but safe exposure levels have been known for decades and are incorporated in regulations with generous margins of safety. Average exposure to U.S. citizens is today about 600 millirem per year, most of it coming from natural sources and nuclear medicine (X-rays, CAT scans, etc.). There are places in the world where average exposure is 30,000 millirem per year with no known detrimental effects. The exposure limit for radiation workers is 5,000 millirem per year, which can be compared to the maximum permissible exposure to the public from the entire Yucca Mountain project of 15 millirem per year for 10,000 years. Two hours at high altitude in jet aircraft or a dental X-ray create a 1 millirem exposure, and a CAT Scan exposes the patient to about 110 millirem.

Conclusion

In sum, the RW & GNEP report ignores several factors that must be considered when examining choices of nuclear fuel cycles. The report exaggerates problems and creates the appearance that the U.S. DOE will act alone and ignore the volumes of lessons learned throughout the past six decades. The report also portends that GNEP will be rooted in decades old technologies, while it promotes anti-nuclear agendas and the irrational fear of radioactivity and radioactive materials, which could inhibit their use in nuclear science, technology, industry, and medicine in addition to nuclear energy. We believe that the future of all of these nuclear technologies is bright and that DOE nuclear initiatives will serve as lynchpins for the worldwide renaissance in nuclear energy.

2. Introduction

In May 2007 the Institute for Policy Studies (IPS) published a report titled Radioactive Wastes and the Global Nuclear Energy Partnership (GNEP).[I] This report, which will henceforth be referred to in this review as the RW & GNEP Report, appears to be a politically motivated criticism of the evolving U.S. Department of Energy's GNEP program with many emotionally charged points, cherry picking of past reports, and omissions of pertinent information.

Because of our perception of a highly slanted nature of the review in this report, a group of professionals dedicated to the advancement of nuclear science, technology, and energy undertook a critique of it. In the time available to the committee, we could not provide a technical response to each issue point by point. That would have taken days or even weeks when the report was obviously intentionally released immediately prior to Congressional energy appropriations deliberations. Furthermore, a point-by-point response to the RW & GNEP Report would obscure a main criticism, which is that in spite of attempts to make it appear to be a scholarly work, it is full of conjecture, short on science, and written by an unknown cadre with unknown credentials; we were unable to determine whether this is the work of a single disgruntled former federal or nuclear industry employee, a team of career anti-nuclear bureaucrats, or respected scientists, engineers, and policy makers. Thus, rather than counter the technical details, our report is intended to illustrate the deceptive content and to reveal factual errors, logical inconsistencies, intentional misimpressions, and apparently politically-motivated opinions. Because it is not a credible technical work, we chose to not evaluate it on a purely technical basis.

One example of this is that RW & GNEP gives the misimpression that the U.S. is going it alone in GNEP, which is precisely opposite of the truth. On May 21, 2007, Russia, the People's Republic of China, France, and Japan joined the U.S. to issue a "Joint Statement on the Global Nuclear Energy Partnership and Nuclear Energy Cooperation."[II] In this statement the world's leading nuclear power nations committed to work together to develop nuclear energy, including recycling technology. This omission of the developing partnerships with several powerful and technologically advanced nations appears to be a deliberate attempt to mislead the readers of this report. World-wide experience should be mentioned in any discussion of used-fuel processing technology, as it has been further developed overseas and is currently in successful use. That technology might be used in this country, through licensing, partnership or purchasing. In addition, the RW & GNEP Report mixes up the current, future and past legacies of radioactive waste management practices. And although there appears to be very little relationship between past defense waste practices and the current GNEP, the authors chose to include it in the Report.

The RW & GNEP report relies heavily upon the study by the National Academy of Sciences review of waste management, cherry picking the points that are adverse to the GNEP program. However, the third paragraph of the summary states: "A reason for supporting continued use of the once-through fuel cycle is that it is more economical under current conditions. Some analysts

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[I] "Radioactive Wastes and the Global Nuclear Energy Partnership," Institute for Policy Studies, Washington, DC (2007). http://www.ips-dc.org/reports/070423-radioactivewastes.pdf

[II] Joint Statement on the Global Nuclear Energy Partnership and Nuclear Energy Cooperation, Washington, DC, May 21, 2007. http://www.gnep.energy.gov/gnepPRs/gnepPR052107.htm (see Appendix B for the full statement) predict that future demand for uranium—and as a consequence its price—may increase to a point where recycling becomes economically competitive. Should this happen, the choice of once-through fuel cycle would have to be reexamined …….”[III] In 2003 the price of uranium was ~$10 a pound, in 2006 it was ~$45, today it is more than $100 per pound—a ten-fold increase. Just based on the 1996 NRC report the once through fuel cycle needs to be seriously reevaluated. This is another fact that the Alvarez report totally neglects. In addition, this NRC report, while it is critical of many of the past waste handling procedures, strongly encourages that R&D for new separations and transmutation technology be pursued.

As the title announces, the report focuses on one aspect of GNEP—radioactive wastes. Indeed, one of the central motivations for GNEP is what it can do and what must be done in the nuclear waste arena to create conditions for expansion of safe, affordable, carbon-free nuclear energy. While a focus on the waste issue is appropriate, we should not lose sight of the complete portfolio of issues that the proposed GNEP program aims to address. The world must increase its reliance on sustainable nuclear power to simultaneously address global energy needs and potential attendant massive environmental consequences. Yet a nuclear power enterprise that relies exclusively on thermal reactors operated once-through is not sustainable. Uranium resources ultimately would not sustain it, but before that would occur, such an enterprise would fail because of the implication of a continuous increase in the number of needed geological repositories for disposition of used fuel. Even in the unlikely event that repositories became easy to site, nuclear used fuel placed in geological repositories all over the world raises its own set of nuclear security issues. Like it or not, nuclear power is here to stay, and the world must responsibly manage the stocks of plutonium in used fuel. In the GNEP approach, plutonium management mainly takes the form of locking up plutonium and other troublesome materials in new fast burner reactors, where they are consumed in production of electricity.

In the following, we examine statements in the RW & GNEP Report and provide additional information to place much of this criticism of GNEP in context with current research, goals, and international experience. For reference, those sections in the RW & GNEP report are titled:

Abstract
I *Executive Summary*
II *Introduction* (we do not include comments on the Introduction)
III *“Once Through” and “Closed” Nuclear Fuel Cycles*
IV *Nuclear Waste Disposal Problems*
V *Defense High-Level Wastes*
VI *Storage and Reprocessing*
VII *Radioactive Wastes from Reprocessing*
VIII *Costs*

For clarity, sections of the RW & GNEP Report are included verbatim herein as italicized, double-indented paragraphs, with the original endnotes included and listed by Arabic numerals at the end of this critique. Many of these sections are followed by our comments, corrections, or rebuttals. Our citations are designated by Roman numeral footnotes on each page. Specific comments on the sections of the report follow.

III. *Nuclear Wastes: Technologies for Separations and Transmutation,* National Research Council, National Academy of Sciences, National Academy Press (1996).

3. Comments on RW & GNEP "I Abstract"

The amortization period for costs is not clearly stated. Considering the number of years during which the proposed facilities may be in use, costs may seem modest for a national energy program.

In section I of the RW & GNEP report, it often states that certain things "could" happen, without any reference to mechanisms, probability, or the presence or absence of harmful effects. To be sure, there have been accidents in this country's combined nuclear energy programs. They have all been rigorously investigated and the lessons incorporated into the "learning curve." Lessons from other countries' accidents have also been studied. The use of the statement that things "could" happen, combined with the large radiation quantities used, has certainly been successful at creating a negative overall impression to those who don't understand these concepts. This might possibly be construed by some to be a scare tactic. Currently in Vermont, the Vermont Yankee nuclear power plant has been licensed by the NRC and approved by the State for Dry Cask storage of used reactor fuel. The Cask storage pad is within the plant fence, which places it close to the Connecticut River. Opponents of the plant say that the plant is "storing radioactive waste on the river bank" which is perfectly true. But it is said with such emotion that the impression is conveyed that harmful amounts of radioactive material will get in the river at any time. Nothing could be further from the truth, since the used fuel is in ceramic pellet form, in the metal tubes it was in when in the reactor. The metal tubes (in bundles, as used in the reactor) will be in helium inerted, welded closed metal cans, shielded and in concrete shells which act as air cooling chimneys. If by some circumstance a Dry Cask got into the river, it would only be better cooled by the water than it was by air.

> *The U.S. Department of Energy's (DOE) Global Nuclear Energy Partnership (GNEP) is being promoted as a program to bring about the expansion of world-wide nuclear energy. To meet this goal DOE proposes to significantly reduce the amount of high-level radioactive waste for geological disposal and to reduce proliferation risks by transmuting fissionable materials into less troublesome isotopes. Crucial to the GNEP plan is using a new unproven type of chemical reprocessing of spent fuel from power reactors"*

In contrast to this statement, in the past several years there have been very good advances in the UREX process. In 2004 Vandegrift reported "Clearly, the UREX+ demonstration was not perfect, and not all process goals were met. However, it did demonstrate that these processes show promise for meeting all process goals."[IV] Thus, this prejudicial statement should instead say "Crucial to the GNEP plan is using a new type of chemical processing of spent fuel from power reactors that has been demonstrated on the laboratory scale." One purpose of GNEP is to develop and implement enhanced chemical processing of used fuel from power reactors that does not separate plutonium from uranium as required for weapons production. In addition, current types of reprocessing for weapons material, and the types used overseas for power reactor fuel, are more proliferation resistant.

> *Unlike direct disposal of spent nuclear fuel rods, reprocessing involves chemical separation of radioisotopes and creates multiple waste streams. It also releases large volumes of radioactivity into the environment, typically by factors of several thousand compared with nuclear reactors. DOE claims that the*

[IV] G. F. Vandegrift, et al., "Lab-Scale Demonstration of the UREX+ Process," *Proc. Waste Management '04*, WM-4432, WM Symposia, Inc. (2004).
http://www.cmt.anl.gov/Science_and_Technology/Process_Chemistry/Publications/WasteManagement04.pdf

> *new reprocessing technology under development will not pose these problems. But it is important to consider the following:*

Without actual quantities and a measure of harm, words like “large” and “factors of several thousand” are meaningless. They must be considered in context. Reprocessing waste streams will in fact release small quantities of radioactivity into the environment compared to nature. We live in a naturally radioactive world, and we create much larger exposures of man-made radiation with medicine and entertainment than with the entire nuclear fuel cycle. We have the technology to control these quantities from GNEP separations to levels that make trivial contributions to just the variations in naturally occurring environmental radioactivity. Depending on the source of naturally-occurring uranium, the extraction, fissioning, and sequestering of uranium and its decay products actually result in a net reduction of the total radioactivity in the environment. Although the releases from recycle processes would typically be much greater than releases from nuclear reactors, this fact simply serves to confirm the negligible, harmless to man and environment, quantities of releases from nuclear power plants.

DOE will institute design requirements that will be met by normal engineering and operations standards to eliminate “these problems.”

- *In order to free up space in a geological repository, the major preponderance of the radioactivity in spent power reactor fuel would be stored and disposed in shallow burial near water supplies. By contrast, much smaller amounts of similar radioactive materials from past reprocessing at DOE sites are to be geologically disposed because they are considered to pose significant risks to the human environment.*

This is not credible. Locating future burial or above grade disposal sites would of course be done based on experience. The actual distance to water supplies for various sites would vary depending on how the local geology affected the likelihood of any leakage that escaped the planned monitoring reaching water supplies.

