New Nuclear Fuel Disposition Opportunities in a Changed World

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ABSTRACT

The world's economic, security, environmental, and technological situation has changed significantly in the last several years and these changes bring new opportunities for substantial policy improvements and redirections in the used nuclear fuel management arena. The passage of new energy legislation; the need for more US nuclear energy; growing state, national and international momentum for carbon emission and other air pollutant reductions; post September 11th Homeland Security threat reduction improvements; desires to improve global nuclear security; rapidly emerging needs for clean electricity supplies in developing countries; and the technological advancements in advanced fuel cycle technologies provide a substantial foundation for future enhancements and improvements in current used nuclear fuel management programs. Past progress, lessons learned, and new used fuel/waste management technological innovations coupled with current and future economic, security, and environmental issues can create new approaches that can help the Federal government meet its obligations while simultaneously addressing many of the difficult regional/state issues that have historically hindered progress.

This paper will examine and integrate the synergy of these issues to explore options and discuss possible new opportunities in the vitally important area of spent fuel management and the entire back end of the nuclear fuel cycle.

INTRODUCTION

The world's economic, security, environmental, and technological situation has changed significantly in the last several years and these changes bring new opportunities for substantial policy improvements and redirections in the used nuclear fuel management arena.

The prospects for nuclear energy today, in the US and globally, are more promising than they have been for many, many years— and the long awaited nuclear renaissance is finally close at hand.

This renaissance is the product of several forces:

- Economic imperatives: Rising fossil fuel prices and increasing concerns about oil and natural gas supplies around the world

- Serious concerns about the environment and the emissions associated with burning of fossil fuels—both greenhouse gases and the more conventional pollutants such as mercury
- Nuclear power plant capabilities—the ability to domestically produce large amounts of base load electricity safely, reliably, economically without air pollutant emissions

Despite these strong motivators, issues of safety, security and waste disposal must be addressed before the nuclear renaissance can be a sustainable phenomenon. Safety at operating reactors and nuclear facilities must be vigilantly maintained at all times, now and in the future. The world has learned much about safety over the last 50 years of nuclear development, and I believe that safety can be achieved and accepted by the public, provided that operators keep safety and operational security as their top priorities in their operations.

Security and protection from nuclear weapons of mass destruction is also an issue that must be adequately addressed to sustain a true sustainable nuclear renaissance. This issue applies to both the front and back end of the nuclear fuel cycle, but this paper will focus only on the back end, but there are great similarities between the front and the back ends, especially in the international non-proliferation political assurance arena.

A corner stone of security and non-proliferation programs is responsible verifiable controlled management of nuclear materials, such as used nuclear fuel and the byproducts of reprocessing. Geologic repositories, interim storage facilities, and reprocessing/recycling facilities have always played an important role together in nuclear materials management; however recent global events and technological advancements require a higher degree of integration than ever before.

Now is the time to integrate advanced fuel cycle technologies, in a balanced and appropriately timed manner, to improve and enhance used fuel management programs while at the same time preserving and protecting essential aspects of existing used fuel management policies. Changes to current policies must be delicately balanced and timed in both a technological and political manner to meet the energy, security and intergenerational ethical environmental protection requirements of today and tomorrow. The synergisms between geologic repositories, integrated interim storage facilities, emerging advanced fuel cycle technologies and international political agreements are an opportunity that must be both politically and technologically integrated if the forthcoming nuclear renaissance is to have a sustainable future.

POLICY CONSIDERATIONS

To bring these all together, let me review a little recent history beginning with the horrible events of September 11, 2001. That day was a world wide awaking of what could happen if terrorist had access to weapons capable nuclear materials. This danger was the only issue that Senator Kerry and President Bush could agree upon during the Presidential debates in 2004.

President Bush stated in a speech two years ago that:

> "The world must create a safe, orderly system to field civilian nuclear plants without adding to the danger of weapons proliferation. The world's leading nuclear exporters should ensure that states have reliable access at reasonable cost to fuel for civilian reactors, so long as those states renounce enrichment and reprocessing."

Secretary Bodman last November stated that:

> "The need for peaceful nuclear power all over the globe has never been more apparent while at the same time, the proliferation threat posed by nuclear materials and technology has never been more grave".

