The Decommissioning Imperative – Motivating Progress in US Used Fuel Management – 15185

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ABSTRACT

When the Yucca Mountain project was terminated in 2010 there was approximately 3500 metric tons of used fuel stored at Independent Spent Fuel Storage Installations (ISFSIs) at which there was no operating reactor (10 shutdown plant sites and the GE Morris facility). By 2015, four additional sites with five reactors will have shut down, causing the amount of used fuel "stranded" at sites where there is no operating reactor to nearly double to approximately 6900 metric tons which will be stored at a total of 15 sites. At each of these sites, once the reactors are decommissioned, the only thing preventing the land from being returned to communities for other uses is the remaining presence of the used fuel. The cost of maintaining 15 stand-alone ISFSIs is born by electric ratepayers and taxpayers.

Going forward, the costs of maintaining stand-alone ISFSIs is certain to grow even if the number of stand-alone ISFSIs does not grow beyond the already announced shutdown of the Oyster Creek reactor in 2019 (which would increase the amount of stranded used fuel by another 10% and create a 16th stand-alone ISFSI). One reason for this cost escalation will be the need for ISFSI owners to renew storage licenses, and implement aging management programs to support these renewals, due to the continued delay in the federal program for removing the used fuel. Storage licenses at 10 of 16 stand-alone ISFSIs will expire by 2021, which is the earliest projected date at which the Department of Energy (DOE) has indicated it could have a pilot interim storage facility available – and nearly 3 decades before DOE projects a repository will be available.

The burden and cost of continuing to renew storage licenses – and manage aging storage facilities – at 16 stand-alone sites instead of moving stranded used fuel to a single consolidated storage location or repository will likely be significant. Industry resources are increasingly being channeled into dry storage aging management activities as public and regulator interest in potential long-term degradation mechanism continues to grow. Whether the ultimate destination for used fuel is Yucca Mountain or some other location, the current stalemate preventing progress in the federal program to move it must be broken – and the increasing prominence of the decommissioned reactor quandary may very well be a pivotal factor in breaking that stalemate.

INTRODUCTION

The 2010 termination of the Yucca Mountain project introduced significant additional uncertainty into what had already been a highly uncertain federal program for the removal of

used nuclear fuel from commercial power reactor sites. This decision came at a point where the federal government was already 12 years in arrears on its statutory and contractual obligation to begin used fuel pick up – and introduced the prospect of significant additional delay.

The ramifications of additional delay in used fuel pick up are substantially different at reactors that are permanently shut down than at operating power plants. Over the past two and a half decades, the U.S. nuclear industry has become highly proficient at managing growing inventories of used nuclear fuel by loading dry cask storage. As the pools originally designed for temporary used fuel storage at reactor sites began to fill up in the 1980s, reactor operators began removing fuel from the pools and loading dry casks placed on concrete storage pads in what is known as an Independent Spent Fuel Storage Installation or ISFSI. The first ISFSI was loaded in 1986, and by July 2014, 83,281 used fuel assemblies (weighing approximately 23,000 metric tons) had been loaded into 1,947 dry storage systems at 64 ISFSIs [1]. At ISFSI locations where a commercial reactor remains in operation, the management of the ISFSI is simply one incremental aspect of the overall operation of the facility. ISFSIs at operating reactors are able to share resources with the adjacent power plant and are housed on land that is fully dedicated to the productive purpose of generating electricity. However, once a plant is shut down and decommissioned – with all of the used fuel moved to the ISFSI – the continued presence of used fuel is the only reason for maintaining, operating, and securing a nuclear facility at that location. All resources required must be uniquely dedicated to the ISFSI and the land on which it sits becomes unavailable for any other productive purpose until all of the used fuel can be removed.

At the time of the Yucca termination announcement, the number of shutdown site ISFSIs in the U.S. had been static for over a decade. However, coincident with this announcement, changes in electricity market conditions (along with other factors) have led to the shutdown of a number of additional reactor sites. The ramifications of continued used fuel storage are now being felt in more communities across a broader cross section of the U.S. In 2010, the land and resource commitments involved in maintaining stand-alone ISFSIs might not have been seen as a major motivating force for overcoming the worsening pattern of delay in the federal used fuel program, but now that may be changing.