- *Under the GNEP plan, separation of cesium and strontium from spent nuclear fuel could result in the storage and near surface disposal after 300 years of the single largest concentration of lethal, high-heat radioactive wastes in the United States and possibly the world. According to DOE spent nuclear fuel estimates, these wastes would still be highly radioactive after 300 years. In order to meet DOE’s tank waste disposal requirements at the Savannah River Site (SRS) in South Carolina, after 300 years, separated cesium and strontium would have to be diluted into a volume of more than 1 million cubic meters, enough to fill the Empire State Building.*

This statement is actually an interesting benchmark. In much less than 300 years we should anticipate that technology would be at least as good as our current and near term abilities. A volume only equal to that of the Empire State building might be considered a very modest amount for a program for the entire nation. In addition there need be no expectation that the material would have to be stored in one location. However, that dilution would need to be just a small fraction (1/1024) of concentrations in fresh sources. In addition, the significant energy and radiation in these sources are of significant potential value, which may eventually make them economic semi-permanent power and irradiation sources, as has been done with reprocessed weapons sources. There is no single designated location in the U.S. or the world for the storage of the separated Cs and Sr in the partnership nations.

The half-life of cesium and strontium from used fuel is around 30 years so that after 300 years or 10 half-lives, the initial radioactivity from these elements is reduced by a factor of a thousand and in 600 years only a millionth of the original radioactivity remains. That is why they are classified as low-level waste for shallow burial at these sites. The heat produced by these wastes has no health impact to the public and it is not relevant to the discussion.

- *Unprecedented amounts of long-lived radioactive wastes could be disposed in the near surface and pose increased contamination risks for thousands of years. For instance, the amounts of cesium-135 that could be disposed under GNEP could be several thousand times greater than generated after decades of U.S. nuclear weapons material production. With a half-life of 2.3 million years, a panel of the National Research Council warned in 2000 that onsite disposal of a much smaller quantity of Cs-135 in wastes at SRS "represents a long term safety concern."*

This is misleading because weapons production produced insignificant quantities of long-lived Cs-135. Thus, "thousands of times" a trivial quantity will never be a significant source. This statement also fails to consider this Cs-135 source in context, as it is within the naturally-occurring radioactivity in the environment, to correctly conclude that it is a trivial additional source that could not possibly contribute to the radiation exposure to humans as a "long-term safety concern." In addition, the discussion incorrectly matches the health effect of radioactive material with its half life (this is a common tactic of those opposed to nuclear science and technology). For equal numbers of radioactive atoms with the same radiation, short half life material causes a greater health effect because it is giving the dose in a short time. The longer half life material causes a lesser health effect because the dose is spread over a longer time, while whole living organisms heal in relatively short times. The longer the half-life of a radioactive element, the less radiation is emitted by that element per unit time. An element with a half-life of days would be very active and of direct health concern, while elements with half-lives in the millions of years, which is why they last so long, represent a much smaller risk factor due to their reduced radioactivity. In comparison, in chemical and other industries billions of tons of materials are released and/or stored annually, and many of these chemical wastes (especially metals) have an infinite half-life and can remain as an infinite health concern. The used fuel waste is a much smaller mass/volume and much more easily contained. The proposed GNEP would create a relatively small volume of waste compared to many other technologies that require careful entombment of some kind accompanied by monitoring. The total record of the nuclear energy program to date proves that this can be done successfully. There have been gross errors in some countries, apparently due to social values that accept a degree of risk and error that is generally unacceptable elsewhere.

- *A clearly defined disposition path for recovered uranium, which constitutes more than 95 percent of spent nuclear fuel by weight, appears to be lacking. Contaminants in the uranium will require it to be re-enriched at a new and costly facility. Otherwise, this uranium will have to be disposed, leaving a small fraction of spent fuel materials to be actually recycled.*

The discussion concludes that uranium recovered from reprocessing will put the U.S. in an either-or situation, requiring either re-enrichment in a new facility or alternately disposal. In fact, other options exist that should not be foreclosed for all future generations by prematurely choosing one of those two options. For example, the development of breeder reactors beginning in the 1950's was precisely intended to overcome this stumbling block of disposal. It has always been stated that breeder reactors and reprocessing would be needed to make nuclear power a viable long term option for more than ship propulsion. In addition to uranium cycle breeders, thorium-cycle breeders have been proven, and India's program intends to use them because of their large indigenous thorium resource.[V]

[V] for the Indian program: www.indembassyathens.gr/India-nuclear%20/India_nuclear%20energy_thorium.htm

> *Major uncertainties have prompted DOE researchers to advocate full federal financing, in the tens of billions of dollars, followed by forgiveness of sunk costs as the key to establishing the GNEP program. The Energy Department's troubled experience with defense high-level wastes should also serve as a cautionary warning. With an estimated liability of more than $100 billion, and after 25 years, DOE has treated less than one percent of the radioactivity from past reprocessing for geological disposal. By contrast, the magnitude of radioactive wastes generated under GNEP could be unprecedented and fraught with potentially greater safety and financial risks."*

Financing decisions for GNEP, and other major national projects to meet national purposes and objectives, are independent of the assessments of the technical issues of public health and safety. However, the pros and cons of financing alternatives are matters of government leadership necessary to achieve national objectives in the public interest versus more indirect and slower development that can be met by the other extreme of fully private investment driven by requirements for short-term profitability. Though this project may begin with the DOE, there is the potential for greater economic efficiency with the transfer to a more privately held organization to go forward with this project. Historically many new technologies, which began with some government organization or funding, went on to the private sector and helped build the United States as a world economic power. Government financing, subsidies, tax credits, and other arrangements have always been used to initiate industries deemed in the public good that the private market would not start. Our history has been to move enterprises to non-government ownership and management as soon as possible. From the canals of colonial times, through railroads and to the present this has been true. Presently airlines are privately owned and operated, while airports are owned by localities, and the Federal government owns and runs the Air Traffic Control System. Congress will determine the arrangement for the nuclear power program that best meets the public's interest, when all alternatives are considered. Consider debates about the transcontinental railroad, the Hoover Dam and Bureau of Reclamation, the TVA, the Rural Electrification Administration, the Maritime Commission for U.S. shipbuilding, COMSAT/INTELSAT, the Interstate highway system, etc.

This again refers to the legacy of post-WWII reprocessing for Pu recovery with limited chemical separations and waste stream processing, vs. proposed applications of advanced chemical engineering development and processing. There was intentionally no rush to process defense wastes for permanent disposal. The emphasis was on safety and technology development. There were many delays, technical and political, and the process has taken longer than first advertised. Vitrification (turning waste into obsidian-like glass) is a good technology for permanent disposal and is currently in use in France's plutonium recycling program.[VI]

> *DOE lacks a credible plan for the safe management and disposal of radioactive wastes stemming from the GNEP program. This plan should address waste volumes, disposition paths, site specific impacts, regulatory requirements and life-cycle costs. Given past failures to address waste problems before they were created, DOE's rush to invest major public funds for deployment of reprocessing should be suspended.*

In fact, the DOE is developing this credible plan for the safe management and disposal of radioactive wastes stemming from the GNEP program. This plan is addressing waste volumes, disposition paths, site-specific impacts, regulatory requirements, life-cycle costs, and more. Given past failures to address waste problems before they were created, DOE's investment of major public funds for deployment of reprocessing will consider waste management at the outset.

[VI] *The Nuclear Waste Primer,* League of Women Voters Education Fund, p 27-28 (1985).

The Manhattan Project, which created the weapons program, made a conscious decision to temporarily store radioactive wastes, because there was a war to win, and no rush to find a permanent solution. Post war, weapons, ship propulsion, power generation, and all other uses of "atomic energy" were authorized; and more wastes were created. In parallel a permanent solution to the waste problem was developed. Simultaneously, a great fear of all things nuclear and radioactivity developed in some citizens, and the "environmental movement" created a "Not In My Backyard" approach, both of which slowed political progress on locating geologic burial sites. The nuclear energy program may be said to have gone forward on faith that a permanent solution to the "waste problem" would be developed. It appears a similar situation exists in going ahead with the GNEP program. The desirability of going ahead on faith that a satisfactory permanent solution will be developed for the "waste problem" has to be determined by Congress as they compare all available alternatives to the use of nuclear power. It is assumed that the total record of dealing with radioactive wastes, not just a few examples of problems, will be considered. It is difficult to truly establish past failures for defense purposes when the priority was not on disposal, but on production, with the Cold War going on for decades.

Suspending funding at this time would result in the United States falling behind other countries that are already reprocessing used fuel and will put the U.S. at an economic disadvantage in this technology. Eventually, the price of Uranium, which has gone from $10 a pound in 2003 to $120 a pound in 2007, would necessitate the retrieval of used fuel from Yucca Mountain for reprocessing to fuel future nuclear power plants. Countries such as China plan on being the leading economic power in this century, fueled by as many as 300 nuclear power plants.[VII] If the United States enters a policy of technology timidity and suspends funding for such projects, the front-runners in other industrialized nations will continue to exploit the benefits of nuclear power. A paralysis of policy will induced by fear or ignorance will cause not just the U.S., but the world to endure a lower standard of living.

VII. *Washington Post* Business Section, May 29, 2007.

4. Comments on RW & GNEP "I. Executive Summary"

In section I of the RW & GNEP report, "Executive Summary," the authors cite many large quantities, without mentioning whether or not these quantities create any significant or insurmountable problems. A program for a major part of the electric power generation in our country would be expected to be substantial, creating large quantities by any measure. For example, in Figure 1, the claim that Cs-135 "dominates human doses in about 600 years" is misleading as Cs-135 never appears as a dose contributor in the Yucca Mountain performance assessments. Indeed, there is no dose to humans at 600 years from Cs-135 or anything else because the waste packages will still be intact. The authors' meaning is thus obscure; it implies that if you have reactor-generated Cs, and you consider the dose only from that, then at 600 years the dose from Cs-135 exceeds the dose from Cs-137. This, of course, is meaningless if no person or part of the external environment will ever be exposed to either the Cs-137 or 135. The section then begins with:

> *DOE plans to <u>use an unproven</u> aqueous reprocessing technology known as UREX+ (URanium EXtraction) and expects to separate uranium for recycle or disposal, transuranics for transmutation in "fast" reactors, and fission products for either surface storage or geological disposal.*

As detailed in section VII new separation technology has been demonstrated on a laboratory scale. The following sentences explain that an engineering demonstration program is planned. Under GNEP, DOE plans to establish this technology or others on a larger engineering or prototype scale. The Apollo mission to the moon was also an unproven technology, but the United States landed there successfully several times. The Wright Brothers also had an unproven technology that is now the safest form of transportation. This point that it is unproven technology (which may not even be correct) is merely the glass is half-empty mindset. Problems are not solved by looking for failure, but by looking for success.

> *An engineering demonstration of this technology is several years away. If this proves successful, a single large scale plant with a throughput of 2,500-3,000 tons of spent fuel per year is planned to go on line around 2030. At that time, DOE projects that about 105,000 metric tons (Metric Tons Heavy Metal) of nuclear spent fuel would be generated by the U.S. nuclear power fleet. Because of its proximity to most of the nation's reactors, access to ports, and its nuclear material processing infrastructure, the Savannah River Site (SRS) in South Carolina is considered a prime candidate for a spent nuclear fuel reprocessing plant. SRS currently stores the nation's largest inventory of radioactivity in high-level wastes.*
>
> *During the course of operation, a reprocessing plant could store 10,000 to 20,000 metric tons of spent fuel either in dry casks or pools capable of ensuring safe containment for 50 to 100 years. According to DOE's data, spent power reactor fuel would contain approximately 12 to 19.4 billion curies by the time reprocessing commences. This is about 24 to 45 times the radioactivity currently contained in high-level wastes stored at the SRS site. Based on DOE's recovery goals for UREX+, waste generation and environmental discharges are likely to be considerable:*

In fact, the NRC, in its Waste Confidence Decision stated that dry casks have been determined to be safe for "at least 100 years." Current SRS radioactivity has experienced decades of radioactive decay. The current total radioactivity at SRS does not indicate a threshold or limit to hazardous conditions.

