System Impacts of Accelerated Transfer of Used Nuclear Fuel to Dry Storage - 15220

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ABSTRACT

In the wake of the September 11, 2001 terror attacks, and again after the March 11, 2011, accident at the Fukushima Dai-Ichi station from the Great East Japan Earthquake/tsunami, concern was expressed regarding security of current spent fuel storage practices in the United States. An approach recurrently proposed to reduce the potential for fire and the release of radionuclides in an accident or sabotage scenario is to reduce the loading of the reactor fuel pools, which are frequently maintained near their full capacity at many reactor sites in the U.S. We assess the impact on the waste management system of different scenarios for accelerating the schedule of used nuclear fuel (UNF) transfer from reactor pools to dry storage casks. We consider scenarios where the spent fuel pools are drawn down to 50% or 25% of full capacity over 5- or 10-year schedules. The scenarios include status quo, where UNF continues to remain in dry storage at the reactor sites, as well as scenarios with UNF transfer to interim storage and eventually to a mined geologic repository. The primary purpose is to evaluate how the different scenarios for accelerating the transfer of UNF to at-reactor dry storage would affect the performance of the entire UNF management system. Areas that were considered include an estimate of the additional system costs that could be incurred and where the existing infrastructure at the reactor sites would come under stress from the transfer demands. This study considered only the fuel-handling logistics and rough-order-of-magnitude cost at reactor sites, interim storage facility, and operations to package UNF into disposal canisters. The effects of minimum fuel age that could be transferred and the accelerated transfer starting date are also examined, but found to have relatively little effect. Impacts on safety and worker dose are not evaluated quantitatively, although effects can be inferred from increases in handling operations, etc. from the scenarios considered.

INTRODUCTION

A U.S. Nuclear Regulatory Commission (NRC) review triggered by the accident at the Fukushima Dai-Ichi station from the Great East Japan Earthquake/tsunami resulted in an NRC lessons-learned Tier 3 issue on Expedited Transfer of Spent Fuel to dry storage [Ref. 1]. NRC staff evaluated the safety and economical aspects, concluding [Ref. 2]:

- Expedited transfer of spent fuel would provide only a minor or limited safety benefit
- The costs of expedited transfer of spent fuel to dry cask storage outweigh the benefits
- Additional studies are not needed
- No further regulatory action is recommended and this Tier 3 item should be closed

The NRC voted to agree with staff recommendation [Ref. 3], however there is still concern being expressed by a variety of stakeholders.

In 2010 the Electric Power Research Institute (EPRI) completed a report that evaluated the impacts associated with the accelerated transfer of 5-year cooled UNF from wet to dry storage at the reactor sites [Ref. 4]. This report was subsequently revised in 2012 by EPRI [Ref. 5].

Both the NRC and EPRI evaluations focused on safety and operational aspects of accelerated transfer of UNF to dry storage with respect to the current fleet of operating reactors in the U.S. Neither the NRC nor EPRI efforts considered the potential impacts to the rest of a future nuclear waste management system.

We present the results of an evaluation that assessed the impact on the waste management system of different scenarios for accelerating the schedule of fuel transfer from reactor pools to dry storage casks. The primary purpose is to evaluate how the different scenarios for accelerating the transfer of UNF to at-reactor dry storage would affect the performance of the entire UNF management system. The primary focus of this evaluation is on the potential impacts on consolidated interim storage facility (ISF) and the packaging of UNF into disposal canisters. The impacts of accelerating the transfer of UNF to dry storage on at-reactor logistics were considered in that they affect the boundary condition between at-reactor UNF management and the rest of the waste management system. Where appropriate, the results obtained were compared against the previous analyses.

Areas that were considered include an estimate of the additional system costs that could be incurred and where the existing infrastructure at the reactor sites would come under stress from the transfer demands. This study considered only the fuel-handling logistics and rough-order-of-magnitude cost at reactor sites, interim storage facility, and operations to package UNF into disposal canisters.

