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Hearing on the future of nuclear energy in the United States and on the role of interim storage and spent fuel recycling in support of nuclear power growth.

Mr. Chairman, and members of the committee, thank you for the opportunity to appear before you today to offer views on the future on nuclear power. These views have been shaped largely by a comprehensive study carried out at MIT over a two year period with eight colleagues from diverse disciplines, and follow-on publications; for the record, references are provided at the end of this statement.

Reexamination of our national nuclear policy, especially with respect to spent nuclear fuel management, is called for, and this committee's interest and leadership have been and will be important. Last year's Energy Policy Act did much to set the stage for a possible expansion of nuclear power by addressing barriers to "first mover" construction of new plants. However, the considerable uncertainty surrounding spent fuel management, and renewed concerns about potential nuclear weapons proliferation associated with global expansion of the nuclear fuel cycle, must be addressed as well if robust growth is to be realized. These issues of spent fuel management and of proliferation risks are linked, as evidenced by current discussions that argue for reprocessing as an approach to improved waste management.

Current U.S. policy for managing radioactive spent fuel from commercial nuclear reactors was largely set by the decisions of Presidents Ford and Carter thirty years ago. They decided to forego spent fuel reprocessing partly based on economics but mostly because of a concern that large amounts of separated plutonium in civilian nuclear power programs across the globe would pose an unacceptable proliferation risk. This committed the U.S. to direct disposal of spent fuel in a geological repository for long term isolation from the biosphere. Yucca Mountain in Nevada, adjacent to the nuclear weapons test site, was subsequently chosen by Congress for repository development. Because the spent fuel contains significant amounts of plutonium, and because management of spent fuel requires a long time commitment, Congress decided that the government would assume ownership of the spent fuel and responsibility for its transportation and long term care. Many new developments call for a fresh look at elements of this policy.

The first driver of a policy reexamination is the renewed interest in nuclear power plant construction in the U.S. Climate change, and a growing expectation that carbon dioxide emissions will be priced relatively soon, is a principal motivation for nuclear power growth; natural gas price volatility and resistance to new pulverized coal plants are other motivators. A tripling of nuclear power by mid-century, equivalent to avoidance of several billion tons of carbon dioxide annually relative to fossil fuel plants, is the scale needed for a meaningful contribution to climate change mitigation. This has two direct consequences for U.S. policy considerations: new construction in the U.S. would need to start very soon if this growth trajectory is to be credible, and thus the importance of the first mover initiative; spent fuel management at a scale well beyond that authorized for Yucca Mountain will require a new statutory and regulatory framework.

Second, the licensability of Yucca Mountain is very much up in the air. We should be clear that long term geological isolation of spent fuel and high level waste appears to be scientifically sound. However, this general scientific consensus does not apply to any specific site, for which judgments must be based on extensive site-specific characterization, measurements, and modeling. Whether Yucca Mountain meets these criteria will be decided eventually in the NRC licensing procedure. In any event, the growth scenario indicated above will require a strategic look at spent fuel management that goes well beyond current plans. Such strategic considerations should be based on the requirements of major expansion and not on the current trials and tribulations with Yucca Mountain licensing.

Third, the failure to begin government acceptance of spent fuel may present a significant impediment to the first mover initiative for new plant construction, not to mention a potentially large financial liability for the government. Of course, this issue is directly linked to the delay in Yucca Mountain licensing. Nevertheless, we should focus on the key issue for nuclear plant operators, which is movement of spent fuel, whether to Yucca Mountain or to interim storage sites.

Fourth, a global expansion of nuclear power creates new challenges to the nonproliferation treaty regime. The U.S. has the largest deployment of nuclear power in the world, about a hundred thousand megawatts, and unique foreign policy responsibilities. The path chosen by the U.S. for its own nuclear power development will be a major determinant for our ability to guide international fuel cycle development in line with our security objectives. The goal of avoiding and discouraging accumulation of separated plutonium remains a key national security objective, particularly in light of international terrorism.

Finally, the Administration has proposed a major initiative, the Global Nuclear Energy Partnership (GNEP). This RD&D program aims to develop advanced fuel cycles that use new forms of reprocessing, removing from the waste package and then “burning” long-lived transuranic elements and providing a fuel cycle architecture that lends itself to fuel leasing to countries with nuclear power programs too small to justify the investment in fuel cycle facilities (in particular, enrichment and reprocessing plants). Reprocessing fundamentally links waste management and nonproliferation objectives because transuranic elements in the spent fuel can pose very long term management challenges but, if removed from the spent fuel through reprocessing, can pose nonproliferation challenges because of their usability in nuclear explosives.

Clearly, this is a complex policy landscape, and the question is what to do. We recommend a set of priorities aimed at enabling a nuclear power growth scenario.

1. Establish a process and program plan for taking Federal title to spent fuel and for moving it as soon as possible from reactor sites to one or more Federal locations for consolidated interim storage over a fifty to hundred year time period.