> *Approximately 7.5 to 12.4 billion curies of cesium- 137 and strontium-90 could be separated for decay storage. After 300 hundred years DOE proposes to dispose of the material as low-level wastes. (See Figure 1 on page 4.) No other nation has adopted this proposed disposal policy. The amounts of cesium and strontium from reprocessing to be ultimately disposed in the near surface could be about 10 to 20 times*

> *greater than in all of DOE’s defense high-level wastes scheduled for geological disposal. Because of large potential concentrations, the time frame for decay storage could be 600 years or more before these wastes meet low-level waste disposal criteria. Moreover, there are no federal standards nor safety criteria that govern this situation such as disposal timelines, radiological concentrations, heat controls, protective waste forms and packaging. The absence of such standards has resulted in about 121 million curies of cesium and strontium capsules separated from high-level wastes at Hanford now being stored in pools inside a building built in the 1940’s. After less than 25 years, these encapsulated sources have experienced costly leaks.*

Those federal standards and safety criteria to govern this situation can readily be, and should be, established. The “1940’s era facility” is actually the Waste Encapsulation and Storage Facility (WESF) at Hanford, which was constructed in 1974.[VIII,IX] Citing problems with facilities at Hanford, not designed for long term use, is not relevant to GNEP. Because no other nation had adopted this type of disposal policy does not mean that it will not work or is not safe, nor that they have rejected or even considered it. This is a <u>global</u> initiative and eventually other nations may adopt such a strategy (if they do not have their own already).

The current quantity of Cs and Sr in defense wastes are not a measure of limits or hazards. Because of large potential concentrations, the time frame for decay storage could be 600 years or more before these wastes meet low-level waste disposal criteria.

The encapsulated sources experienced <u>one</u> costly leak, which, along with gross testing of capsules, led the DOE to encapsulate 23 similar capsules in stainless steel overpacks.

> *Chemical separation of cesium-135 from highly active cesium-137 is not feasible, and such large quantities of this long-lived radionuclide, thousands of times greater than in all DOE defense high-level wastes, could also be disposed in the near surface. After 600 years Cs-135 could become a significant source of contamination. With a half-life of 2.3 million years, a panel of the National Research Council warned in 2000 that onsite disposal of a much smaller quantity of Cs-135 in wastes at SRS “represents a long term safety concern.”*

After 600 years, Cs-135 will become the dominant source compared to Cs-137, which will have decayed by a factor of more than one million. That does not establish that the cesium is any greater “source of contamination” than when it was mixed with cesium-137. How might the Cesium be a problem? Is large leakage assumed? Planned monitoring of disposal sites, as has been practiced for decades, can be expected to be mandatory.

NRC 2000 refers to the Cs-135 “safety concern” with respect to uncertainties about current regulatory requirements for treating SRS waste salts in the minor context of considering an alternative waste process unique to SRS, stating: “Barring an actual analysis, however, the ability of the site to meet these performance objectives remains uncertain. The direct grout waste stream is unusually high in long-lived radionuclides for a near-surface disposal facility. In particular, the concentration of cesium-135 in the direct grout supernate waste stream represents a long-term safety concern.”

Also, it is not a barrier to GNEP waste disposal if the small quantities of remaining long-lived fission products, including, e.g., iodine-129 (15.7 million year half-life), which could be

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VIII. Backgrounders and Fact Sheets “B Plant and the Waste Encapsulation and Storage Facility (WESF),” U.S. Department of Energy Richland Operations Office (2006). http://www.hanford.gov/rl/?page=1102&parent=1091
IX. Improving the Scientific Basis for Managing DOE's Excess Nuclear Materials and Spent Nuclear Fuel, Board on Radioactive Waste Management; National Research Council, Washington DC (2003).

determined to be small radioactivity sources to be added to intermediate-level waste repositories, or even the then operating high-level waste repositories instead of shallow-land burial. This would simply depend on the rationalization of regulatory analyses and standards of the time, including consideration of the solid form of the waste products. Again, these sources will also be trivial additions to the naturally-occurring long-lived radioactivity in soils. In addition, these fission products are not transuranic alpha emitters, but very low energy beta emitters, comparable to, e.g., natural potassium-40 (1.3 Billion year half-life), rubidium-87 (48.8 Billion year half-life), and tritium, carbon-14, sodium-24 (with effective infinite half-lives as they are continuously produced by cosmic radiation striking the atmosphere), and other ubiquitous primordial and cosmogenic radioactivity sources.

> *Separated transuranics would contain as much as 638 metric tons of plutonium-239 — more than two and a half times the amount produced worldwide for nuclear weapons. Assuming 99 percent recovery, (TRU) process losses could contain as much as 24 times more radioactivity than TRU wastes generated for nuclear weapons during the Cold War. These wastes are highly radioactive, and will require costly remote handling and nuclear criticality controls. TRU wastes from the UREX process will constitute a unique waste stream that was not previously envisioned for disposal the Yucca Mountain site. If they are required to meet DOE's current geological disposal criteria for remote-handled transuranic wastes, the projected volume could be as much as 65 times greater than from nuclear weapons production.*

The current quantity of TRU from defense wastes is not a measure of limits or hazards. These wastes are highly radioactive, and will require costly remote handling and nuclear criticality controls. Plutonium that can't be separated from the other wastes is not a proliferation concern. The controls and handling have been in use for decades. The volume of waste may be more than in the past, but is much less than the volume generated in a short time from fossil fuels.

Such costs of remote handling are a normal cost of doing business, as with many hazardous materials in commerce, and are sufficiently well-known to establish that they would not significantly affect the economic performance of the fuel cycle considering the value of recovered materials, and reduction in natural uranium extraction and waste repository costs.

In addition, used fuel was not originally envisioned for disposal in deep geological repositories; and this waste disposal form has resulted in extreme waste packaging costs and repository volumes that were not anticipated when technical decisions to dispose of solidified high-level wastes in deep geological repositories.

> *Assuming 90 percent recovery, approximately 57,000 to 95,000 tons of uranium could be separated. Because of increased levels of uranium- 236 that reduce fissionability, recycle of uranium will require a new, large-scale re-enrichment facility. However, DOE research indicates there may be difficulties in removing transuranic elements. If so, recovered uranium may not be suitable for recycle in power reactors and may require disposal in a geological repository, which is not currently authorized by law.*

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Current law reflects imprecise interpretation of current knowledge and political judgments which is subject to revision to respond to significant advances in knowledge and conditions. Because it is not currently authorized by law does not mean laws will not change in the future as the technology evolves.

> *Gaseous discharges such as tritium (H-3), carbon- 14 (C-14), krypton-85 (Kr-85), techtnetium-99 (Tc-99) and iodine-129 (I-129) could be considerable. Assuming DOE's recovery goals can be achieved, environmental discharges of Tc-99 (half-life of 218,000 years) are comparable to the inventories in high-level wastes at SRS and the Hanford site. Environmental discharges of Iodine- 129 (half-life of 15.7 million years) could be up to three times than in DOE defense high-level wastes at SRS and Hanford. Long-term doses from the disposal of a far less amount of I-129 remain an obstacle for onsite disposal of tank wastes at Hanford.*

Discharges are not considerable unless they cause people or the environment to exceed the allowed yearly dose. These allowed doses need to be compared to the yearly dose from natural releases from the earth, including periodic spikes from volcanoes. In addition, these facilities will be engineered and operated to comply with regulatory requirements for gaseous and liquid releases from reprocessing facilities, to result in inconsequential environmental radioactivity, and radiation exposure to persons, offsite.

Constraints on onsite disposal of Hanford tank wastes associated with I-129 are a result of the original waste processing methods and forms. As stated above, the engineering of specific processing and ultimate disposal forms will be in accordance with regulations which, for the long-lived fission products, after 300 or 600 years, will be small remainders with no heat generation and, depending on processing methods, potentially small volumes, and may include alternative disposal in intermediate- or high-level waste repositories.

> ***Costs***
>
> *The domestic experience with commercial reprocessing <u>does not inspire confidence</u>. According to a recent review by the U.S. Nuclear Regulatory Commission (NRC), after 6 years, "significant radiation protection problems" led to the closure of the only operational commercial reprocessing plant near Buffalo, N.Y. in 1972. Cleanup of this plant is estimated by DOE to cost taxpayers $4.5 billion and take 40 years. More recently, DOE researchers found that "there are very large cost uncertainty ranges for these facilities." For instance:*
>
> - *According to a DOE study done in December 2006, the per-unit cost for reprocessed material would double if process capacity does not exceed 50 percent.*
> - *Another recent DOE analysis implies that if uranium were recycled, the current price for uranium would have to increase four fold for a UREX+ facility to be economically competitive.*

If "the domestic experience" includes the rest of the world, e.g. the large French program, confidence increases. The early U.S. domestic attempt is part of the learning curve.

In fact, the spot price of uranium, which is now traded on commodity markets, has increased more than ten-fold in response to current world nuclear power development, and uranium prices continue to increase. Longer-term increases in world energy requirements will substantially increase the demand for, hence the price of, uranium. In addition, the cost of disposing of high-level waste will be reduced compared to the cost of disposing of used fuel, including the cost of opening additional repositories.

> - *The same analysis found that reprocessing, waste management and transmutation costs would consume would add [sic] as much as 33 percent of the price for nuclear generated electricity.*

Oddly, this statement was not reflected in Section VIII "Costs." However, nuclear power already internalizes the costs for both decommissioning and waste disposal (once-through); yet it still has the lowest marginal cost of any power produced in the U.S. Other energy sources do not include the externalities (e.g. sequestration of all wastes) of their use like nuclear power. If this is an increase in the cost, it will still be very competitive in the future as fossil fuels get more expensive and have additional environmental regulations placed upon them. We note a recent French claim that the cost of reprocessing and recycle once to PWRs adds less than 6% to the cost of electricity.[X]

- *Based on recent estimates by the U.S. Uranium Enrichment Corporation, a new enrichment facility of the scale to recycle recovered uranium would cost $2.3 billion.*

Such a cost is equivalent to just one nuclear power plant, which would not significantly affect the economic justification of nuclear power and nuclear energy in meeting the power and energy requirements of the U.S. and the world. In addition, this is a very small cost to drastically reduce the environmental impacts of energy extraction and use. Such fuel costs would be a small fraction of the relative costs of fossil fuels. It is unavoidable that increases in the price of electricity will be part of the cost of a clean environment, just like increased sticker prices of automobiles decades ago.

> *Other cost estimates suggest that reprocessing costs may exceed costs for geological disposal. In 1996, a panel of the National Academy of Sciences (NAS) assessed elements of the GNEP initiative and concluded that capital and operating costs for a reprocessing plant that would handle 62,000 metric tons ranged from $30 to $150 billion.*

Such costs are only partial costs of the selection of nuclear fuel cycle alternatives. This cost must be amortized over all the years and all the electric power sold, while also considering that ratepayers are putting more than three-quarters of a billion dollars into the nuclear waste fund every year.

> *Additional waste processing and disposal costs associated with UREX+ may be considerable:*
>
> - *According to British Nuclear Fuels, Limited the control and disposal of krypton gas would cost about $600 million.*
> - *DOE research indicates that control and disposal of tritium discharges would be in excess of $2 billion.*
> - *Based on estimates developed by an advisory panel of the British government in 2004, costs for decay storage are approximately $30 billion.*

The costs associated with the above discussion are in many instances based on estimates and do not consider the cost of not recycling used nuclear fuel for future reactors and the time factor of money (amortization).[XI] Costs of krypton gas and tritium control will be assimilated, and more precisely estimated, within the design studies for the reprocessing plant. Decay storage costs are required in any alternative; such costs are normal costs of nuclear fuel cycle economics. All these costs may be modest for the multi-year program considered for a large part of the nation's electric power.