The scenario simulations are based upon calculations done by the Transportation Storage Logistics-Civilian Radioactive Waste Management System Analysis and Logistics Visually Interactive (TSL-CALVIN) simulation tool. The TSL-CALVIN simulations tool is a system-level tool capable of simulating a broad set of potential future scenarios for managing UNF. It supports the evaluation of a range of back-end UNF management scenarios involving at-reactor storage, storage at one or more off-site interim storage facilities, and ultimate disposal using concepts specific to different geologic settings. It can be used to evaluate different UNF pick-up scenarios within broader overall scenarios, and model the costs and logistics of transportation, storage, repackaging (as needed), and disposal. The TSL-CALVIN simulation tool couples the legacy Civilian Radioactive Waste Management System (CRWMS) Analysis and Logistics Visually Interactive model (CALVIN) and Transportation Operations Model (TOM) into a framework for evaluating the entire system for managing UNF. The software simulates the logistics of and costs associated with managing UNF across the various facilities within the system (reactors, storage facilities, and disposal facilities). TSL-CALVIN establishes the shipping schedule between facilities.

MODELING OF UNF MANAGEMENT SCENARIOS

The impacts on the waste management system of different scenarios for accelerating the schedule of UNF transfer from reactor pools to dry storage casks were assessed. Scenarios where the spent fuel pools are drawn down to 50% or 25% of full capacity over 5- or 10-year durations were considered. The scenarios include those where UNF continues to remain in dry storage at the reactor sites indefinitely (aka "no-acceptance"), as well as scenarios with UNF transfer to an interim storage facility (ISF) and eventually to a mined geologic repository (MGR). The TSL-CALVIN simulation tool was used to calculate the response of the fuel handling system to each of the scenarios. A complete list of the scenarios used along with their parameters is provided in Table I.

In order to calculate the behavior of the fuel handling system to the acceleration scenarios, a few assumptions were made to be consistent with current practice as well as reference system spent fuel acceptance assumption used in previous systems studies. For the cases in which there is no repository development or fuel removal from the reactor sites over the next 100 years (No-Acceptance Cases), all UNF continues to be stored on-site. These no-acceptance scenarios are used to determine boundary conditions and they provide some insight into the costs associated with delays in implementing a permanent disposal path for UNF. For other cases where a geologic repository is eventually developed (Acceptance Cases), it is assumed that:

- A Pilot ISF begins operation in 2021, and accepts all UNF only from currently shutdown reactors by 2024.

- The Pilot ISF is followed by a Larger ISF that accepts UNF from all sites in 2025.
- UNF is transferred to the Larger ISF at 3,000 MTHM/yr acceptance rate and is allocated for shipment based on an Oldest-Fuel First (OFF) prioritization.
- The geologic repository begins operation in 2048 with an emplacement rate of 3,000 MTHM per year and all UNF packaging is done at the repository.
- UNF has a minimum of 5 years of aging in the reactor pools before transfer to dry casks or being shipped off-site. Note that sensitivity analyses were performed that investigated a minimum 10-year aging limit (see Table I).

In the UNF acceptance cases shown in Table I, two sets of scenarios for how UNF would be accepted from the reactor fleet were considered:

1. All UNF is transported from the reactor sites in dual-purpose canisters (DPCs)
2. UNF in DPCs is transported from at-reactor dry storage and UNF from the fuel pools and is transported in re-useable transportation casks.

In the cases where bare fuel was accepted at the ISF, cases were considered for both bare fuel storage in pools at the ISF or in canisters loaded at the ISF. This range in conditions was meant to ensure that specific assumptions about the UNF handling and disposal could be distinguished from those attributable to the accelerated transfer.

Note that the TSL-CALVIN code is constrained to transfer UNF at the acceptance rate specified[1] (in this evaluation, 3,000 MTHM/yr) as long as UNF that can be transported is available, regardless of whether reactor site resources are physically capable of processing canisters/casks to achieve this rate. As will be shown later, this constraint becomes an important consideration for the more aggressive acceleration schedules (e.g., 5-year duration or pool draw-down to 25% capacity). Specifically, it is necessary to evaluate the logistic simulation results to see if the schedule is feasible.

At-Reactor Logistics Results

This section summarizes the implications of accelerated transfer of UNF to dry storage on nuclear power plant operations, specifically at-reactor logistics. Aspects of the logistics that were evaluated include the total number of canisters loaded at reactors and the maximum number of canisters loaded at a specific reactor site in a year. The total number of years that shutdown reactors still have fuel on-site is also investigated for various cases.

We first consider the no-acceptance cases, represented by scenarios wherein there is no ISF or MGR, and the fuel remains at the reactor sites indefinitely. Some of the metrics calculated for the no-acceptance scenarios, such as number of canisters per year loaded at operating reactors, are not contingent upon the existence of an ISF or MGR. Others, such as the ROM costs over a time interval, are affected. The no-acceptance scenarios represent a baseline for comparison with more complex UNF management and disposal scenarios. Thus, some of the observations of at-reactor impacts from the no-acceptance cases are unchanged in the acceptance cases.