BACKGROUND

In 1982, the Nuclear Waste Policy Act (NWPA) [2] provided for the owners and operators of the United States' commercial nuclear power plants to enter into contracts with the federal government for disposal of the used nuclear fuel arising from the operation of these plants. These contracts obligated the US Department of Energy (DOE) to provide disposal services to every one of the nation's commercial nuclear reactors and, even today, companies seeking to license new commercial nuclear plants are still entering into such agreements with DOE. In 1987, the NWPA was amended to focus DOE's disposal program solely on a proposed repository site at Yucca Mountain Nevada. In 2002, the Yucca Mountain Development Resolution (YMDR) [3] was enacted to override the objections of the Governor of Nevada and codified in federal law DOE's determination that the Yucca Mountain site was suitable for the development of a repository and directed the Department to proceed with the process outlined in the NWPA by which DOE would seek licenses from the US Nuclear Regulatory Commission.

Following enactment of the YMDR, DOE moved slowly to develop, and submit to NRC, the required license application. The application [4] was filed in 2008 and by 2010 the first phase of the NRC review (staff technical review) was nearing completion and preparations for the second phase (adjudicatory proceedings) were well under way. But progress was disrupted when, in March of that year, DOE filed a motion to withdraw its license application [5]. NRC's Atomic Safety and Licensing Board (ASLB) – one of four three judge panels that had been established to manage the adjudicatory phase of the process –ruled on June 29, 2010 that DOE did not have the authority to withdraw [6], but the Commission was evenly divided on this question and unable to either uphold or overturn the ASLB decision. Eventually, citing a lack of funding, the Commissioners directed NRC staff to close out its technical review of the Yucca Mountain license application, and the Atomic Safety and Licensing Board to suspend its adjudicatory hearing on the application, by September 30, 2011 [7].

In January 2012, the Blue Ribbon Commission on America's Nuclear Future – appointed by President Obama in the wake of the Yucca Termination – published recommendations for getting the federal used fuel management program moving forward again. In making recommendations for prompt efforts to prepare for and develop consolidated storage capability the Commission stated "substantial benefits can be gained from a modest early investment in planning for the transport of spent fuel from shutdown reactor sites" [8]. DOE embraced these recommendations in a strategy document published in 2013 which called for consolidated storage with a "focus on accepting used nuclear fuel from shut-down reactor sites" at two facilities – a pilot scale facility to begin operations in 2021 and a larger scale facility in 2025 [9]. According to this strategy, DOE would subsequently plan to begin operating a repository for final geologic disposal in 2048. However, DOE conceded that the Department could not begin to implement any of the elements of this strategy until first Congress acted to specifically authorize it.

To date, Congress – divided between proponents of restarting the Yucca Mountain project and those who insist that a new course be charted – has taken no action on DOE's proposal. The NWPA remains in effect, but there is no funding or organization in place at DOE to implement it. The contracts that DOE signed with each and every reactor owner also remain in effect – which means that reactor owners can recover, and are recovering, damages through settlements and court judgments for DOE's failure to remove used fuel from their sites. This has created a potential liability to the U.S. taxpayers amounting to several billion dollars.

One provision of these contracts of particular interest to the owners of shutdown plants is an exception to the requirements governing how DOE prioritizes its removal of used fuel from reactor sites which states "Notwithstanding the age of the SNF and/or HLW, priority may be accorded any SNF and/or HLW removed from a civilian nuclear power reactor that has reached the end of its useful life or has been shut down permanently for whatever reasons" [9]. Therefore, if DOE was in a position to act, it would be able to do so in a way that could specifically address the unique needs of shutdown plants

Nevertheless, as of this writing, the stalemate persists. It is against this backdrop that used fuel remains stored at a growing number of shutdown plant sites. As the owners of the sites that have most recently shut down contemplate their decommissioning strategy, the ramifications of

continued storage are likely to weigh heavily on their decision-making. And they will most certainly be seeking alternatives to the status quo.