X. P. Pradel, "Assessment of Nuclear Power Development and Growing Uranium Demand," MIT Intl. Symposium Rethinking the Nuclear Fuel Cycle, Massachusetts Institute of Technology (October 2006).

XI. "The Economics of Reprocessing Versus Direct Disposal of Spent Nuclear Fuel," *Nuclear Technology*, June, 2005

5. Comments on RW & GNEP ‘III The “Once Through” and “Closed” Nuclear Fuel Cycles’

Section III of RW & GNEP, “Once Through and Closed Nuclear Fuels Cycles,” is critical of early AEC estimates of deployed reactors and the resulting optimistic estimates of resource demand which produced a sense of urgency about the problem of uranium exhaustion, leading to the need for the development of the fast reactor and reprocessing. The report states “uranium supplies swelled into a world-wide glut.” As global expansion of nuclear energy begins to accelerate, world uranium prices have increased six-fold in the last 2.5 years. Rather than suggesting a “glut”? Are we seeing the effects of a finite supply of uranium resources coupled with increasing global demand and expectation of future demand?

> *Recognizing the extraordinary hazards of high-level radioactive wastes, Congress passed the Nuclear Waste Policy Act in 1982 requiring they be disposed in deep geologic repositories so as to protect humans for at least hundreds of millennia. Under the Act, intact spent fuel rods were to be sent directly to a repository — a “once through” nuclear fuel cycle. Radioactive materials in spent fuel are bound up in ceramic pellets and are encased in durable metal cladding, planned for disposal deep underground in thick shielded casks.*
>
> *The “once through” nuclear fuel cycle was adopted by President Carter in 1977. Three years earlier, India exploded a nuclear weapon using plutonium separated from power reactor spent fuel at a reprocessing facility. President Ford responded in 1976 by suspending reprocessing in the United States. President Carter converted the suspension into a ban, while issuing a strong international policy statement against establishing plutonium as fuel in global commerce. President Carter’s decision reversed some 20 years of active promotion by DOE’s predecessor, the U.S. Atomic Energy Commission (AEC), of the “closed” nuclear fuel cycle. The AEC had spent billions of dollars in an attempt to commercialize reprocessing technology to recycle uranium and provide plutonium fuel for use in “fast” nuclear power reactors. Reprocessing consists of mechanical chopping of irradiated fuel elements, followed by the dissolution of spent fuel in nitric acid. The dissolved fuel is then treated with a mixture of solvents in several complex steps to separate plutonium, uranium, and other isotopes. This process, known as PUREX (Plutonium URanium EXtraction), was developed in the 1950’s by the United States for the chemical separation of plutonium for use in nuclear weapons.”*

India’s atomic weapon was instead developed from Canadian-design CANDU research reactor-irradiated fuel, which was operated as a production reactor with low burn-up. In current fuel cycles, the fuel remains in a reactor for several years, which degrades the isotopic quality of the plutonium such that it is extremely difficult to use in a nuclear weapon.[XII] Many now accept that the decision by initiated by Pres. Ford and finalized by Pres. Carter was a mistake that left the U.S. far behind in separation technology as compared to France and Japan. The vision of GNEP is to have strict oversight of all reprocessing facilities. If GNEP would have existed in 1974 India might not have been able to develop a weapon.

In addition, the concept that if the United States halted reprocessing, other nations would follow proved an empty promise. Other countries did not follow what the U.S. wanted to do and the U.S. already had more then enough nuclear weapons. So stopping the reprocessing in the 1970’s

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[XII] From the Federation of American Scientists at http://www.fas.org/nuke/guide/india/nuke/: “India acquired a Cirus 40 MWt heavy-water-moderated research reactor from Canada and purchased from the U.S. the heavy water required for its operation. In 1964, India commissioned a reprocessing facility at Trombay, which was used to separate out the plutonium produced by the Cirus research reactor. This plutonium was used in India's first nuclear test on May 18, 1974” brings us to the same argument today. The U.S. has lost 30 years of technology that other countries have exploited. In terms of proliferation, a country does not have to reprocess used fuel from a reactor. Instead some countries have adopted an easier route with centrifuge enrichment. So the argument made in the 1970's for halting reprocessing only hurt the U.S. as other countries moved ahead; we may now need to learn from their technologies.

> *It was reasoned that fast reactors generate more subatomic particles, known as neutrons, than conventional power plants and it is neutrons which split uranium atoms to produce energy in conventional reactors. Because of their potential abundance of neutrons, plutonium-fueled fast reactors held the promise of producing electricity and also making up to 30 percent more fuel than they consumed."*

The excess plutonium fuel is created by the absorption of excess neutrons in abundant non-fissile uranium-238 process by which the converting isotopes to fissile plutonium-239. This creates fissile nuclear fuel in addition to the small amount of fissile uranium-235 isotopes (0.7%) in natural uranium. Thus, recycling uranium could make the nuclear fuel cycle totally sustainable for centuries or millennia.

> *In contrast to existing power reactors in the United States, a fast reactor uses different coolants, such as liquid sodium* [instead of water in a conventional light water reactor]*, so the neutrons remain at high energies and can be captured by uranium atoms — to produce plutonium-239, which would subsequently be extracted and remanufactured into new plutonium fuel — a closed cycle.*
>
> *In 1974, the AEC declared that by the end of the 20th century some 1000 reactors would be on line in the United States.*[2] *As a result, the AEC predicted that world uranium supplies would be rapidly exhausted.3 And so large-scale reprocessing and fast reactors would have to be deployed, no later than the mid 1980's. However, this prediction never materialized. Uranium supplies swelled into a world-wide glut, while nuclear power growth turned out to be a small percentage of what was predicted. The only U.S. commercial reprocessing plant in the U.S. operated near Buffalo, NY, between 1966 and 1972. Operations were suspended at the West Valley Site in 1972, when significant radiation protection problems forced the plant's shutdown for upgrades. The plant was permanently shut down in 1976 after it was determined that the site could not meet regulatory requirements to process commercial spent fuel. During the six years of operation, the plant processed approximately 640 metric tons of spent nuclear fuel, about three-fourths of which was provided by the AEC (60 percent of the total was from U. S. defense reactors). Over 600,000 gallons of liquid high-level radioactive waste was produced during reprocessing. The radioactive waste cleanup was estimated in 2001 by the DOE to take over four decades with a total cost to the federal government and the State of New York at $4.5 billion. By 1982, proliferation concerns <u>combined with technical and cost problems</u>, led to the abandonment of commercial reprocessing in the United States and an end of federal funding for breeder reactors."*

Again, the concept of proliferation concerns in the U.S. is an interesting comment, unless the U.S. was going to send this technology overseas. As noted before, the U.S. has more than enough nuclear weapons, so stopping the technology for this reason is not logical. The time frame mentioned above was during a period of very anti-nuclear politics (post TMI) with many members of Congress were either unaware of the technology or pressured by the negative media attention given to nuclear power.

Again, deceptive wording was carefully chosen for the above paragraph. The AEC projected rather than "declared" that 1000 reactors could (not "would") be in use in the United States by 2000. The resulting prediction of requirements for fast reactors has been delayed for a variety of reasons. Uranium supplies did swell into a world-wide glut, a situation that appears to have been totally reversed recently with the rapid nuclear expansion in China and elsewhere. Nuclear power growth, indeed growth of all energy demand, did turn out to be a small percentage of forecasts. However, the West Valley plant was shut down because upgrades to increase reprocessing capacity and make facility changes to meet new regulatory requirements were too expensive. The plant was permanently shut down in 1976 after it was determined that the costs of plant back-fit modifications required by the AEC and state regulators would make the plant uneconomic.[XIII]

The last statement in the previous section (underlined) also conflicts with the author's previous statements that President Ford "suspended" (1976) and Carter "banned" (1977) reprocessing. Technical and cost problems had nothing to do with suspension of commercial reprocessing. In fact, commercial reprocessing is being done successfully by the French, and a claimed cost of reprocessing and single recycle adds less than 6% to the cost of electricity. [X] In addition, the statement neglects another reason for the end of federal funding for breeder reactors—political opposition from the environmental movement. Earlier, thorium-uranium breeding in light water reactors was demonstrated at the government's demonstration facility at Shippingport, PA. The whole plant was subsequently decommissioned and removed to six feet below grade as a demonstration of successful decommissioning and decontamination of a nuclear site.

XIII. "Plutonium Recovery from Spent Fuel Reprocessing by Nuclear Fuel Services at West Valley, New York from 1966 to 1972," Prepared by U.S. Department of Energy (1996). http://www.osti.gov/opennet/document/purecov/nfsrepo.html

6. Comments on RW & GNEP "IV Nuclear Waste Disposal Problems"

In section IV of RW & GNEP, "Nuclear Waste Disposal Problems," the ISP highlights what some would have to refer to as ancient history. These experiences were the early learning that occurs in any industry, and they occurred in a time when we were more concerned with survival, first during a world war, then during a cold war, than with the environment or individual health and safety. Those times have changed, which is one reason for the DOE's new focus on GNEP.

> *Twenty-five years after the Nuclear Waste Policy Act was enacted, the government's nuclear waste disposal program is being impacted by legal challenges, technical problems, scandal and congressional funding cuts. As a result, the schedule for the proposed Yucca Mountain disposal site in Nevada has slipped almost two decades past the original* [Congressionally mandated] *opening date of January 1998. The 1982 Nuclear Waste Policy Act imposes a limit of 70,000 metric tons of high-level radioactive wastes. If that amount is exceeded, the law requires a second repository to be selected. Under the law, DOE spent fuel and high-level wastes are to make up no more than 10 percent of this limit.*

Certainly legal challenges have been a cause of delays, many frivolous and some brought by sponsors of the RW & GNEP Report. We are unaware of technical problems that could legitimize the schedule delays seen to date, but we are quite aware of the political opposition that has instead caused them. The authors chose not to reveal the specifics of "the scandal," but obviously included the emotionally charged word to detract from the progress made in the project. And as to congressional funding cuts, what high-profile, very long-term program of the U.S. government has not experienced funding reductions or outright cancellation?

> *The DOE concluded in 2004 that 63,000 metric tons of nuclear spent fuel could be stored in the Yucca Mountain site, but continued operation of reactors would generate about 105,000 metric tons by 2030. In effect, by the time the Yucca Mountain Site would be full, nuclear power plants will have accumulated nearly the same amount of spent fuel stored at reactor sites today — requiring the establishment of a second repository. (See figure 3.) In response to these problems, DOE is seeking to restore the closed fuel cycle through deployment of large-scale nuclear reprocessing and "fast" reactors. By doing this, GNEP proponents claim that a much smaller amount of high-level nuclear waste would have to be disposed in a geological repository, while troublesome stocks of weapons materials would be greatly reduced. Instead of using fast reactors to make more fuel than they consume, GNEP advocates propose to harness this technology to transmute or "burn" long-lived radioactive materials, such as plutonium into less problematic isotopes.*

Rather than a limited capacity, GNEP studies demonstrate that the physical capacity of Yucca Mountain could be increased dramatically, up to a factor of over 200,[XIV] if the research and development program for envisioned processing technology is successful. It isn't simply that a "much smaller amount of high-level nuclear waste would have to be disposed," rather, the technology proposed would lessen the decay heat of the product sent to the repository, thus expanding the national nuclear generation that Yucca Mountain could support. The great news from these studies is that a single repository could physically accommodate all of the GNEP high level wastes generated in the remainder of this century, even if nuclear power were to grow at 2-3 percent per year.[XV]

XIV. R. Wigeland, "Interrelationship of Spent Fuel Processing, Actinide Recycle, and Geologic Repository Design," MIT Intl. Symposium Rethinking the Nuclear Fuel Cycle, Massachusetts Institute of Technology (2006).

