September 6, 2011

To: Blue Ribbon Commission on America's Nuclear Future

To the attention of: The Honorable Lee Hamilton, Co-Chair,
The Honorable Brent Scowcroft, Co-Chair.

Department of Energy
Timothy A. Frazier, *Designated Federal Officer*
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Washington, D.C. 20585-0001

Gentlemen:

The nation should be most thankful for your willingness to serve and for your effort in addressing one of the U.S.' most urgent problems. With great interest but with some disappointment, have I taken notice of the content of the July 2011 draft report of your Blue Ribbon Committee: While the report contains many worthwhile considerations, it seems to be short on long-term policy insights and it does not offer a viable solution for the current spent-fuel dilemma. In order to better understand how the U.S. arrived where it is now, some background information may perhaps be useful. I beg therefore to be allowed to digress briefly:

Having dedicated my working career to nuclear energy since 1957, both in industry and in research, it has been with profound sadness that I have witnessed the decline of the U.S. global leadership in this area. This decline started in the second half of the 1960s when the Atomic Energy Commission (AEC), later followed by ERDA and DOE, embarked on a program of micro-managing rather than providing broad policy outlines as had been the earlier practice. Among the main presumed justifications for this change was the fact that EBR-II (a first-of-a-kind project) had been built with a cost overrun of about 20% and with a delay of around two years on its original estimated schedule. Those who were considered responsible for this EBR-II "debacle", were frozen out and their accumulated experience was lost to a large extent. From then on, abject servility was required from any organization and persons dealing with AEC/ERDA/DOE. The follow-up project, the Fast Flux Test Facility (FFTF), was finally built with a delay of over ten years and a cost overrun of about 1,000%. It never operated as intended and was shut down. It stands in the Richland, WA area as reminder of 'great insight' and 'excellent management skills'.

The next major step in the decline of U.S. nuclear leadership occurred in 1977 when President Carter declared that the U.S would thence forward forego the reprocessing of spent nuclear fuel and that the fast breeder program was to be terminated. As a follow-up, the Clinch River Breeder Reactor (CRBR) project was shut down.

Shortly after President Carter's declaration, a large international conference on nuclear fuel cycle development was held in Salzburg, Austria. The full papers had been approved several months earlier (i.e. prior to Carter's policy change) and were available in printed form at the conference, including those prepared by a large delegation of U.S. scientists / engineers. These U.S. papers explained in detail the road to be followed for developing nuclear fission technology into an inexhaustible source of energy in the service of humanity, as had been foreseen earlier by great scientists such as Enrico Fermi and Walter Zinn.

As a participant in this international conference, I had the very sad experience of having to be a witness to the public humiliation of all the participating U.S. scientists by their own government, which forbade the distribution of any of their printed papers. Furthermore, all U.S. scientists / engineers were "invited" into a meeting room (i.e., instructed to attend) where they were told in no uncertain terms not to speak in support of any programs that were not in line with the new U.S. policy. I believe it may be difficult to find another example in modern times in which an industrial nation has publicly humiliated and insulted its own leading scientists in this way. For a democratic nation to 'throw around its weight' at an international scientific conference and to interfere with the free exchange of information by denying its citizens the right to express their opinions, should certainly be cause for some misgivings and questioning.

The final blow to U.S. nuclear leadership came in the 1990s when, under President Clinton, the last surviving vestiges of fast-neutron fission technology development were killed and when the EBR-II reactor, after more than 30 years of flawless operation as a test reactor, was shut down for misguided political reasons. As a consequence of this, the U.S. lost its only in-pile test-bed for fast-reactor fuel development and closed off a very successful road which had already led to burn-up levels with metallic fuel that are about five times higher than those achieved in light-water reactors.

I hope you will accept my apologies for bringing up this short historical account which is not intended to cast aspersions on, or imply any culpability of, the current staff of DOE, but is solely aimed at 'learning-from-the-past' by recalling how a combination of misguided-policy decisions and a lack of insight, has resulted in the current dilemma. If the U.S. had not embarked on a self-destructive course of action and if it had followed the ideas of Enrico Fermi and Walter Zinn, as further detailed in numerous publications by leading U.S. and non-U.S. scientists and engineers (including, Bernard Cohen, Leonard Koch, Charles Till, Georges Vendryes from France, Wolf Haefele from Germany, etc.), the U.S. could have found itself still among the global nuclear leaders. As it is, other nations (France, Russia, Japan, India, China) are now leading in nuclear energy development for peaceful purposes, and the U.S. will find itself more and more relegated to the position of observer, no longer capable of affecting global nuclear policies.

Rather than giving detailed comments on your report, I hope you will allow me to make some suggestions as to the future road to be followed by the U.S. These suggestions are presented in bullet format for the sake of brevity. I shall be glad to elaborate on them, if so desired.