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[1] The concepts described in this paper do not in any way affect the responsibilities of the parties as defined in the Standard Contract for the Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961). Pursuant to the Standard Contract, the U.S. Government will only accept bare used nuclear fuel (10 CFR 961.11, Article VI.A.1.(a)). A modification of the Standard Contract would have to be agreed to in order for the U.S. Government to accept used nuclear fuel in dual-purpose canisters. The potential impacts of this provision of the Standard Contract were not factored into this study.

Table I. Accelerated Transfer to At-Reactor Dry Storage Scenarios

Acceptance Start	Acceptance Rate	Minimum Pool Capacity	Minimum Fuel Age (yr)	Acceleration Transfer Start	Acceleration Transfer Duration (yrs)	Acceptance Method	ISF Storage Method
None	None	100%	5	None	N/A	N/A	
		25%	5	2015	10		
					5		
		50%	10	2015	10		
					5		
		50%	5	2015	10		
					5		
		25%	5	2020	10		
					5		
		50%	10	2020	10		
					5		
		50%	5	2020	10		
					5		
2021 Legacy Shutdown - Reactors 2025 – Rest of Nuclear Fleet	Clearing by 2024 3000 MTHM/yr	100%	5	None	N/A	All Canisters	All Canisters (Dry)
		50%		2020	10		
					5		
		100%	5	None	N/A	Canisters and Bare Fuel	Canisters (Dry) and Bare Fuel (Pools)
		50%		2020	10		
					5		
		100%	5	None	N/A	Canisters and Bare Fuel	Canisters (Dry) and Bare Fuel (Dry)
		50%		2020	10		
					5		

1. All cases assume 3,000 MTHM/yr acceptance and OFF priority allocation

Figure 1 shows the cumulative number of canisters transferred to dry storage between the years 2010 and 2030 for a range of cases where accelerated transfer of UNF to dry storage begins in 2015. The parameters varied in these cases are:

- minimum pool capacity that the pools will be drawn down to (25% or 50%),
- duration of acceleration (5 or 10 years), and
- minimum fuel age (5 or 10 years).

In Figure 1, the different scenarios are abbreviated by the acceleration start year, followed by the percent of full pool capacity, the duration (in years) of the acceleration period, and the minimum fuel age transferred to dry storage. For example, “2015-25-10, 5 yr fuel” means that acceleration starts in 2015 to draw down to 25% pool capacity within a 10-year window with 5-year (minimum) out-of-reactor fuel.

The solid lines in Figure 1 are the cumulative number of canisters loaded, while the dashed lines represent the number of canisters that are loaded at less than full capacity in order to meet thermal limits on dry storage canisters (termed as short-loading). The results show that how the accelerated transfer to dry storage would be performed has a significant impact on the amount of UNF that would be transferred. By far the largest impact is the desired capacity of the fuel pools. The results shown in Figure 1 show the same trends as those observed by EPRI for a 10-year acceleration window starting in 2015 [Ref. 5, Figure 4-2].

The cumulative number of canisters loaded shows similar trends whether acceleration begins in 2015 or 2020. The only significant difference is that an earlier start of acceleration increases number of canisters that would have to be short-loaded, primarily in the more aggressive acceleration cases where the drawdown is to 25% pool capacity. The five-year delay allows for fuel assemblies to cool further such that the number of canisters that have to be short-loaded reduces.

The annual transfer of UNF to dry storage is shown in Figure 2 under various no-acceptance scenarios for a 2015 (acceleration start. These results show that the combination of low ultimate pool capacity (25%) and a short transfer window (five years) lead to a very large amount of UNF, on the order of 10,000 MTHM/yr, that would have to be transferred annually across the reactor fleet. Extending the period over which the acceleration occurs or reducing the desired pool drawdown (50% versus 25% pool capacity) reduces the amount of UNF that would have to be transferred annually. The combination of the two (50% pool capacity and 10-year acceleration period) leads to the lowest annual amount of UNF that would have to be transferred, 4,000 – 5,000 MTHM/yr.