The Secretary went on to speak about developing nuclear energy technology and systems, enhancing the work of international forums, and that:

> "Establishing Yucca Mountain as the nation's permanent repository for spent nuclear fuel and permanent geologic storage at Yucca Mountain offers the safest, most secure solution for dealing with this challenge."

In the area of international agreements he said:

> "We are also examining issues related to the return and storage of spent fuel, which could allow recipient states to avoid a number of cost, safety and safeguards burdens. In the longer term, we see fuel cycle states offering "cradle-to-grave" fuel cycle services, leasing fuel for power reactors and then taking it back for reprocessing and disposition.
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> The success of this initiative will require the full commitment not just of my government, but of all fuel supplier and fuel recipient states as well. In particular, we will need to cooperate on disposition methods and technologies for high-level wastes and for spent fuels. We also mustn't close the door on the possibility of establishing international spent fuel repositories."

Deputy Secretary Sell and Ambassador Brooks have also given recent speeches that spoke to international cooperation with advanced recycling technologies, the possibility of establishing international spent fuel storage facilities and repositories, and the examination of concepts for the leasing, return and storage of spent fuel to alleviate cost, security, and safeguards burdens on recipient states.

The Bush Administration has announced its Global Nuclear Energy Partnership (GNEP) initiative in conjunction with the fiscal year 2007 budget which describes in more detail the interrelationship of these issues. It is also expected that the Administration will release its legislative proposal to address further policy changes to the current Nuclear Waste Policy Act in the very near future.

Bills have also been introduced in the Congress, e.g. Senator Reid's S-2099, to require dry storage of used fuel at existing power reactor sites indefinitely. Congressional Committees are already scheduling hearings to address these issues and it is expected that the Congress will debate and likely change the current policy in some as yet unknown manner in the coming months or few years. The outcome of this political process will be influenced to a greater or lesser degree by the ability of the political and technological communities to be able to mutually

understand and integrate the synergisms of theses highly interrelated complex technological political issues and a balanced and fair meaningful way that is to the benefit of both current and future generations.

TECHNOLOGICAL AND INSTUTIONAL CONSIDERATIONS

As we heard from the previous speakers this morning, there are future advanced nuclear technological enhancements that can supplement and enhance the performance of a Yucca Mountain repository, but they can not replace it. All advanced fuel cycles need a repository because there are still high level waste streams resulting from their operations. In any case, a geologic repository is absolutely essential to the disposition of used nuclear fuel, regardless of the development of any known technology.

Yucca Mountain is a good repository site, but it is not a perfect site. The only perfect high level waste disposal site is the Sun, but it is a difficult site for transportation. Since we can not reasonably transport our materials to the Sun for the foreseeable future, we need to continue with a good repository here on earth and Yucca Mountain, in my opinion, is a good repository site. It has been evaluated with a sound science program that has cost billions of dollars to the American electricity consumer and tax payer and it has been through an exhaustive political and legal site designation process.

Yucca Mountain does certainly have challenges and difficulties, but I believe that most of these are of an instutitional/political/legal nature that has been driven fundamentally by historical regional equity and fairness concerns. If political solutions can be found to these fundamental Nevada concerns, I believe that other technical, regulatory, management and budget issues can be adequately addressed. An opportunity is likely coming to address these policy issues in the Congress and I believe that the current global situation and advanced nuclear technologies can be integrated to play an important role in revising current policy in an acceptable way for everyone.

Although advanced nuclear fuel cycles hold significant promise, and should be developed as important R&D programs, they have yet to be proven, are decades away from meaningful implementation and are not in themselves a waste disposal solution. We should not get caught in an impossible search for the practically unobtainable "better" when we have "good" with an enhanced or augmented Yucca Mountain repository facility.