THE BURDEN AND COST OF MAINTAINING USED FUEL INVENTORIES AT SHUTDOWN SITES

While the status quo with respect to the federal program to remove used fuel from reactor sites seems to be frozen in time, the status quo with respect to shutdown reactors is rapidly evolving. Following the shutdown of Zion and Maine Yankee in the late 1990s, favorable economics and the nuclear industry's outstanding operational performance provided a strong business case to keep all nuclear assets running – with no additional plants entering the decommissioning category for about a 15 year period. But in recent years, the economic equation has changed. The availability of cheap and plentiful natural gas and subsidized renewables to produce electricity along with the increased regulatory costs imposed on nuclear reactors following the Fukushima accident in Japan have made the continued operation of some older plants in competitive markets less viable. Additionally, three reactors at two plants had significant technical problems which forced their premature shutdown. The resulting growth in used fuel stored at shutdown reactors is shown in Table 1 below. Even if no additional shutdowns are announced (a somewhat optimistic assumption given current economic conditions), the amount of fuel at shutdown reactors will have more than doubled in the current decade – with used fuel being "stranded" at 16 different sites.

Table 1

USED FUEL INVENTORY AT SHUTDOWN POWER REACTORS [1]

YEAR	2010	2015	2020
Humbolt Bay	31	31	31
Rancho Seco	228	228	228
Ft St Vrain	25	25	25
Connecticut Yankee	422	422	422
Zion	1019	1019	1019
GE Morris	642	642	642
Maine Yankee	542	542	542
Yankee Rowe	122	122	122
Big Rock Point	58	58	58
Trojan	345	345	345
Lacrosse	38	38	38
San Onofre		1680	1680
Crystal River		550	550
Kewaunee		522	522
Vermont Yankee		645	645
Oyster Creek			815
TOTAL USED FUEL (MTU)	**3472**	**6869**	**7684**

Once decommissioning of these reactors is complete, the entire cost of maintaining these sites as licensed nuclear facilities will be attributable to the used fuel that remains in dry storage at the ISFSI. Based on current experience, the annual cost of maintaining such a stand-alone ISFSI is approximately $10 million [10] – or $160 million for all of the currently announced shutdown sites. Much of this expense will be borne by the taxpayers, as shutdown site owners pursue litigation and settlement collection from DOE for failing to remove the used fuel in accordance with the contract.

And these costs may be only the tip of the iceberg. The lost opportunity costs from not having the land associated with these ISFSIs available for other purposes are impossible to estimate, but likely significant to the surrounding communities. And the direct costs of the ISFSIs themselves are likely to increase over time as storage licenses will need to be renewed and additional aging management efforts are implemented.

USED FUEL STORAGE LICENSE RENEWAL AND AGING MANAGEMENT

U.S. ISFSIs are licensed by the NRC. These licenses take one of two forms:

1. Site Specific Licenses under 10 CFR Part 72 – in this case a license is granted to a licensee previously authorized to possess used nuclear fuel under 10 CFR 50 (typically a reactor owner/operator) for a specific storage system to be deployed at a specific ISFSI site. License terms and conditions are specific to that system and site.
2. General Licenses under 10 CFR Part 72 – in this case a Certificate of Compliance (CoC) is granted to a licensee who designs, builds, and sells dry storage systems (typically a vendor) for a specific system that can be deployed at any ISFSI site owned/operated by a 10 CFR Part 50 licensee who is authorized to possess used nuclear fuel.

Initially, NRC licensed ISFSIs under 10 CFR Part 72 for 20 year periods with the option for 20 year renewals. Three site specific ISFSI licenses at operating reactors, initially loaded in the 1980s, were renewed prior to 2010. Based on the technical information gathered through these renewal processes, NRC gained additional confidence in the long-term safety of the dry storage systems and, in 2011, revised 10 CFR Part 72 to provide for licenses and renewals to be granted for up to 40 years. Each of the three operating reactor renewals (at Surry, Robinson, and Oconee Stations) was granted for the full 40 year period. In addition, during the same decade, NRC granted 20 year renewals to two stand-alone ISFSIs (at Ft. St. Vrain and GE Morris).