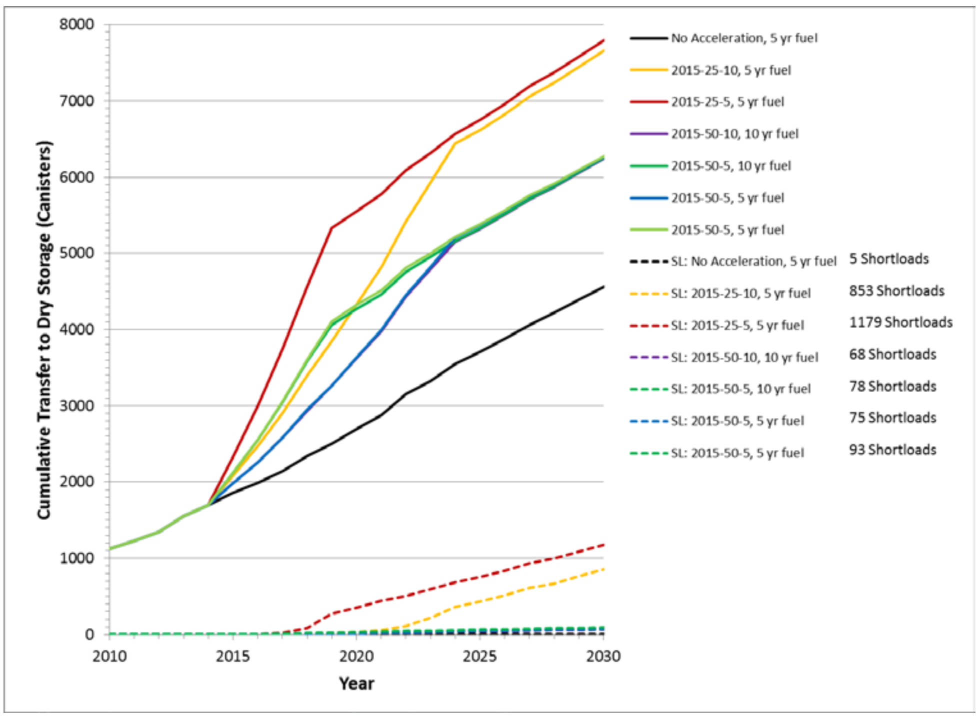

Figure 1. Cumulative Number of Canisters Transferred to Dry Storage – No Acceptance with Accelerated Transfer Beginning in 2015

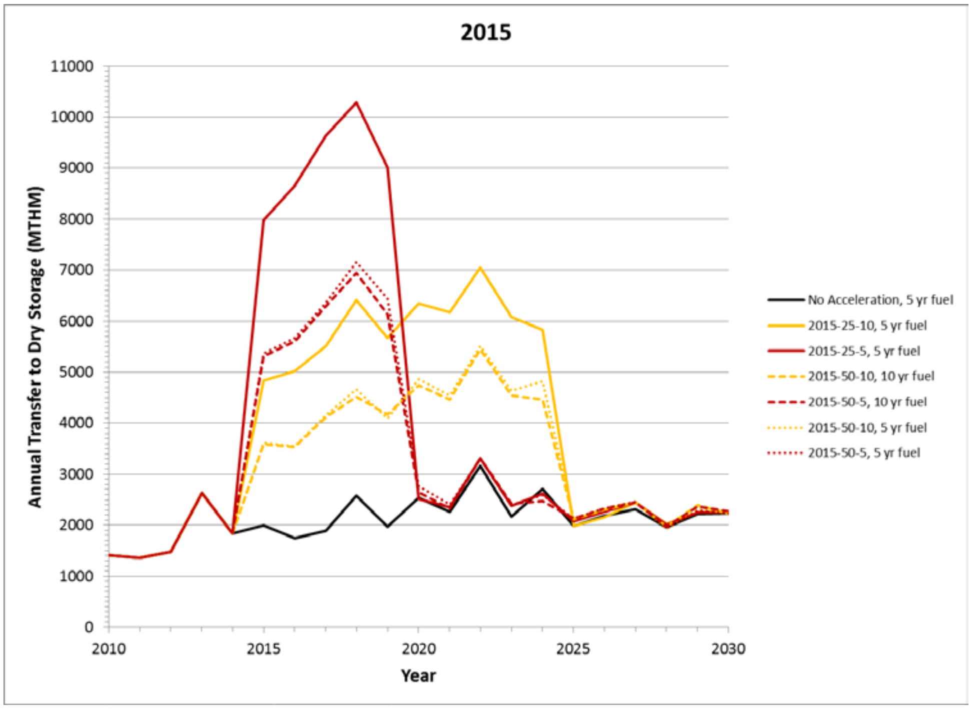

Figure 2. Annual Number of Canisters Transferred to Dry Storage – No Acceptance with Accelerated Transfer Beginning in 2015

Note that after the acceleration period, the annual amount of fuel that would be transferred to dry storage returns to approximately 2,000 MTHM/yr, which is the rate that UNF is being discharged from the reactor fleet.