XV. M. Lineberry, R. Benedict, and C. Solbrig, "Avoiding Need for Multiple Repositories in a Nuclear Growth Scenario," *Proc. Waste Management '04,* WM-4432, WM Symposia, Inc. (2004). http://www.wmsym.org/abstracts/2004/pdfs/4432.pdf

7. Comments on RW & GNEP "V Defense High Level Wastes"

In Section V of the RW & GNEP report, "Defense High Level Wastes," the authors make an unconvincing linkage between historic defense waste practices and that which would be used in a modern, state-of-the-art reprocessing plant. At the Idaho Chemical Processing Plant, for example, naval reactor cores were reprocessed for the sole purpose of recovering uranium. Plutonium and minor actinides were sent with fission products to high-level wastes, which were eventually calcined into a relatively stable form for longer-term storage. Such treatment of plutonium and minor actinides would be unthinkable in any process today.

> *Now, through GNEP, the DOE is seeking to resurrect the vision of a "closed" fuel cycle possibly at the Savannah River Site. For nearly 50 years the United States operated several large reprocessing plants to chemically separate 100 tons of plutonium from spent production reactor fuel for nuclear weapons. DOE has also accumulated spent nuclear fuel from past material production and research reactors. As of 2001, DOE high-level wastes and spent fuel contained about 2.4 billion curies.*[4]
>
> *About 100 million gallons of high-level radioactive wastes from reprocessing were generated and are stored in large underground tanks at the Hanford site in Washington, the Idaho National Engineering Laboratory and the Savannah River Site in South Carolina. Many tanks have leaked and threaten water supplies. High-level radioactive wastes resulting from production of nuclear explosives in the United States are among the largest and most dangerous byproducts of the nuclear age. According to the National Research Council in 2006:*
>
> > *"The Department of Energy's (DOE's) overall approach for managing its tank wastes is the following: To the maximum extent practical, retrieve the waste from the tanks (and bins in Idaho); separate (process) the recovered waste into high- and low-activity fractions; and dispose of both remaining tank heels and recovered low-activity waste on-site in a manner that protects human health and the environment."*[5]

Water supplies are not "threatened" by groundwater plumes from Hanford tanks that are slowly dispersing toward the large Columbia River flow. Projected releases of these groundwater plumes to the Columbia River are orders of magnitude less than natural radioactivity in the Columbia River, so they cannot possibly harm people or the environment. Monitoring programs which include test wells around the tank fields demonstrate that leaks have not reached water supplies.[XVI] As indicated by actual health and safety effects over the course of sixty-plus years, from a beginning with little technical knowledge and great scientific uncertainty, and with rudimentary technology and often short-sighted management, the successful AEC-DOE control of radioactive materials without significant consequences, especially as compared to human health and safety with other industrial and commercial processes and materials, has demonstrated the low danger from these materials. Problems with legacy wastes as products of the technologies and management during the Cold War do not represent, and are not indicative of, developed commercial reprocessing technologies. The long-term operation of COGEMA plants in France and the Sellafield plants in the UK represent early technology, and commercial operations of used fuel reprocessing, even including the current large THORP Plant leak (which had no adverse consequences), provide current experience to assess used fuel reprocessing.

> *DOE also has about 2,700 metric tons of spent reactor fuel. There are 256 types of spent fuel in the DOE inventory, and only a few have been analyzed. Most of this fuel (2,100 metric tons) is at the Hanford Site. Smaller amounts of spent nuclear fuel associated with nuclear weapons production are stored at the Savannah River Site. Spent nuclear fuel from the Naval Nuclear Propulsion Program is stored at the*

[XVI] XVI. Hanford Site Environmental report for Calendar Year 2005, PNNL-15670 (2006). http://hanford-site.pnl.gov/envreport/2005/groundwater/pnnl15670.pdf

> *DOE's Idaho National Engineering Laboratory (INL) and, for a short time, at some naval nuclear shipyards. The DOE will also assume responsibility for fuel from some special-case commercial nuclear reactors, foreign research reactors, and certain domestic research and test reactors.*

Finally, the defense waste legacy can only be weakly linked with Global Nuclear Energy Partnership conditions. The descriptions of practices at various national laboratories and other sites, e.g. INEL, West Valley, Hanford, and Savannah River (sections deleted herein because we do not comment on the contents), demonstrate the success of the health and safety and environmental protection programs, achievements of the AEC/DOE management of defense nuclear wastes. These programs included a steep learning curve of the short-term creation and development of entirely new nuclear technologies in a massive wartime project, followed by the imperatives of the cold war national defense and weapons programs and taking some shortcuts in meeting national defense priorities, over a period of decades of experience that included various errors and even accidents. Even so, there is no significant environmental damage or human health impact costs compared to most other major technology developments, despite some associated increases in long-term economic costs.

8. Comments on RW & GNEP "VI. Storage and Reprocessing"

> *DOE estimates that 175 shipments per year over 24 years will be required to move an accumulated spent fuel inventory of 63,000 metric tons. If SRS were to serve as the primary reprocessing operation for the United States this would translate into 4,200 shipments.*[17]

One shipment every other day does not seem to be a burden.
The Department of Transportation estimates that there are more than 800,000 hazardous materials shipments daily in the U.S. This would translate into 7 Billion shipments over 24 years. Most of these are flammable liquids.[XVII] These constitute much greater hazards than the transportation of used fuel or solidified high-level waste. In all the years of shipping radioactive material, in the weapons program and for power reactors, there have been no accidents that harmed the public.[XVIII]

> *This does not include shipments from other countries. A spent fuel storage facility for reprocessing at SRS would likely have the capacity to contain about 10,000 to 20,000 metric tons. (The French reprocessing plant run by Cogema has a storage capacity of 14,400 MTU.)*[18] *The spent fuel could be stored in pools of water, as the case in France and England. If the spent fuel is stored in a dry mode, this would translate into 1,000 to 2,000 casks (assuming current approved designs are used). Last year, the House Energy and Water Appropriations Committee stated that:*
>
> > *"In the Committee's view, any such integrated spent fuel recycling facility must be capable of accumulating sufficient volumes of spent fuel to provide efficient operation of the facility. A first test of any site's willingness to host such a facility is its willingness to receive into interim storage spent fuel in dry casks that provide safe storage of spent fuel for 50 to 100 years or longer."*[19]

Considering the delays to the Yucca Mountain project caused by failure to obtain public support or acceptance, passing this test will require a substantial public communication effort. In Vermont now, a small group of dissidents has slowed the progress of the Vermont Yankee plant in getting federal and state approvals for a power uprate, dry cask storage and license extension. Providing factual information to counter errors and omissions such as those in this report is necessary, but certainly not sufficient, to obtain that support.

> *A large reprocessing plant would have to operate for approximately 30-40 years to handle between 63,000 and 105,000 metric tons of spent fuel. According to DOE, a reprocessing plant would require a capacity of 2,500- 3,000 metric tons per year.*[20]

The picture accompanying this section is uncaptioned and uncredited, but presumably shows a technician checking on storage casks of some type. The fact that he is in street clothes demonstrates the safety of work with these storage media as well as other radioactive materials.

XVII. R. Craft, "Crashes Involving Trucks Carrying Hazardous Materials," Federal Motor Carrier Safety Administration, Office of Information Management Publication #: FMCSA-RI-04-024 (2004). http://www.fmcsa.dot.gov/facts-research/research-technology/analysis/fmcsa-ri-04-024.htm.

XVIII. "Safety of Spent Fuel Transportation," U.S. Nuclear Regulatory Commission, NUREG/BR-0292 (2003) (available in the USNRC Reading Room or http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0292/br0292.pdf)

9. Comments on RW & GNEP "VII. Radioactive Wastes from Reprocessing"

In Section VII, "Radioactive Wastes from Reprocessing," the authors again place the U.S. waste experience and current planning in improper context. While they correctly note that U.S. law prohibits disposal of GNEP waste at the Waste Isolation Pilot Plant (WIPP) in New Mexico, they inexplicably then apply WIPP waste criteria to GNEP waste. But trying to use WIPP waste criteria only obfuscates the issue. If used fuel were not processed in GNEP facilities, then clearly 100% of the transuranics would go to the repository. If, when processed, 1% of the transuranics end up as losses to waste, then 1% of the transuranics would end up in the repository. Which is better from the perspective of waste disposal, 1% or 100%?

Also the authors take exception to removal of Cs-137 and Sr-90 from the high level waste. The rationale for such a step is that these two isotopes dominate the decay heat characteristic of used fuel for several tens of years after removal from the reactor. But they both have half lives close to 30 years, and in 300 years their population is reduced by natural decay by a factor of 1000. Is it reasonable to suppose that a safe way can be found to isolate these waste products for 300 years? We think so, and point to structures all over the world which have survived intact for much greater periods. At the end of that period, perhaps the material could be disposed in low level burial sites, but if not, they can be placed in geological burial at that time. Or perhaps our descendents will have better technology than today. The point is by removing them and holding them out of the repository for that period, the repository capacity can be significantly increased.

> *In May 2006, the Energy and Water Appropriations Committee of the U.S. Congress also expressed concerns over the DOE's lack of cost data for GNEP:*
>
> > *"The Department has failed to produce a complete accounting of the estimated volumes, composition, and disposition of the waste streams that will be involved in GNEP. The Department has also failed to produce even the most rudimentary estimate of the life-cycle costs of GNEP. Before the Department can expect the Congress to fund a major new initiative, the Department should provide Congress with a complete and credible estimate of the life-cycle costs of the program."*[21]
>
> *The GNEP program is seeking to develop an aqueous reprocessing technology called UREX+ (URanium EXtraction). UREX+ involves a series of five solvent extraction process steps that would separate spent nuclear fuel into seven product and waste streams,*[22] *including:*
>
> - *Iodine-129 (half-life of 15.7 million years) for geological disposal*
> - U_3O_8 *[sic] for recycle in light water reactors or disposal as low-level wastes*
> - *Neptunium-237 and plutonium isotopes for mixed oxide fuel in light water reactors*
> - *Technetium-99 (half-life of 210,000 years) for geological disposal*
> - *Americium and curium for fast-reactor fuel*
> - *Cesium and strontium for decay storage and surface disposal*
> - *Mixed fission products for repository disposal*
>
> *UREX+ has no proven history of success and is several years away from an engineering scale demonstration. Chemical separations and waste treatment are more complex than the PUREX process, and involve several technologies that have yet to be demonstrated beyond the laboratory scale. (See Figure 6 page14*—not included herein*).*

While it is true that UREX+ does not have a long history of demonstrated performance, this statement is prejudicial and implies that there is no history. In fact, in 2003 Westinghouse Savannah River reported: "Demonstration of the UREX flowsheet at baseline conditions showed that the process will meet all goals for recovery and decontamination." [XIX], [XX] This demonstration was completed with actual used nuclear fuel from the Dresden nuclear power plant. The statement could have just as easily said that all the processes have been demonstrated on the laboratory scale or better, and an engineering-scale demonstration is a few years away. Of course, that would support the need for the GNEP program to include that engineering-scale demonstration—the opposite of the authors intentions.

> *As Tables 1* (not included herein) *indicates, a typical civilian reprocessing plant, based on the PUREX technology, has the following general waste streams and disposition paths:*

See Table 1 in the RW & GNEP report.

> *By comparison, the UREX+ technology is planned to not generate significant amounts of liquid wastes. Cost and performance data for large-scale deployment do not yet exist.*[23] *As Table 2 (page 14 —* not included herein*) indicates the assumed waste streams from the UREX differ from those of the PUREX process, particularly with respect to off-gas recovery and surface storage/disposal of cesium and strontium wastes.*
>
> ***Total Radioactivity** — The estimated total amount of radioactivity in spent power reactor fuel generated by 2030 would be approximately 11.8 to 19.4 billion curies. 24 By comparison, this is about 27 to 45 times the amount of radioactivity estimated by DOE in 2001 in the high-level wastes at SRS.*[25]

Production of electricity and other energy supplies by nuclear power reactors with high burn-up fuel is not directly comparable to low burn-up irradiation of targets to produce plutonium-239 for nuclear weapons. Inventories of plutonium-production wastes, from the PUREX process to separate pure plutonium, are not measures of the conditions or health and safety limits from the radioactivity from the UREX process which separates uranium from actinides with the greater mix of plutonium isotopes as a weapons-resistant "burnable" nuclear fuel. And again, we should expect that a program for the whole nation would produce a large quantity of waste, in this case radioactive waste. However, sixty years of experience prove that the relatively small volume of these materials can be handled safely.