Most of the earlier ISFSIs were built under specific licenses. However, in recent years, nearly all new ISFSIs have come to be under general licenses. The General License creates an interesting dynamic with respect to renewal – in that the expiration date of the CoC is tied to the date at which the vendor initially received it. Dry storage systems will be loaded at various sites at various points in time after the initial CoC was granted, however all of these systems will be subject to renewal at the same time regardless of when the systems were loaded at each site (typically either 20 or 40 years after the initial CoC was granted depending on whether or not the original CoC pre-dated the change to 10 CFR Part 72 to allow longer licenses). Table 2 below identifies the expiration date of each of the licenses or, alternately, CoCs in effect at each of the 16 ISFSIs at shutdown reactor sites.

Table 2
SHUTDOWN PLANT ISFSI LICENSE EXPIRATION DATES [11]

ISFSI	LICENSE	EXPIRATION
Oyster Creek, Crystal River*, & Kewaunee	CoC – NUHOMS/1004	2015
Trojan	Site Specific	2019
Rancho Seco	Site Specific	2020
Yankee Rowe, Connecticut Yankee, & Lacrosse	CoC – NAC-MPC/1025	2020
Vermont Yankee	CoC – HI-STORM/1014	2020
Maine Yankee	CoC – NAC-UMS/1015	2020
Big Rock Point	CoC – FuelSolutions/1026	2021
GE Morris	Site Specific	2022
San Onofre	CoC – Advanced NUHOMS/1029	2023
Humbolt Bay	Site Specific	2025
Zion	MAGNASTOR/1031	2029
Ft. St. Vrain	Site Specific	2031

*Has yet to load any dry storage systems under this license

Each time a license is renewed, the licensees and/or CoC holders involved will be required by NRC to commit to increasingly rigorous aging management programs. These programs will include inspection and monitoring as well as supporting research and development activities. The 2010 termination of the Yucca Mountain project has resulted in an increasing focus being placed on these programs and activities – as the industry and regulator grapple with the increasing likelihood that ISFSIs will be in service for considerably longer periods of time. Since 2010, two site specific ISFSIs (at the Prairie Island and Calvert Cliffs operating reactors) have come due for renewal and one CoC (NUHOMS/1004) has begun pre-renewal interactions with the NRC. In all three cases, the dialogue on aging topics has been much more extensive, and the level of commitment expected to address aging mechanisms has been considerably more significant, than what was associated with the pre-2010 renewals. Two specific technical issues – long-term degradation of high-burnup[1] fuel (HBF) cladding and chloride induced stress corrosion cracking (CISCC) of stainless steel dry storage canisters – have received the most attention. In both cases, a significant amount of scientific and technical effort is being undertaken in support of these and future ISFSI license renewals. These two issues are summarized in Table 3 below.

[1] Burnup is the amount of energy generated by a fuel assembly. Decades ago fuel was typically discharged with burnups less than 45 gigawatt-days/ton (GWD/t). Now typical discharge burnups are 45-60 GWD/t burnup.