One particular good aspect of the Yucca Mountain repository is that its geologic setting and design provides flexibility for the future with outstanding reversibility characteristics for centuries to come. The emplacement area is in the unsaturated zone, approximately 300 meters above the water table, with a tunnel design that is capable of relatively easy removal of waste packages for 300 years or more in the future. In other words, Yucca Mountain can operate as an engineered storage system with active monitoring and ventilation for well over 100 years in the future or it could be sealed and passively protect the environment depending upon the judgment of our next generations. This approach allows this generation, under the intergenerational ethics principle, to provide an acceptable, although not perfect, permanent disposal solution option for future generations, but it does not irreversibly commit them to only that solution. It allows them to implement a better option or variation, such as added recycling if they have it, or to implement

direct disposal if they deem that the best option under the situation during their time. Therefore, the Yucca Mountain repository approach is already consistent with a future that includes recycling or not, even though recycling can make Yucca Mountain better in many aspects.

A great advantage of a geologic repository over a traditional engineered surface or near surface interim storage facilities is that future generations are not required to actively manage the repository unless they chose to do so. Storage only facilities require active societal maintenance indefinitely until some unknown disposal solution is developed by future generations for permanent disposal of the materials stored there. If future generations do not, or can not e.g. due to a societal breakdown, perform the required active maintenance, there would be an inevitable degradation of the storage system with likely drastic uncontrolled releases of radioactive materials into the environment at some point in the future. Since we do not know the societal conditions in the future with certainty, it would seem that a facility, like Yucca Mountain, that can operate as an active monitored underground storage facility and also as permanent passive geologic repository, provides future generations the flexibility to do the best thing, with minimal imposed burden upon them, depending upon whatever their situation is in their time.

As everyone knows the Yucca Mountain schedule has been significantly delayed and the DOE is working hard to make the necessary improvements to establish an appropriate new schedule for a successful license application to the NRC. Despite the efforts by the DOE, the fact is that used fuel receipt at the traditional Yucca Mountain repository has been delayed long after it was expected to be able to receive used nuclear fuel when the original Nuclear Waste Policy Act was written back in 1982.

I believe it is very important that the Federal government meet its legal and moral obligations to remove used nuclear fuel from reactor sites as soon as possible. Although utilities have been able to safely store used nuclear fuel on their reactor sites in the interim, this is not an overall appropriate solution for the long term. The highest need is to remove fuel from the isolated shutdown reactor sites where spent nuclear fuel is currently stranded. These private companies and public cooperatives want to discontinue nuclear business and from a security, environmental protection, and economic perspective, these nuclear materials should be taken into Federal custody to an isolated, well protected site that is designed for long term storage, recycling or disposal as soon as possible. These reactor sites were chosen as electricity production sites and were thus located on our rivers, lakes and sea shores, and were never intended to be long term used nuclear fuel or high level nuclear waste storage sites.

Hopefully policy changes can be made to speed up the ability of the DOE to receive spent fuel as soon as possible within the construct of the fundamental Yucca Mountain principals. Such changes would be a political challenge, but I believe that the social political economic nuclear paradigm has changed so significantly that with coupling of advanced nuclear technology concepts and international agreements, such as GNEP, with the basic aspects of a geologic repository provides an even greater political opportunity for near term progress. Volunteer storage and disposal sites have been achieved in Finland, Sweden and France and I believe it is possible to also achieve similar results here. Equitable assured arrangements could be achieved at existing nuclear sites that might receive used nuclear fuel as part of an integrated planned advanced nuclear technology developmental activity that is integrated with the Yucca Mountain

repository program. Assurances that these sites will not be the final resting place for byproduct high level waste can be made in a manner that could be politically acceptable to host government jurisdictions. The benefits to a host site can be very substantial while safety, security and environmental protection can be adequately assured.

This will be primarily a political process decided in the Congress and in state capitals with competing international, national, state and local priorities that will need to be balanced and timed in a fair and equitable manner. This process will not only consider the traditional federal-state nuclear waste issues, such as storage and disposal, but will now also have to consider the broader international and national energy, security and environmental needs in the context of the presence of proposed advanced nuclear technology initiatives. It is the addition of the proposed advanced nuclear technologies into this political process where I see the greatest risks and rewards.