In none of the following discussions of radioactive materials is the actual impact on the world's people presented. There is no discussion of danger because if there is any, it is so low as to not be measurable. The authors did not answer pertinent questions such as:

"What was the dose to the population compared to the naturally occurring dose?"
"What was the adverse impact on the environment?"
"What was the harm to people?"

> ***Plutonium-239** — The total amount of plutonium 239 in separated transuranics from U.S. commercial spent fuel would be as much as 638 metric tons.*[26] *This is more than 6 times the amount produced for the U.S. nuclear arsenal from 1944 to 1988,*[27] *and more than two and a half times the amount produced worldwide for nuclear weapons. Previous reprocessing experience in the U.S. and other countries has been based on using the PUREX technology. Worldwide stocks of separated plutonium from civilian nuclear power spent fuel have currently grown to 250 metric tons — enough to fuel more than 30,000 nuclear weapons.*[28] *This huge supply of nuclear explosive materials is accumulating at reprocessing plants in Western Europe, Russia, Japan and India. Efforts to "burn-up" these stocks of plutonium in "fast"*

XIX. T. S. Rudisill, et al., "Demonstration of the UREX Solvent Extraction Process with Dresden Reactor Fuel," Westinghouse Savannah River Company (2003). http://sti.srs.gov/fulltext/ms2003089r1/ms2003089r1.html

XX. G. F. Vandegrift, M. C. Regalbuto, A. Bakel, and D. L. Bowers. "Lab-Scale Demonstration of the UREX+1 Process Using Spent Nuclear Fuel," 2005 Annual Meeting of the Amer. Inst. of Chem. Engineering (2005). http://aiche.confex.com/aiche/2005/techprogram/P30240.HTM

> *reactors have proven difficult, costly and slow.[29] Only about one-third of this plutonium has been used as fuel in power reactors, leaving a surplus of about 200 tons of weapons-usable plutonium in civilian hands.*

The mention of the amount of Pu-239 being more than two and a half times the amount produced worldwide does not mean it is "weapons-grade" plutonium, but it could be used as a fuel in commercial reactors. In fact, there is another success story with the use of Russian weapons-grade uranium that was diluted down in enrichment to use as a fuel in U.S. reactors in the U.S.-Russia Megatons to Megawatts program. This fuel has been providing ten percent of U.S. electricity (fifty percent of nuclear generation) for years, and almost two years ago reached a milestone with the destruction of the equivalent of more than 10,000 Russian nuclear warheads.[XXI] This program needs to continue and to be accelerated to remove potential weapons material more quickly, including weapons grade and reactor grade plutonium.

The plutonium and the actinides will be continuously fissioned (destroyed) to produce useful energy for the U.S. and the world. Unlike plutonium stored for nuclear weapons, no significant amount of plutonium, much less pure plutonium-239 will be accumulated according to GNEP program plans. The plutonium is not weapons grade plutonium-239. It is a mix of plutonium isotopes that can make crude nuclear devices only by people with substantial intelligence, logistical and heavy-lifting support to steal and retain such plutonium stores, and then to have technological and industrial support capabilities to form such stores into potential nuclear devices, including implosion capabilities. These factors serve to enhance, not downplay, the justification to implement GNEP! GNEP intends to solve the identified problems, first, by incorporating the actinides into the separated plutonium to reduce weapons-potential and, second, by "burning" the plutonium and actinides in reactors to produce valuable energy supplies at accelerated plutonium destruction rates. While separated plutonium is a concern worldwide, the GNEP initiative would solve the problem by sending that plutonium to Advanced Burner Reactors (ABR). These fast reactors, depending on design, would lock up 5-10 tons of this plutonium for every 1 GWe of capacity. Thus between 60 and 120 GWe of installed ABRs would put 500-1000 tons plutonium into reactors, essentially the entire amount contained in commercial spent fuel, simultaneously producing electricity and removing plutonium from the legacy of clean nuclear energy. At about 100 GWe of installed capacity, the ABRs would match the installed capacity of the entire U.S. Light Water Reactor fleet today.

It would accomplish this while addressing the waste disposal problems and high costs caused by the unfortunate political decisions to attempt to dispose of used fuel instead of the appropriate waste form, solidified high-level wastes. The used fuel disposal problems are caused by the poor used fuel waste form, attempting to accommodate those weaknesses by high waste package integrity (eventually including even "drip shields" and other good-faith but misbegotten engineering solutions to address politically motivated problems); with repository constraints and limited capacities caused by high used fuel repository heat loads from both the short-term (300 years) fission products and the long-term (tens of thousands of years) actinides, by the unfortunate attempt to engineer used fuel disposal without adequate storage time for significant cooling, nor extracting high heat contributors in the used fuel.

XXI. "10,000 Nuclear Warheads Eliminated," U.S. Enrichment Corporation, Sep. 2005. http://www.MegawattstoMegatons.com and http://www.usec.com/v2001_02/content/Megatons/10K_Poster.pdf

> ***Decay Storage of Fission Products** — The GNEP plan envisions the separation and permanent surface storage /disposal of radioactive wastes, principally Cs-137 and Sr-90, which nominally take about 300 to 600 years to decay to safe levels. After 30 years of operation, approximately 7.5 to 12.4 billion curies (not decay corrected) could be separated and are likely to remain at the site.*
>
> *DOE researchers suggest these wastes could be converted into granular solids using steam reforming. Steam reforming processes waste in a high-temperature fluidized bed under a slight vacuum. The process is expected to destroy organics, nitrates and nitrites. Additives are expected to incorporate radionuclides, sulfate, chlorine and fluorine into a granular waste form.*
>
> *Specific criterion for waste form leachability for the 300-600 year decay time has not been established, much less for considerable quantities of Cs-135 in the wastes that pose safety concerns for tens of thousands of years. Nor has the granular product from steam reforming been assessed for leachability, which may also require development of high integrity packaging to meet disposal requirements. Additional processing may also be necessary, such as putting the granular product into a monolithic form, in order to meet waste disposal requirements. DOE-sponsored research suggests that cesium and strontium wastes should be stored in a water pool for 30 to 50 years prior to transfer for near surface- underground decay storage and disposal.*

Once again, one of the roles of GNEP is pointed out to be a deficiency of the program. The “specific criterion for waste form leachability” has not been established because this is one of the roles of the future GNEP program. Extracting cesium at this stage will produce a small quantity of low-activity/energy waste that can be readily disposed of in intermediate- or high-level waste repositories. We concur with the last statement in the preceding paragraph, but such actions and results are consistent with the GNEP program decisions that are to be made.

> *By comparison, in the early 1970’s approximately 131 million curies (decay corrected 1995) of cesium and strontium were separated and concentrated in 15 metric tons from defense high-level wastes at the Hanford site to reduce decay heat in waste tanks. According to the 2003 report by a panel of the National Academy of Sciences, these wastes “have been described as the nation’s most lethal single source of radiation other than inside an operating reactor.”[30] They were concentrated as salts and placed in stainless steel capsules for storage in pools. It was envisioned that these sealed sources would be used for commercial purposes such as food irradiation. However, this effort ceased after a capsule leaked at a commercial site in 1988 resulting in $50 million in cleanup costs.[35] They are now stored at a 1940’s era facility awaiting disposal in a geological repository.[31] While DOE has agreed with the State of Washington that the cesium and strontium capsules should be disposed in a geological repository, no credible plan has emerged to accomplish this plan. Dose rates range from 8,600 to 18,000 rems/hour for the Cs-137 capsules and from 20 to 420 rems/hour for the Sr-90 capsules. Concentrations are so great that the National Research Council panel concluded that it would take approximately 800 years for the strontium to decay to a level acceptable as low-level waste.[32]*

Extracting these sources from the waste tanks should be considered as to whether this was a responsible action for the AEC/ERDA/DOE waste stewardship responsibilities. It should be noted that these sources had been extracted from PUREX process wastes for government and commercial applications for many years, since the 1950s. While this was undoubtedly so stated in NRC 2003, it is instructive to note that RW & GNEP uses the phrase “have been described” which is far short of the NAS expressing their own considered confirmation of this as factual. It is the same here. In a previous statement, the Report addressed “the greatest source of radioactivity.” While this may or may not be the case, here the terms “lethal” and “radiation” imply human access to the source, in which case it would seem that typical high-dose irradiator facilities for, e.g., cancer therapy and other applications of linear accelerators, or for food or sterilization irradiation, may be greater lethal radiation sources. Of course, one would have to know the specific configuration of the various cesium-137 and/or strontium-90 capsule sources to assess this. However, obviously, this is simply an insignificant characterization of the nature or source of the hazard.

It should also be noted that early utilization of cesium-137 and strontium-90 sources extracted from PUREX waste streams have had substantial success since the 1950s. A very large use was for military and civilian Radioisotope Thermoelectric Generators (RTGs), especially for remote unattended power sources, including, e.g., the U.S. Navy's deep-sea monitoring network for Russian submarines.

The termination of the use of cesium irradiation sources caused by a single case of leakage, once the nature of the chemistry problem was known, was a gross over-reaction. The "1940's era facility" is actually the Waste Encapsulation and Storage Facility (WESF) at Hanford, which was constructed in 1974.[VIII] These wastes are not awaiting disposal, they are however awaiting the determination of transferring them for improved security, and a subsequent determination of whether they should be disposed of in a geological repository. The statement regarding the agreement with Washington State and the lack of a "credible" plan is incorrect, but could be revised to be accurate.

> *Concentrations of cesium and strontium in SRS waste tanks represent no more than a few percent of the total volume. However, if disposed on site, these radionuclides could remain a major dose contributor for 15 to 20 half-lives (450 to 600 years.)[34] It is therefore likely that the 300 year time-frame proposed by DOE for surface storage and disposal of cesium and strontium extracted from spent power reactor fuel could be substantially longer before concentrations reach the level allowed for low-level waste disposal. The existing regulatory framework for radioactive waste disposal does not address near surface decay storage and disposal of cesium and strontium from spent nuclear fuel.*

GNEP development will be consistent with meeting the regulatory basis to be established for ultimate disposition of decayed strontium-90 and cesium-137/135 capsules. The regulatory framework needs to be established, whether GNEP is implemented or not, and GNEP will be implemented accordingly; but it is not a significant priority health and safety issue for SRS or GNEP.

> *According to DOE spent fuel data, these wastes would still be highly radioactive after 300 years. Approximately 12.1 million curies would remain. If this quantity was to meet DOE tank waste disposal requirement for strontium and cesium at SRS, it would have to be diluted in more than one million cubic meters of waste volume. (DOE projects that 3 to 5 million curies35 of primarily strontium and cesium will be disposed in about 410,000 cubic meters36 of grout, known as "saltstone.") Assuming 90 percent recovery, as much as 1.2 billion curies of cesium and strontium could be lost to process. If one percent of the cesium and strontium lost to process were disposed as Class A low-level wastes this would result in more than 1 million cubic meters which is comparable to the total projected volume of low-level wastes from all DOE sites.[37]*

See the previous comment on this Cs & Sr comparison, which is not significant to GNEP implementation. The past 50 years provide examples of how much progress has been made, and how successfully, but not perfectly, our country has handled radioactive wastes and non-wastes. There is of course much to be done, but past successes provide confidence that technical problems can be overcome. For example, earlier in the report in the INEL pertion of Section V is an example of solidification of waste, and present dry cask storage uses leach-proof containers.