This recommendation is, first and foremost, a strategic one for incorporation into a spent fuel management strategy appropriate to a nuclear power robust growth scenario, and not a result of frustration with Yucca Mountain progress. There are three principal motivations. First, and most important, consolidation of spent fuel in dry cask storage at one or more Federal sites, with the spent fuel moved from reactor locations within ten years of the end of irradiation, serves to decouple the private sector nuclear power plant operator from the uncertainties inherent in any massive, long term, first-of-a-kind government program. The statutory requirements of Federal ownership and long term stewardship of spent fuel, with nuclear utilities paying a current fee, is in effect aimed at such a decoupling, so interim storage as described is a logical extension of this public-private relationship. Second, such an approach adds considerably to system flexibility for adjusting to new technical or social developments (for example, a possible move to advanced reprocessing fuel cycles beyond mid-century). Third, spent fuel heat generation drops by about a factor of five at a hundred years after high burn-up irradiation, relative to the level at ten years. This relieves some aspects of repository design and operational challenges. Overall costs are not high and indeed may prove to be comparable with those for shorter term direct geological emplacement in a system net present value analysis.

2. Yucca Mountain should not be abandoned as interim storage is developed.

Whether Yucca Mountain is suitable for long term radioactive waste isolation will be determined in due course through NRC licensing. For difficult first-of-a-kind projects such as this, with work spread out over decades, schedule-driven approaches seldom work out well. DOE should take a fresh look at assessing Yucca suitability under various system conditions (such as long term consolidated interim storage, including implications for fuel packaging and transportation) and adjust the schedule accordingly. If Yucca is licensed relatively soon, based on the rigorous application of scientific standards and analysis, radioactive waste emplacement can proceed at a measured pace, consistent with continued monitoring and verification. Parallel work on the interim storage infrastructure provides flexibility for the intermediate term and a better system architecture for the long term in a growth scenario.

3. The Administration should intensify its efforts to promulgate international nuclear fuel cycle arrangements based on fuel leasing – that is, to have nuclear supplier countries provide fresh fuel to and remove spent fuel from countries with small nuclear power programs, if they agree to forego dangerous and costly fuel cycle facilities for a significant period of time.

The Administration has taken some first steps on assured supply of fresh fuel, but a more comprehensive effort is needed that addresses incentives and political asymmetries and that also focuses on the fuel cycle “back end”. The latter problem is quite challenging in light of the fact that waste management issues have not been dealt with fully anywhere. With several colleagues, we proposed a comprehensive approach called the Advanced Nuclear Fuel Services Initiative (ANFSI). It is based as much as possible on recognition of fuel cycle economics and on fuel-service transactions between commercial entities negotiating commercial contracts, as today, but with a hierarchy of security of supply backup guarantees. Incentives for states leasing the fuel include removal of spent fuel and selective participation in advanced technology development programs; in addition, indirect financial incentives would be offered, such as carbon emissions credits for new nuclear plants in participating “fuel user” countries. Such an approach does not pretend to resolve all of the difficult cases, but rather to isolate them in the interest of coordinated international diplomacy.

An important feature of the proposal is a “stay put” period of ten to fifteen years. This is not so long as to ask countries to reject permanently the development of new technology options should nuclear power grow dramatically, but is long enough to provide considerable stability for evolution of new international institutional arrangements appropriate to a global growth scenario. A fixed term commitment with review and renewal is not new for international nonproliferation agreements.

4. The Administration and Congress should not advocate reprocessing of current spent fuel inventories over the next decades. In particular, the U.S. should continue to discourage implementation of the PUREX/MOX process, which was developed for production of high purity weapons plutonium and leads to the separation of weapons-usable plutonium.

The concerns of Presidents Ford and Carter have been realized in the sense that about 250 tons of separated plutonium have accumulated globally. As a reminder, the IAEA significant quantity for plutonium is less than twenty pounds.

Is reprocessing needed in the near term? As stated in the 2005 report of the American Physical Society Panel on Public Affairs on nuclear power and proliferation resistance: “There is no urgent need for the U.S. to initiate reprocessing or to develop additional national repositories. DOE programs should be aligned accordingly.”

The stated benefits of reprocessing are efficient resource utilization and improved waste management. First, estimates of conventional uranium resources indicate adequacy to support the full lifetime operation of a tripled fleet of nuclear power plants (roughly a million megawatts globally). In addition, there was little uranium exploration for a long time because of low prices, so experience with other natural resources suggests that there may be considerably more uranium accessible at reasonable cost. Today, the open or once-through fuel cycle is less costly than the closed MOX fuel cycle. Of course, long term interim storage preserves the possible value of the spent fuel at some time in the future if the balance of costs, risks, and benefits of reprocessing versus direct disposal changes. There are suggestions today about substantial cost reductions relative to current performance that may be possible with large scale PUREX/MOX plants, but no experience to back up such assertions. The history (including recent history) with nuclear plant costs based on engineering estimates is not particularly good.