Table 3
EXAMPLES OF AGING ISSUES BEING ADDRESSED IN ISFSI LICENSE RENEWAL

ISSUE	DESCRIPTION	SCIENTIFIC AND TECHNICAL WORK SUPPORTING LICENSE RENEWAL
Long-term Degradation of High-Burnup Fuel (HBF) Cladding	Although dry storage of lower burnup used fuel (LBF) has occurred in the United States (U.S.) since 1986 and industry has collected data on the performance of the fuel cladding in storage, dry storage of high burnup fuel (HBF) has been more recent. As of December 2012, approximately 200 dry storage casks have been loaded with at least some HBF. Furthermore, almost all used fuel being loaded in the U.S. is now HBF. Since HBF has different mechanical properties than LBF, industry needs additional data on HBF under storage conditions. While analyses predict storage of HBF is safe, empirical data to confirm the analytical assumptions is needed.	Industry, in partnership with DOE, is undertaking a High Burnup Demonstration Research Project (HDRP) that will select a diverse population of HBF from the pool at Dominion's North Anna station, place it in dry storage, gather monitoring data with the fuel in storage, and eventually open the dry storage canister in a hot cell for post-test examination (and comparison of results to "sister" fuel rods extracted from the same assemblies prior to being placed into dry storage. Licensees seeking ISFSI renewal are committing to assess the results of the HDRP at specific points in the future and confirm the continued safe storage of HBF.
Chloride Induced Stress Corrosion Cracking (CISCC) of stainless steel dry storage canisters	Austenitic stainless steels (304, 304L and 316L) used for confinement boundary in SNF storage canisters may be susceptible to SCC when exposed to a chloride containing atmosphere (References 1 through 4). Fog and spray aerosols from salt water bodies can contain airborne chlorides that may deposit on canister surfaces, potentially leading to SCC. Degradation from this phenomenon may impact the ability of the storage system confinement boundary to perform over an extended operating period. SCC, if present, may also impact the future transportation performance (if the system or component is dual-purpose certified and the canister is used as a second watertight barrier for moderator exclusion during transport).	Industry has begun inspections of the canisters using current Non-Destructive Examination (NDE) technology and is initiating the development of more advanced NDE techniques. Commitments are now being made in ISFSI license renewal that call for the deployment of more advanced NDE technology to future inspections (It is difficult to deploy existing technologies in the limited space between the canisters and concrete over-packs which provide radiation shielding. Efforts are also underway to assess the specific susceptibility of different sites (given environmental conditions) to narrow the number of casks requiring inspection.

The total scope of effort required to address just the HBF and CISCC aging management issues is likely to extend into the hundreds of millions of dollars. While much of the cost of this effort will be spread out over the entire industry or will be paid by the DOE, there will be significant expenses (in terms of licensing and/or inspection work) incurred at each ISFSI either being renewed or containing dry storage systems for which the CoC is being renewed. Of course, work associated with these and other storage aging management issues could be more efficiently done if storage were transferred to a consolidated site, where the research and development infrastructure necessary to support long-term storage and subsequent license renewal could be centrally housed. As can be seen from Table 2, licenses for storage systems at 14 of the 16 shutdown plant ISFSIs will be up for renewal in the next ten years. This means that the lead time to take advantage of the opportunity to consolidate aging management activities by consolidating

storage of shutdown plant fuel is growing quite short. This, in addition to the mounting annual costs, could have a motivating effect on progress in the federal program to remove it.

CONTINUED STORAGE AND POTENTIAL REPACKAGING

Another ramification of the 2010 Yucca termination was litigation by States and activist groups to challenge NRC's Waste Confidence Rule (which had been, in part, based on assumptions about the availability of a repository). This resulted in a 2012 court decision that remanded and vacated the waste confidence rule and, among other things, instructed NRC to consider the environmental impacts of a repository never being built [12]. NRC responded to this mandate with a revised rule (now referred to as the Continued Storage rule) that was built on a Generic Environmental Impact Statement (GEIS) that included an indefinite ISFSI storage scenario [13]. In that scenario, NRC made the simplifying assumption that used fuel at ISFSI sites would be repackaged every 100 years.

While it is entirely possible that existing dry storage systems might be able to remain in service for longer than 100 years, and the current population of shutdown site ISFSIs is at least 70 years away from that point, the prospect of repackaging used nuclear fuel at a site with no operating nuclear facility infrastructure – at any point in time – is certainly a reason to give serious re-consideration to indefinitely leaving used fuel at shutdown sites. Also, regardless of when repackaging may actually be necessary, there are some who may recommend a more conservative approach (see discussion below regarding the State of Minnesota). However near, or far, in the future potential repackaging may be, the infrastructure needed to repackage would likely involve some of the same or similar facilities to that required to support aging management technical and scientific research. The opportunity for synergy between these objectives should be seen as further motivation for action to move and consolidate used fuel – and avoid the unnecessary expense of building repacking facilities at multiple shutdown plant sites.