> ***Transuranics** — Assuming that 99 percent of the transuranics (TRU) from commercial spent power reactor fuel could be recovered[38] – as much as 63 million curies of TRU waste could be left behind in process losses.[39] This is approximately 24 times more radioactivity than in current TRU waste inventories at all DOE sites.[40] These wastes would be quite radioactive and would require a greatly expanded remote*

> *handling at SRS to process them for disposal in a geological disposal site. In particular, plutonium-241, plutonium-238, americium 241, and 242m have significant specific activities.*

Although TRU wastes may be handled remotely at SRS, they are relatively innocuous compared to many high specific activity, high radiation energy, radionuclide sources that are remotely handled safely with no adverse consequences to workers or the public. The SRS TRU is not a significant hazard, other than the hypothetical hazards of long-term gross environmental releases, which, as alpha emitters, they would be highly unlikely to exceed the human exposures to the great quantities of naturally-occurring long-lived alpha-emitters and their many short-lived decay products (including radon gas and its very short-lived decay products). In addition, "24 times" an innocuous specific activity is just a greater volume of an innocuous radioactivity source. Handling such increased volume is straightforward and affordable. This characterization of an increased hazard is invalid and misleading.

> *Current law prohibits disposal of GNEP waste at Waste Isolation Pilot Plant (WIPP), since it is only for defense related TRU. However, TRU wastes generated by the UREX process will constitute a separate and unique waste stream. DOE has yet to specify the disposition of TRU wastes from reprocessing. Waste volumes also appear to exceed the limits set by federal law. For purposes of comparison, if TRU wastes lost to process were to be packaged to meet the current waste acceptance criteria for disposal at the DOE's WIPP, this would yield approximately 1.3 million drums of remote handled TRU wastes, which is about 65 times greater than DOE's remote handled TRU wastes projected for disposal (20,000 drums).[41] The total amount of radioactivity in TRU waste from a reprocessing plant would be 8 times greater than allowed for disposal at WIPP under the Land Withdrawal Act of 1996 (P. L. 104-201, 110 Stat. 2422.)[42] Preliminary cost estimates for the characterization of DOE's remote-handled TRU wastes range from $400 million to $6 billion.[43] The estimated life-cycle cost for disposal of current DOE TRU wastes at WIPP is $ 17.6 billion (2007 dollars.)[44]*

The U.S. DOE needs to establish disposition of non-defense TRU whether or not GNEP is implemented. The Land Withdrawal Act was written (and laws generally are written) to reflect extant technical conditions; in this case, the legacy defense wastes and the lack of proposed commercial reprocessing. However, laws are revised to reflect changes in conditions as they develop (or more often, unfortunately, after they develop). Such is the case with the growing recognition of the imperative to expand nuclear power as a major component of rational U.S. and world energy policies. This follows the hiatus caused by the slowdowns in needs for growth of new large-scale base-load energy supplies riding on decades of 7% annual growth and associated installed capacity. This period of slow (1-2% annual) growth was accompanied by significant increases in nuclear power plant capacity and performance as well as an irresponsible national policy change to overturn the proscription on using natural gas supplies for electric power. Therefore, lawmakers must address changed conditions by revising laws to attempt to resolve competing interests under the changed conditions. More rational (legal and regulatory) requirements may reduce such extreme costs for such limited public health and safety risks, in addition to reduced costs from technology and management improvements.

The life-cycle costs could be further reduced with advanced technology. Much progress has been made in disposal of transuranics in the vitrification (turning into glass) process. Future developments may create more solid dilution methods for disposal, which could increase the volume of waste and the number of storage sites, but decrease the number of years during which the dose from the waste would be of concern. The choice of approach is again mostly a political decision. Progress is still needed in regulatory development and public acceptance. In addition, again the cost may be modest when averaged over the whole program.

> ***Uranium** — More than 95 percent of spent nuclear fuel are uranium isotopes, principally U-238. During irradiation in a reactor other uranium isotopes are produced, which contaminate the U-238. Of particular concern is uranium-232 contamination. U-232 is 60 million times more radioactive than uranium-238. This is due to high-energy gamma radiation emitted in the decay scheme of U-232 daughter products (thorium-228, radium-244, and thalium-228). Typically, U-232 is currently stored at DOE sites in amounts that are 5 to 50 parts per million. 45 Even though U-232 concentrations are small, in the range of 10 to 100 grams commingled in 2 tons of U-233, its gamma radiation constitutes a potentially significant external hazard.*
>
> *Another contaminant of concern is uranium-236. U- 236 is a neutron absorber which impedes the chain reaction, and means that a higher level of U-235 enrichment is required in the product to compensate. DOE has not estimated what the costs would be for a new re-enrichment facility to process 5,000 tons of previously irradiated uranium. Currently, a new enrichment facility that the United States Uranium Enrichment Corporation (USEC) is seeking to build is estimated at $2.3 billion.*[46] *Being lighter, both isotopes tend to concentrate in the enriched (rather than depleted) output, so reprocessed uranium which is re-enriched for fuel must be segregated from enriched fresh uranium.*
>
> *Current DOE research suggests that uranium recovered from reprocessing may be disposed as waste or recycled for use in nuclear power plants. However, according to the results of a DOE-sponsored experiment using actual spent fuel, "The criterion to contain less than 100nCi/g of TRU is most difficult to meet, requiring a decontamination factor from plutonium of >10 5. If the uranium is destined for recycle in reactor fuel, it purity requirements are greater…"*[47]
>
> ***Long Lived Fission Products** — Long lived fission products from high-level radioactive waste which dominate human exposures over long periods of time include I-129 (15.7 million year half-life), Cs-135 (2.3 million year half-life), Tc-99 (210,000 year half-life), Sn-126 (100,000 year half-life) and Se-79 (65,000 year half-life).*
>
> *Removal of cesium-135 (half-life 2.3 million years) in a reprocessing plant is not considered feasible because of the difficulties in isotopic separation from highly active Cs-137.*[48] [49] *About 36,000 to 60,000 curies of this radionuclide could be generated and remain in wastes for permanent surface disposal.*[50] *By comparison, this amount of Cs-135 is several orders of magnitude more than in high-level radioactive wastes at SRS.*[51] [52] *After 600 years Cs-135 will become the dominant source of radioactivity and human doses over long periods of time could be significant.*[53]

"Dominant" does not mean significant. This implies that a small dose over an entire human lifetime (say 1 mSv/lifetime) would cause cancer over one million years (say 10 person-Sv for a 100 year lifetime). And that, therefore, this is being used to indicate that this could cause a hazard that warrants extreme costs for waste disposal. Every shovelful of earth may have more potassium-40 radioactivity and radiation than the maximum exposure from release of the cesium-135 source.

> *Carbon 14 inventories in spent fuel are large. With a half-life of 5,700 years, C-14 is also naturally occurring and widely distributed in nature and is present in all organic compounds. During the chopping and dissolution phases, a reprocessing plant could release between 95,000 to 160,000 curies of carbon-14, none of which DOE contemplates recovering. While individual doses are small, C-14 poses risks to large populations. Using a cost benefit analysis adopted by the U.S. Nuclear Regulatory Commission ($1,000 per person per rem), the costs of reducing the amount of C-14 released from reprocessing U.S. spent nuclear fuel could be substantial.*[54]
>
> *Assuming 90 percent recovery, as much as 16,000 curies of carbon-14 could be released. By comparison, the contribution of C-14 produced in nuclear reactors and from DOE sites is estimated to be less than 600 curies per year.*[55]

The steady-state inventory of carbon-14 in the biosphere is about 300 million curies. There are about 13 million curies in the atmosphere. The cosmogenic production rate in the upper atmosphere is about 38,000 curies per year. These sources of carbon-14 contribute 1 to 2 millirem per year to the natural background dose that ranges from a low of less than 100 millirem per year to more than 1,000 millirem per year, with an average of about 300 millirem per year in the U.S. and 240 millirem per year in the world.

> *Wastes containing iodine-129 are of concern. Reprocessing plants have contributed the largest quantities of I-129 into the global environment. For instance, the Sellafield facility in England and the La Hague facility in France released a cumulative total of 1,440 Kg (250 curies) of I-129 — 32 times more than the quantities released from atmospheric weapons tests.[56] Beginning in 1994, direct releases from Sellefield and La Hague were 220 Kg/yr (40 Ci) and 18 Kg/yr (3.2 Ci) into the ocean and atmosphere respectively. Cold War-era weapons materials reprocessing at SRS has resulted in the largest measurable concentrations of I-129 in North America in the Savannah Rive. Spent nuclear fuel could contain as much as 3,900 curies of I-129 which is 62 times more than in DOE defense high-level wastes at Hanford and SRS.[57] [58] Assuming 95 percent recovery, this could result in 120 curies released into the environment — about twice that contained in HLW at SRS and Hanford. The long-term doses from several curies of I-129 are an obstacle to onsite disposal of secondary wastes associated with high-level waste processing at the Hanford site.[59]*
>
> *There would be between 950,000 and 1.6 million curies of Tc-99 in spent nuclear fuel. The current research target is to capture at least 95 percent of this radionuclide in the UREX process.[60] Assuming this goal can be achieved, about 47,500 to 80,000 curies of Tc-99 could be discharged into the environment. The total Tc-99 in SRS high-level wastes is estimated at 48,000 curies.[61]*
>
> ***Tritium** — The amount of tritium released from a reprocessing plant is considerable. With a half-life of 12.3 years, tritium is very mobile and readily absorbed in the environment. It poses both a localized and global risk of exposure. Tritium is released as a gas when the fuel is chopped and dissolved. The total tritium that can be released during reprocessing of LWR spent fuel is in the range of 800,000 to 1 million curies per year[62] – which is comparable to the tritium releases at SRS from the 1950's to the 1990's.[63] The retention and isolation of tritium has not been adopted because it is expensive as it requires relatively long term storage for 50 to 100 years and subsequent disposal. Since tritium is also a key ingredient for nuclear weapons, its retention and storage would also require increased safeguards, material control and accountancy.*
>
> ***Noble Gases** — Other radioactive gases released during chopping and dissolution also include isotopes of krypton and xenon. Because they are chemically inert, these gases are released from the reprocessing stack directly into the atmosphere. Of particular concern is Kr-85, which has a half-life of 11 years. Like tritium and carbon-14, Kr-85 poses both local and global exposure risks. In 2004, the La Hague reprocessing plant released about 7.7 million curies of Kr-85 into the atmosphere — perhaps half of the input of Kr-85 released worldwide from nuclear activities.[64] The inventory of Kr-85 in U.S. spent nuclear fuel is in the range of 250 million curies. By comparison, the amount of Kr-85 estimated to have been released at the DOE's SRS site from 1954 to 1989 is approximately 15 million curies.[65] Thus, assuming 90 percent recovery, Kr-85 releases would be about 60 percent greater than SRS releases.*

There is much of discussion in this section on the potential amounts of radioactive material, but there are no specifics of 1) as to how these are going to completely leak out to the environment, 2) pathways to the population, and 3) the population that is going to be exposed. Manyf large quantities and elements are mentioned, but the U.S. has dealt with these wastes for decades and there have been no definitive studies showing negative impacts on the population.[XXII, XXIII]

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10. Comments on RW & GNEP "VII Costs"

In Section VIII, "Costs," the authors absurdly point to the NAS/NRC study completed 10 years before and draw conclusions about the "plan envisioned under GNEP," whereas GNEP was first put forward as a concept in 2006. Much changes in science, technology, and global politics in ten years.