The improved waste management arguments are also unconvincing. Volume reduction is often offered as a benefit, but in fact this is of minimal value for a mined repository. Heat and radiation are the key issues for disposal and transportation. These are generated principally by the fission products for about a century and, since these are left with the reprocessed high level waste, there is little impact from reprocessing during that time period. Long term interim storage addresses this issue of fission product heating and provides ample time to evaluate the merits of future reprocessing depending on the scale and rate of nuclear power deployment, technical progress on the fuel cycle, and uranium availability and cost. Furthermore, MOX fuel must be recycled repeatedly to maximize long term benefit, but no spent MOX fuel has yet been recycled commercially for technical, operational, and cost reasons. There is much to do to provide a convincing demonstration of the merits of PUREX/MOX for waste management.

There is one potentially significant advantage of reprocessing for long term repository heating: if spent fuel is reprocessed soon after discharge from the reactor, long term heating may be reduced by a factor of three to four. This obviously does not apply to the spent fuel generated up to now. Further, unless the nuclear fuel cycle system were very well tuned to balance spent fuel discharge, reprocessing, and the use of separated plutonium, and were able to repeatedly recycle MOX fuel, the long term heating benefit would be compromised and/or more separated plutonium would accumulate. The large amount of separated plutonium today is evidence that such fine tuning has proved elusive.

5. A substantial R&D program should be initiated to develop and evaluate multiple options for nuclear power deployment and nuclear fuel cycle development. R&D for both open and closed fuel cycles is important.

For nuclear power to reach a terawatt (million megawatts) of global capacity by mid-century, and thereby to play an important role in limiting greenhouse gas emissions, substantial technology development is needed. For this purpose, the relevant DOE R&D programs need both to grow and to align with the strategic objective of enabling robust growth over the next few decades. This calls for R&D supportive of both open and closed fuel cycles.

Key areas that impact open fuel cycle deployment include updating the uranium resource inventory, developing more advanced engineered barriers for waste isolation, exploring alternative geological isolation concepts (such as deep borehole disposal), and promoting development of high temperature gas reactors and modular reactors with long-lived cores. These areas are receiving little or no support relative to closed fuel cycle R&D and yet could have a greater impact during the next decades.

GNEP has been put forward as the centerpiece of the R&D program. We support the underlying concept, namely, that full actinide recycle in "burner" reactors offers the possibility of dramatically simplifying long term waste management and supports proliferation resistance by lending itself naturally to the fuel leasing approach to global fuel cycle development. It is unclear whether such a fuel cycle will prove to be technically and economically competitive. Only an extensive, and expensive, R&D program sustained over many decades can answer the question. However, we differ with the proposed program architecture in that an effort of this magnitude and complexity should focus first on its foundations, and not move prematurely to expensive pilot and demonstration plants. A new generation of fuel cycle modeling and simulation tools is needed first, together with considerable basic research that explores alternative concepts. Highly integrated choices of fuel form, reactor design, and reprocessing technology are needed to optimize such a fuel cycle, and it is premature to make sub-system choices before examining options much more thoroughly. When significant facilities are eventually required, they (as well as significant parts of the preceding development work) would best be placed at consolidated interim storage sites. There is an excellent chance that an approach that emphasizes basic research and tool development first will answer key questions about the potential of advanced fuel cycles earlier than a program front-loaded with demonstration facilities; indeed we know from experience that expensive mistakes early in a program that requires a sustained commitment across many Administrations guarantee indefinite delays or termination.

In conclusion, interim storage is, in my view, a key enabler for a robust nuclear energy growth scenario. Because nuclear fuel cycle materials and technologies have the potential for misuse in nuclear weapons applications, government is likely to continue with the responsibility for long term spent fuel management. Designing and implementing a spent fuel management system is a complex, massive, multi-decadal, first-of-a-kind effort with difficult technical and social issues. It does not lend itself to a schedule-driven program. Yet, it must be interfaced with the discipline of the private sector. Long term consolidated interim storage at one or more Federal sites serves to facilitate decoupling of the private and government activities and provides critical flexibility to respond to new technical and societal developments. It also preserves options for several decades down the road, including the possibility that advanced closed fuel cycles may look attractive for mitigating waste management and proliferation concerns with competitive economics.

Mr. Chairman, that concludes my statement, and I look forward to further discussion.

Source Materials:

- The Future of Nuclear Power – An Interdisciplinary MIT Study; co-chairs: J. Deutch and E. Moniz (Cambridge MA, 2003), available at http://web.mit.edu/nuclearpower/
- Making the World Safe for Nuclear Power; J. Deutch, A. Kanter, E. Moniz, and D. Poneman (Survival, vol. 46, no. 4, Winter 2004-2005, pp. 65-80)
- Nuclear Power and Proliferation Resistance: Securing Benefits, Limiting Risks; Report by the Nuclear Energy Study Group of the American Physical Society Panel on Public Affairs, chair: R. Hagengruber (APS 2005), available at http://www.aps.org/public_affairs/proliferation_resistance/
- A Plan for Nuclear Waste; J. Deutch and E. Moniz (Washington Post opinion page, January 30, 2006)
- The Nuclear Option; J. Deutch and E. Moniz (Scientific American, vol. 295, no. 3, September 2006, pp. 76-83).