PUBLIC INTEREST IN STRANDED USED FUEL

Another thing that has changed in the post-Yucca world, is the extent to which public awareness regarding used fuel remaining at recently shutdown plants has heightened. The situation at San Onofre station in Pendleton California, which was permanently shut down in 2013, is an interesting example in this regard. In February of 2014, a Community Engagement Panel (CEP) was formed to facilitate stakeholder input to the decommissioning process [14]. The CEP meets quarterly, its meetings are well attended and receive considerable media coverage. The topic of used fuel storage and disposal is one of their key focus areas. One local activist group that participates – San Onofre Safe – has gone as far as to weigh in on the selection of dry storage technology for the decommissioned site [15]. The attention placed on used fuel aspects of San Onofre decommissioning has been such that California Senator Barbara Boxer has even mentioned the topic of HBF in Committee hearings. This is a very different dynamic that what previously existed regarding used fuel at reactors going into decommissioning. If the level of interest continues to be high, and is paralleled at other sites, it could be a motivating factor for Congress to act in support of the removal of used fuel from decommissioned sites.

THE IMPACT OF DECOMMISSIONING UNCERTAINTIES DUE TO STRANDED USED FUEL ON OPERATING PLANTS

The potential for decommissioning implications to affect used fuel management decision-making is not specifically limited to the used fuel stored at the 16 shutdown sites. These implications are also being felt at operating plants, as the owner/operators of these plants must consider the effects of used fuel uncertainties in their plans and preparations for decommissioning. An interesting example of this is occurring in the State of Minnesota where Xcel energy currently operates three reactors.

During the 2011 session of the Minnesota Legislature a law was enacted that requires Xcel Energy to address the cost of used nuclear fuel storage management after plant shutdown as part of its decommissioning cost accrual to ensure sufficient funds are being collected from the current customers that benefit from nuclear power today. Xcel Energy is required to provide cost estimates assuming used nuclear fuel storage in Minnesota for 60, 100 and 200 years following plant shutdown. These cost estimates are provided to the Minnesota Public Utility Commission (MPUC) who then reviews the progress of the federal government towards removing used nuclear fuel from Minnesota's nuclear plants and the MPUC decides which cost estimate most closely reflects the current state of affairs which then becomes part of the basis for decommissioning costs collection from ratepayers.

Xcel Energy filed its first cost estimate under this new statute in 2011. In its 2011 filing Xcel Energy presented a cost estimate for used nuclear fuel storage management for 36, 60, 100 and 200 years. The 36 year scenario was included by Xcel Energy based on DOE's strategic plan to implement the recommendations of the Blue Ribbon Commission's recommendations where DOE indicated that with authorization from Congress they could have a pilot interim storage facility operational by 2021, a larger interim storage facility by operational by 2025 and a repository operational by 2048. For the 200 year scenario the costs of replacing canisters after 100 years of storage was assumed including the cost of a transfer facility on-site to transfer the stored used nuclear fuel from the old canisters to new ones. The MPUC found that 36 year scenario was optimistic based on the past performance of the federal government and Xcel Energy was directed to use the cost estimates for used nuclear fuel storage management from the 60 year scenario. The MPUC also directed Xcel Energy to change the assumption for frequency of canister replacement from every 100 years to every 50 years in its next filing.

Xcel Energy's second triennial filing under the statute enacted in 2011 is due to be submitted on December 1, 2014. Xcel Energy will again provide a 36, 60, 100 and 200 year scenario with used nuclear fuel transferred from old canister to new canisters once under the 100 year scenario and three times under the 200 year scenario. Current cost estimates for spent fuel storage management for Monticello and Prairie Island range from approximately $850 million for the 36 year scenario to over $7 billion for the 200 year scenario with new canisters provided every 50 years.

While the Minnesota example may be unique, stakeholder interest in accounting for used fuel uncertainties in decommissioning planning is likely to be on the rise elsewhere as well. The

effects of such concerns on the operating fleet could provide further motivation for action on a federal program to facilitate the movement of used fuel.