The annual number of canisters transferred to dry storage is qualitatively insensitive to a change in start date from 2015 to 2020, aside from a 5-year offset, so it is reasonable to conclude that the starting year does not have a large impact upon the at-reactor logistics, at least for accelerating starting in the next decade. The results shown in Figure 2) show the same trends as those observed by EPRI for a 10-year acceleration window starting in 2015 [Ref. 5, Figure 4-1].

One potential concern regarding the at-reactor logistics is whether there are practical resource limitations on performing the large number of fuel transfers required by some of the scenarios at the reactor sites. As pointed out by EPRI [Ref. 5], the reactor sites have a limited amount of time to perform dry storage loading campaigns between refueling outages owing to the resources shared between reactor pools and reactor refueling and maintenance. An operating reactor (and even shutdown reactors) can only load a limited number of canisters every year because there are only a few weeks available over which all loading must be completed. Recent experience in loading dry storage systems indicates that approximately one cask can be loaded per week with the industry typically loading between 10 and 15 DPCs into dry storage during a campaign.

Currently, times to load DPCs are not modeled in TSL-CALVIN and the code does not constrain how many canisters can be loaded at a reactor site in a given year. All loading decisions in TSL-CALVIN are controlled either by acceptance rates or the amount of fuel that has to be transferred to dry storage to maintain pool capacity. However, it is recognized that without loading process efficiency improvements, some of the results seen in this study for some of the scenarios may be unrealistic (for operating and shutdown reactors). While it is recognized that there is site-specific variability, recent experience in loading dry storage systems indicates that approximately one cask can be loaded per week with the industry typically loading between 10 and 15 DPCs into dry storage during a campaign. Increased loading efficiency, such as performing loading operations 24 hours per day, 7 days a week, is not expected to significantly increase the number of DPCs that could be loaded during a campaign.

An accounting of DPC loading operations appears as frequency histograms of the number of heavy loading operations per year at operating reactors between the years 2015-2030 is shown in Figure 3 for 2015 start. From this, it is clear that the more ambitious transfer schedules would likely be unattainable at most operating sites. For instance, pool draw-down to 25% (solid lines) and draw-down within 5 years (red lines) result in significant (> 100) occurrences needing 15 or more fuel handling operations within a calendar year. Again, the results in Figure 3 are not sensitive to start date (2015 vs 2020), affirming a weak dependence of logistics on starting time in the near-term.

EPRI has identified the issues associated with challenging loading campaigns [Ref. 5] and the results shown in Figure 3 show that not only would some of the more aggressive scenarios likely not being attainable, even those that appear to be attainable would still be very aggressive requiring a large commitment of the nuclear utilities and the cask vendors.