Respectfully submitted,

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Appendix

Why the U.S. needs to re-start Development of Fast-Neutron Fission Technology

- Development of Fast-Neutron Fission Technology (FNFT) needs to be re-started, among others to:
  - **offer a solution to the nuclear waste dilemma,**
  - **reap the full benefits of nuclear energy,**
  - **restore some of the U.S. global nuclear leadership role.**

- Reprocessing of spent fuel constitutes an integral part of FNFT. The recommended reprocessing technique is pyro-electrolysis which differs from the currently followed aqueous reprocessing in that no water is used. Pyro-electrolysis offers great advantages, over aqueous reprocessing including:
  - **enhanced proliferation resistance,**
  - **sharp separation of actinides from other radioactive fission products**, thus reducing the radioactivity of waste to a historical time scale of some 400 years**,**
  - **low probability for reactivity incidents** (this could be relatively high for the aqueous version in case of fast reactor fuel with considerably higher fissile content than LWRs)**.**

- It is recommended to **re-start the development of pyro-electrolysis** no later than 2012, including its **adaptation to LWR oxide fuels**. This promising technology has been proved on a laboratory scale but needs further development to upgrade it to commercial scale *This program should have highest priority*.

- It is recommended to start construction **of a fast-reactor demonstration plant** (e.g., PRISM, developed at GE), in view of the fact that (subsequent to the shut-down of EBR-II) no in-pile test bed is available in the U.S for fast reactor fuel development.

- Pyro-electrolysis is highly **resistant to proliferation** in that Pu-239 is not separated out in pure form at any stage of the process, but will remain mixed with other actinides, preventing its use as weapons material. Furthermore, the **pyro-electrolysis and fuel-fabrication plants may be co-sited with the electricity generating plant** (as suggested in the **IFR concept**, developed by Argonne National Laboratory), thus further enhancing proliferation resistance by obviating off-site transportation of spent fuel. Only fission products would leave the site.

- Pyro-electrolysis is capable of achieving a **high degree of separation** of the long-lived actinides, which can be 'burned' in the fuel. Consequently, the remaining radioactive waste (i.e., fission products) will **decay to background radiation levels in about 300 to 400 years**, rather than in hundreds of thousands of years.

- FNFT is capable of fissioning all uranium (i.e., both uranium recovered from spent fuel as well as depleted uranium left at the enrichment plants), thus **able to harvest about 100 times (i.e. 10,000%) more energy** from the same amount of mined uranium. Spent fuel, rather than being radioactive waste, is a valuable asset for the production of energy.

- The currently available spent fuel and the stored depleted uranium from enrichment plants, if used in FNFT, **suffice to supply all needed energy for hundreds of years,** without any additional mining being required**.**

- Additional mined uranium (if necessary from lower-grade deposits and/or from the sea) will make FNFT an **inexhaustible source of energy**, placing it in the same category as wind- and solar-energy, which are often referred to as 'renewable'.

- Fast reactors in conjunction with reprocessing can **lessen the amount of the spent fuel and drastically reduce the volume of radioactive waste,** which will consist only of fission products with relatively short half-lives.

- Fast reactors with metal fuels offer certain valuable **inherent safety-enhancing characteristics** that are not present in the current generation of commercial nuclear power plants. This was shown to an international audience in the 1980s during a demonstration at EBR-II in which a number of postulated 'accidents' were simulated, including Loss-of-Flow without scram and Loss-of-Heatsink without scram.

- **Aqueous reprocessing is prone to nuclear-weapons proliferation** because it is capable of separating out plutonium that has the chemical purity needed for weapons. The current generation of commercial nuclear power plants (referred to as 'thermal reactors' of the Light-Water Reactor type – LWR) is **capable of using less than 1% of mined uranium**. Apart from this being extremely wasteful, it leads to large quantities of spent fuel and even larger quantities of depleted uranium.

- **The once-through fuel cycle, as currently applied in the U.S., is not sustainable**. Even if there may be adequate supplies of uranium available at economically viable price levels for the coming decades, to continue accumulating spent fuel as a legacy for future generations, is not acceptable. Furthermore, without reprocessing, a large number of spent-fuel storage facilities of the size of Yucca Mountain will have to be built.

- **Increased global capability of uranium enrichment will be prone to nuclear-weapons proliferation**, as has already been shown (Pakistan, Iran, North Korea). Such an increase will be required if the once-through fuel cycle were to be continued in conjunction with a world-wide increase of nuclear energy use. However, once FNFT is available, no further extension of enrichment capability would be necessary.

- *It is ironic that President Carter's intention of preventing the proliferation of nuclear weapons by limiting nuclear energy generation to the once-through fuel cycle, may actually have resulted in enhancing the likelihood of proliferation by requiring increased global enrichment capability.*

- World population growth, together with the need to reduce CO_2 emissions and the fact that fossil fuels are a limited resource to be left for future generations, will inevitably require an increased global use of nuclear energy. **It is important that the U.S. will again become an active and technically competent participant in steering this development on the right course.** A technically incompetent U.S. will undoubtedly be relegated to the role of passive observer. The Global Nuclear Energy Partnership (GNEP) initiative should be re-started.