> *Recently, the DOE submitted its budget request to the U.S. Congress for Fiscal Year 2008. DOE is requesting $405 million for GNEP, of which $395 million will be the Advanced Nuclear Fuel Cycle Initiative within the DOE's Office of Nuclear Energy.*[66] *DOE is aggressively pursuing concurrent strategies of research and development and technology deployment. However, DOE has yet to provide baseline life-cycle cost estimates and an overall procurement strategy.*
>
> *The costs associated with major elements of GNEP were provided at the request of DOE in 1996 by the National Research Council of the National Academy of Sciences. The NAS panel concluded that the plan envisioned under GNEP would cost some $500 billion and require "approximately 150 years to accomplish the transmutation."67 Capital and operating costs for a reprocessing plant in the U.S, according to the NAS, would range from $30 to $150 billion.*[68] *The NAS panel also concluded that this program was uneconomical and would require a federal subsidy of $30 to $100 billion.*[69]

The term "uneconomical" must be taken in context with global economics, a comparison to the costs of global environmental impacts, and the cost benefits to mankind of NOT burning coal. Many consider a price tag of $500 billion and a time period of 150 years to accomplish recycling and transmutation of nuclear waste a very small price to pay to defeat the scourge of environmental degradation and its potentially devastating effects on the human population, biosphere and economies of the world as the energy use of eight to ten billion people grows to match that of the developed nations by mid-century.

> *There were several principal issues identified by the panel which would effectively increased costs:*
>
> - *"…the magnitude of the development and demonstration program required before wide-scale implementation of a transmutation strategy can be implemented;*
> - *difficulty in obtaining a government financial commitment because of the expected high cost of transmutation technology development/implementation and the difficult-to-quantify benefits to public health and safety; and*
> - *difficulty in attracting private capital due to the perceived high technical/economical/institutional risk of reprocessing/transmutation projects relative to alternative opportunities for investment capital, resulting a higher cost of capital due to the higher perceived risk."70*
>
> *A more recent analysis done in July 2006 by the DOE's Idaho National Laboratory (INL) concluded:*
>
> > *"The specific designs and methods for separation in a future fuel recycle facility have not yet been determined. There are limited cost data available on new recycle facility costs that would be applicable to a United States facility construction application. The AFCI program has compiled historical reports and studies on recycling and has determined that there are very large cost uncertainty ranges for these facilities."*[71]

In fact, we should continue working to determine costs and reduce the uncertainty precisely because we of this cost uncertainty. Did the nation know in 1961 the true costs of reaching the moon in 1969?

> *The 2006 INL analysis indicates that two thirds of the total costs for a reprocessing plant would be operational. As a first-of-a-kind facility, a large-scale UREX+ facility may have a lower annual processing capacity, which would significantly affect economic viability of this project. For instance, a 50 percent reduction in capacity would double the cost per unit.*[72]

> *Given these risks, the analysis concluded that "the lowest unit costs and lifetime costs follow a fully government owned financing strategy, due to government forgiveness of debt as sunk costs."73 A separate INL study done in December 2006 underscores this finding, indicating that the cost of the UREX+ process would be about $1,279 per kilogram of spent fuel.*[74] *This indicates that the price of uranium would have to increase to about $400 per pound — more than four times the current price - in order for reprocessing to be economical.*[75]

This cost has recently increased to more than $100/lb., and commodities traders suggest that it will continue to increase as nations continue, and possibly accelerate, their nuclear expansion. While there is no way of knowing if it will ever reach $400 per pound, it is very unlikely it will ever return to the $10 per pound price of a few years ago. Supplies of uranium, like oil, coal and natural gas, are finite. But unlike fossil fuels, uranium can indeed be recycled, and it can be done so multiple times.

> *Costs associated with reductions in radioactive effluent emissions from reprocessing are considerable:*
>
> - *The retention and isolation of tritium requires storage for 100 years and subsequent disposal. In 1986, SRS researchers estimated the cost of controlling H-3 discharges from a reprocessing facility at $2.7 billion (2007 dollars).*[76]
> - *In 2002, British Nuclear Fuels estimated that the costs of retaining and disposing of krypton-85 discharged from its reprocessing plant would be $500 to $600 million.*[77]

All of these are precisely why GNEP should be supported on a world wide scale. Development of new technologies requires time, effort, and expense; for a technology that will benefit billions, the investment in time, effort, and financial resource should be expected to be massive. Doing so with a global partnership could lead to a set of optimum solutions in reduced time and at a minimal economic burden to all of the nations involved. Thus, we could be on the road earlier to saving the environment while expanding the availability of clean, affordable, reliable, environmentally sound, safe, secure, and sustainable nuclear energy for the citizens of the Earth.

> - *As mentioned previously, disposal of one percent of process losses from cesium and strontium extraction as low-level waste could result in more than 1 million cubic meters. Currently, DOE's lifecycle estimate of 410,000 cubic meters for disposal of SRS tank wastes onsite is $2.8 billion.*[78]
> - *Life cycle costs of decay storage of cesium and strontium remain uncertain. However, based on data from the Sellafield reprocessing plant, the decay storage of cesium and strontium would cost about $18.9 billion for operating costs associated with treating the wastes and $11.2 billion for 600 year interim storage (2007 dollars).*[79]

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Endnotes from the RW & GNEP report are provided herein so readers of this critique do not have to refer to the original report. However, we have not attempted to format these endnotes identically to the original report.

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Appendix II. Joint Statement on the Global Nuclear Energy Partnership and Nuclear Energy Cooperation [from the website of the U.S. Department of Energy, Office of Nuclear Energy: (http://www.gnep.energy.gov/gnepPRs/gnepPR052107.htm) (May 21 , 2007)]

Senior International Energy Officials Issue Joint Statement in Support of the Global Nuclear Energy Partnership

WASHINGTON, DC – U.S. Secretary of Energy Samuel W. Bodman today announced that the U.S. Department of Energy (DOE) and senior energy officials from some of the world's leading economies issued a joint statement in support of the Global Nuclear Energy Partnership (GNEP) and nuclear energy cooperation. The People's Republic of China, France, Japan, Russia and the United States issued the Joint Statement, which addresses the prospects for international cooperation in peaceful uses of nuclear energy, including technical aspects, especially in the framework of GNEP.

"Today's Joint Statement officially puts the 'P' in the Global Nuclear Energy 'Partnership,'" Secretary Bodman said. "For Americans, pursuing nuclear power is wise policy; for industry it can be good business; internationally, it is unmatched in its ability to serve as a cornerstone of sustainable economic development, while offering enormous potential to satisfy the world's increasing demand for energy in a clean, safe and proliferation-resistant manner."

The Joint Statement was agreed upon today in Washington, DC, after high-level international officials participated in a DOE-hosted ministerial meeting, bringing together some of the leading nuclear fuel cycle states to discuss GNEP and its path forward toward increasing the use of safe, reliable and affordable nuclear power worldwide. Chairman Ma Kai of the People's Republic of China (National Development and Reform Commission); Chairman Alain Bugat of France (Commissariat a l'Energie Atomique); Minister Sanae Takaichi of Japan (Minister of State for Okinawa and Northern Territories Affairs, Science and Technology Policy, Innovation, Gender Equality, Social Affairs and Food Safety); Deputy Director Nikolay Spasskiy of the Russian Federation (Federal Atomic Energy Agency); and Secretary of Energy Samuel W. Bodman of the United States participated in today's ministerial meeting on GNEP and nuclear energy cooperation. The United Kingdom and the International Atomic Energy Agency also participated as observers to the ministerial.

In addition to providing overviews on each countries' national and international nuclear energy policies in relation to GNEP, senior officials are also moving forward on topics considered crucial to GNEP's development. The topics include: infrastructure development needs for countries considering nuclear power; development of advanced fuel cycle and safeguards technology; establishment of reliable fuel services; spent fuel management; and building the partnership and next steps to pursue this major global initiative.

GNEP is a Presidential initiative, which includes key research and technology development programs as well as international policy cooperation. It addresses two long-standing barriers to enable expansion of nuclear power: (1) the means to use sensitive technologies responsibly in a way that protects global security, and (2) the pathway to safe management and disposition of spent fuel. GNEP focuses on overcoming these barriers, and doing so in cooperation with other advanced nuclear nations, to bring the benefits of nuclear energy to the world safely and securely. To meet the goals of GNEP, collaboration among industry, the U.S. national laboratories and other nations will be essential.

GNEP, first announced by President Bush in 2006, is part of his Advanced Energy Initiative, which aims to change the way we power our lives by utilizing alternative and renewable fuels to increase energy, economic and international security. GNEP seeks to develop worldwide consensus on enabling expanded use of clean, safe, and affordable nuclear energy to meet growing electricity demand. GNEP proposes a nuclear fuel cycle that enhances energy security, while promoting non-proliferation. Additional information on GNEP.

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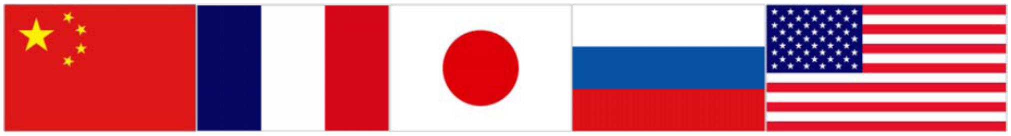

Joint Statement on the Global Nuclear Energy Partnership and Nuclear Energy Cooperation

Washington, D.C.

May 21, 2007

Ministers and other senior officials representing the respective governmental agencies of China, France, Japan, Russia, and the United States met in Washington, D.C., on May 21, 2007 to address the prospects for international cooperation in peaceful uses of nuclear energy, including technical aspects, especially in the framework of the Global Nuclear Energy Partnership (GNEP). The International Atomic Energy Agency (IAEA) also attended as an observer.

At the meeting, representatives exchanged views on the GNEP and their vision for nuclear energy cooperation to enable the safe and secure expansion of civilian nuclear energy for peaceful purposes, to discourage the spread of sensitive nuclear fuel cycle technologies, and to afford other nations currently without nuclear power the opportunity to realize the benefits of nuclear energy as a clean, reliable source of energy that does not emit greenhouse gases harmful to our climate.

The GNEP vision was described in broad terms to allow for diversity of technologies and solutions to help states effectively meet the growing global energy needs through increased use of nuclear energy while heeding the requirements for responsible management of long term duties. The participants believe in order to implement the GNEP without prejudice to other corresponding initiatives, a number of near- and long-term technical challenges must be met. They include development of advanced, more proliferation resistant fuel cycle approaches and reactor technologies that will preserve existing international market regulations.

The participants recognized that national priorities, legislation and capabilities result in each country having unique nuclear energy needs and challenges and that a variety of approaches and technical pathways may be necessary to achieve their long-term goals. The participants share a common view that a long-term vision of the global nuclear fuel cycle cannot be achieved without broader cooperation and partnerships involving nations that currently utilize, or are planning to develop, civilian nuclear energy.

The participants reached common recognition at this meeting that, while recognizing the need for a variety of approaches and technical pathways in achieving long-term vision of the future global civilian nuclear fuel cycle, the cooperation in the following areas will be developed to support it:

- Work to support the expansion of nuclear power, realizing its contribution to sustainable development and assistance in meeting the world-wide growing energy demand, while encouraging a closed fuel cycle which supports minimization of waste volumes and radioactivity as well as effectively managing global nuclear resource;
- Pursue the development and demonstration of the advanced technologies for recycling spent nuclear fuel that meet our energy and nonproliferation goals;
- Incorporate the highest levels of safety, security and safeguards, while working to address proliferation concerns;
- Develop, demonstrate and deploy advanced fast reactors;
- Promote the development of grid-appropriate power reactors suitable for regional use;
- Ensure materials and technologies utilized in the civilian fuel cycle are used only for peaceful purposes.

The participants decided that they will work for broader cooperation and partnership, including convening a follow on conference. They recognize the need to take advantage of existing international fora to foster a broad-based dialogue on the issue.