SHUTDOWN SITES AS A POTENTIAL MOTIVATOR FOR A RETURN TO YUCCA

The infrastructure that will be needed for the scientific and technical programs needed to support dry storage aging management and, perhaps, provide for future used fuel repackaging already has a well-developed design precedent. The surface operations facilities described in the Yucca Mountain Safety Analysis Report [16] either already have the capability, or could be readily modified, to support both of these missions. And, although the project still remains dormant for the time being, there have been a couple of key developments that appear to support a potential future revival. On August 13, 2013 the U.S. Court of appeals ruled in favor challenges to the suspension of the Yucca Mountain licensing process brought by project supporters in a Writ of Mandamus ordering "unless and until Congress authoritatively says otherwise or there are no appropriated funds remaining, the Nuclear Regulatory Commission must promptly continue with the legally mandated licensing process" [17]. NRC is complying with this order to the extent permitted by available funds and has resumed work on a Safety Evaluation Report (SER) to Document the results of NRC staff's technical review. In October of 2014, NRC issued a significant portion of this evaluation – SER Volume 3: Repository Safety after Permanent Closure – which concluded "with reasonable expectation that the proposed Yucca Mountain repository design meets the applicable performance objectives" of its regulations.

Given that both the legal and the scientific basis for resuming the Yucca Mountain project has been recently strengthened, taking a second look at the project from the perspective of the shutdown plants may, indeed have merit. Perhaps, adding a scientific and technical research mission to the project's focus oriented towards the needs of the shutdown plants could be one way to give it further momentum.

A research focus to addressing contentions raised in the Yucca Mountain licensing process was specifically explored in a paper submitted in last year's waste management conference [18]. The concept proposed in that paper would call for DOE and the intervening parties to negotiate settlements to many of the over 200 contentions filed in the licensing process by forging mutual commitments to R&D programs designed to further address the fundamental safety questions at issue in each dispute. If both parties to the settlements had the authority to judge the satisfactory completion of these R&D programs, the State of Nevada would have a much stronger role in assuring the safety of its citizens – something that is very much needed for the process to achieve the level of "consent" recommended by the Blue Ribbon Commission. NRC could proceed towards making its initial licensing determination – an authorization to construct the repository – while these R&D programs were underway. R&D program would then inform subsequent licensing decisions to receive and possess nuclear materials or to close the repository.

NRC's existing regulations (10 CFR Part 63.21(c).16) already provide for such an approach, allowing for R&D programs "to resolve safety questions, including a schedule indicating when these questions would be resolved". The current license application does not utilize this provision, instead including, as Chapter 3, only a placeholder stating that DOE "pursuant to 10 CFR Part 63.21(c).16, has not identified any safety questions". However, taking a second look at

the safety questions embedded in the Yucca interveners licensing contentions could offer a better way forward. Doing this in a way that would also address the needs of shutdown plants, or even begin moving shutdown plant fuel to Yucca Mountain ahead of full repository development as an initial, or pilot, step could serve to give the project a much needed impetus.

CONCLUSION

With respect to used fuel removal from reactor sites and disposal, the nation is at an impasse. A broad view of the political landscape does not appear to offer much hope that this will change. But dotted across that landscape, are 16 locations, at which there is very good reason to believe that the seeds of change may be about to take root. The costs of maintaining these sites as stand-alone ISFSIs and public interest in their situation are both on the increase. The costs are affecting not only the owners of shutdown plants, but are also beginning to be felt at operating reactors. The benefits of consolidating the scientific and technical work necessary to support aging management programs for these used fuel inventories are rapidly becoming apparent and the prospect of potential future used fuel repackaging at multiple shutdown sites is substantially daunting. Finally there are signs of life emerging from the still dormant Yucca Mountain project, and along with that, opportunities for synergy with the shutdown plants that could drive progress on both fronts. Looking forward into a world of uncertainty, one can indeed gather some clarity from what is happening at shut down plants – and from what, logically, should happen in the future.

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