This political process will need to determine if policy changes are to be made or not, and if changes are made, that the changes are balanced and properly timed. By properly timed, I believe they need to function to support proper societal policies over short (a few years), medium (a few decades) and long (century-millennium) term time periods. For example a short few year time perspective matter could steps to permit early receipt of used fuel for recycling demonstration, direct disposal preparation, or a combination of both. A medium few decade time perspective issue could be development of appropriate R&D projects and prototype and demonstration recycling and geologic disposal facilities. These medium term demonstrations and/or prototypes could include a variation of the Yucca Mountain repository, along the concept of the "adaptive staging" development of geologic repositories as described in the National Academes of Sciences report, *One Step at a Time*, in 2003. A long term, century plus time perspective issue could be the establishment of appropriate investments and actions to establish very long term adequate secure and environmentally responsible global energy sources in an intergenerational ethical manner for future generations which would include adequate assurances for long term public health and environmental protection.

As the Congress debates these issues they should consider the realistic interaction of what advanced nuclear technologies can and cannot do relative to geologic repositories and the uncertainties that lie ahead. The promise of advanced nuclear fuel processing and recycling technologies should not be to divert our attention from long term geologic disposal. No matter how much we believe in eventually closing the nuclear fuel cycle and no matter how great the long-term promise of used fuel reprocessing and actinide recycle and transmutation of fission products and fast reactors, this technology development is unproven and many decades away from implementation in any meaningful way. And even if we develop these technologies successfully, we will still need at least one permanent geologic disposal repository.

Although technology development is a good thing, there are often unforeseen developments that result in good technology theory alone not being able to address society's needs. An example of an unfulfilled technological solution is the historical management of the liquid high level nuclear wastes in the Hanford tanks. Fifty some years ago, the nation's policy makers evaluated various disposal options concerning those tank wastes. Even at that that time, this was a difficult political and budgetary matter. Those policy makers were heavily influenced by arguments that

better solutions would be developed in the future and that the political and financial burdens did not have to be faced then and could be passed on for better resolution by the future generations. The decision made was to delay implementation and to rely upon interim tank storage and for future technology to manage the ultimate disposition of the tank wastes.

Now, fifty years later, most would agree that that was not the appropriate national policy. Although I believe that we know much more about the storage of used nuclear fuel than we did about the Hanford tank wastes, it is an example of how unforeseen issues can prevent good scientific theory and good intentions from being fulfilled in a practical sense.

At this point in time there is no certainty on what, if anything will change in national policy. All we, in the technical community can do is to properly frame and present the options for our elected leadership to make rational, considered decisions that are properly balanced and integrated from many equity perspectives such as:

- Time equities, e.g. present versus future generations
- Regional equities, e.g. international, national, state and local
- Energy option alternative equities
- Security alternative equities
- Environmental protection alternative equities
- Economic impact equities
- Uncertainties in implementation equities

There needs to be a proper consideration of technical possibilities and possible enhancements, and there also needs to be a consideration of the ability to implement the options before shifting from more realistic nearer-term, although probably suboptimal solutions, to less certain longer-term potentially better solutions.

In summary, I hope that the forthcoming political process will take place with a realistic view of the current and possible future technologies that are properly considered in total context with today's global and national situation. Although the outcome of Congressional deliberations is unknowable, I personally hope that it will lead to a modified US program with the following elements:

- Continuing forward with an adaptive, flexible, geologic repository at Yucca Mountain with a reasonably achievable successful schedule.
- Development of an appropriately paced advanced nuclear R&D recycling program to possibly supplement and enhance the Yucca Mountain repository in the future.
- Provide for expedited receipt of used nuclear fuel into the Yucca Mountain based Federal system to permit beginning removal of used nuclear fuel from existing reactor sites, starting with permanently closed isolated reactor sites.
- Create new appropriate equitable arrangements between the federal government and host jurisdictions to hopefully end or at least minimize vehement host state political objections.

As the nation enters into this critical decision making time period, we should be open to changes and improvements to the repository and overall used fuel management programs to incorporate technology advances, future domestic and international policy accords that may evolve as every nation strives to provide affordable, clean, safe and secure energy for their people while also protecting and not just passing on problems from waste that we created to future generations. The generation that produces the wastes should create known acceptable solutions for safe disposition of their wastes, while still allowing the future generations the option of developing better solutions if they can or so desire.