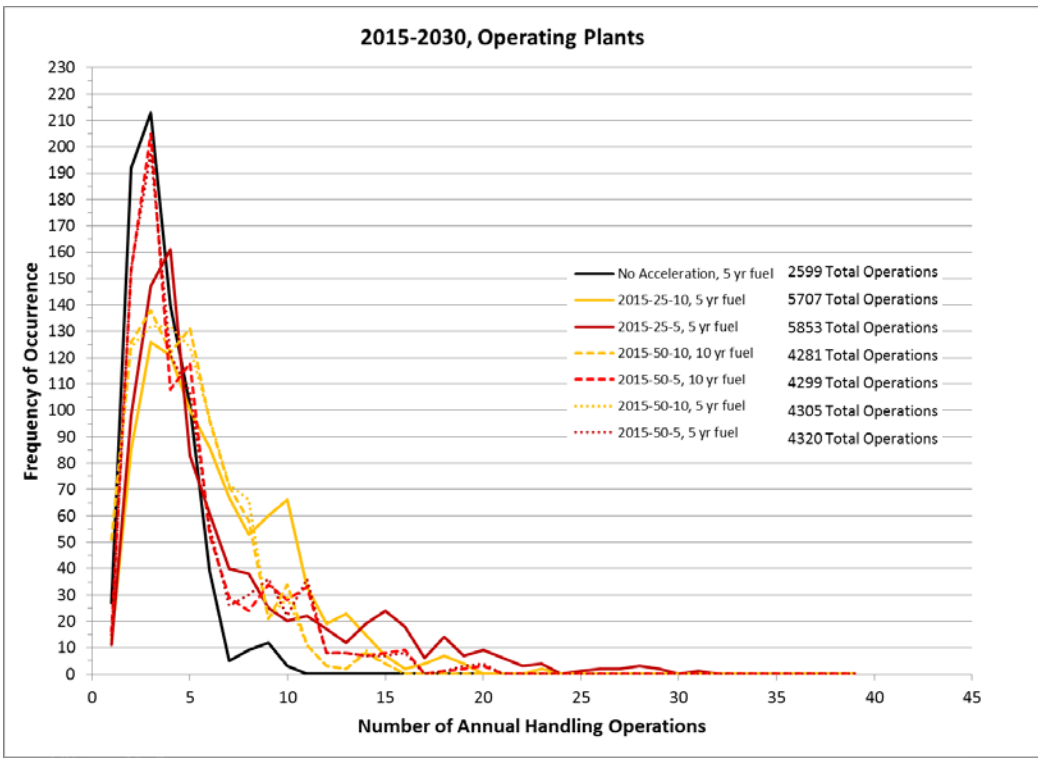

Figure 3. Fuel Handling Operations at Reactor Sites (2015-2030) – No Acceptance with Accelerated Transfer Beginning in 2015

Next we consider the at-reactor logistic results of scenarios that include the acceptance by an ISF/MGR system of UNF from the reactor sites. Specific impacts on reactor operations due to the accelerated transfer of UNF from at-reactor pool to dry storage were evaluated, including the ability to clear reactor sites of UNF, and the rate and type of canisters/casks that would be shipped to waste management facilities.

Again, two sets of scenarios for how UNF would be accepted from the reactor fleet were considered:

1. All UNF is transported from the reactor sites in dual-purpose canisters (DPCS)

2. UNF in DPCS is transported from at-reactor dry storage and UNF from the fuel pools is transported in re-useable transportation casks.

An acceptance rate of 3,000 MTHM/yr was assumed with OFF allocation priority in each scenario. It was also assumed that the accelerated transfer of UNF from at-reactor pool to dry storage begins in 2020 with a desired pool capacity of 50% of total pool capacity. Accelerated transfer durations of 5 and 10 years were evaluated.

Key reactor site logistic results are summarized in Table II. It can be seen that the maximum at-reactor dry storage inventory and cumulative number of canisters transferred to dry storage increase significantly for scenarios when the transfer of UNF from at-reactor pool to dry storage occurs. This increase occurs over the period where accelerated transfer occurs, as shown in Figure 4.

There is a slight increase in the cumulative number of canisters shipped from the reactor sites when all UNF is shipped in DPCs. This is primarily due to an increase in the number of canisters that would have to be short-loaded in the accelerated transfer scenarios (see further discussion on short-loading impacts above). The increase in the number of canisters shipped from the reactor sites is more significant for the acceptance scenarios where bare fuel in the reactor pools is transported from the reactor sites. This is again caused by the accelerated transfer and may reduce system flexibility down-stream if the packaging of UNF into disposal canisters is necessary (discussed below) in that additional DPCs would have to be cut open.

Table II. At-Reactor UNF Management Logistic Results

Scenario Description		Maximum MTHM In Storage	Maximum Canisters in Storage	Cumulative MTHM Into Storage	Cumulative Canisters into Storage	Cumulative Canisters Shipped	Fuel Site Years Post-Shutdown
Shipment of All Canisters	No Acceleration	49674	4029	79951	6435	11400	1903
	2020-50-10*	60966	4838	91565	7308	11609	1903
	2020-50-5	63815	5075	94263	7518	11657	1903
Shipment of Canisters from Dry Storage; Bare Fuel from Pools	No Acceleration	44474	3597	48725	3982	3982	1752
	2020-50-10	61655	4901	66290	5315	5315	1752
	2020-50-5	65325	5186	70468	5646	5646	1752

*Scenario Case Names: Acceleration start (2020), Pool Capacity (50%), Acceleration duration (5 or 10 years)

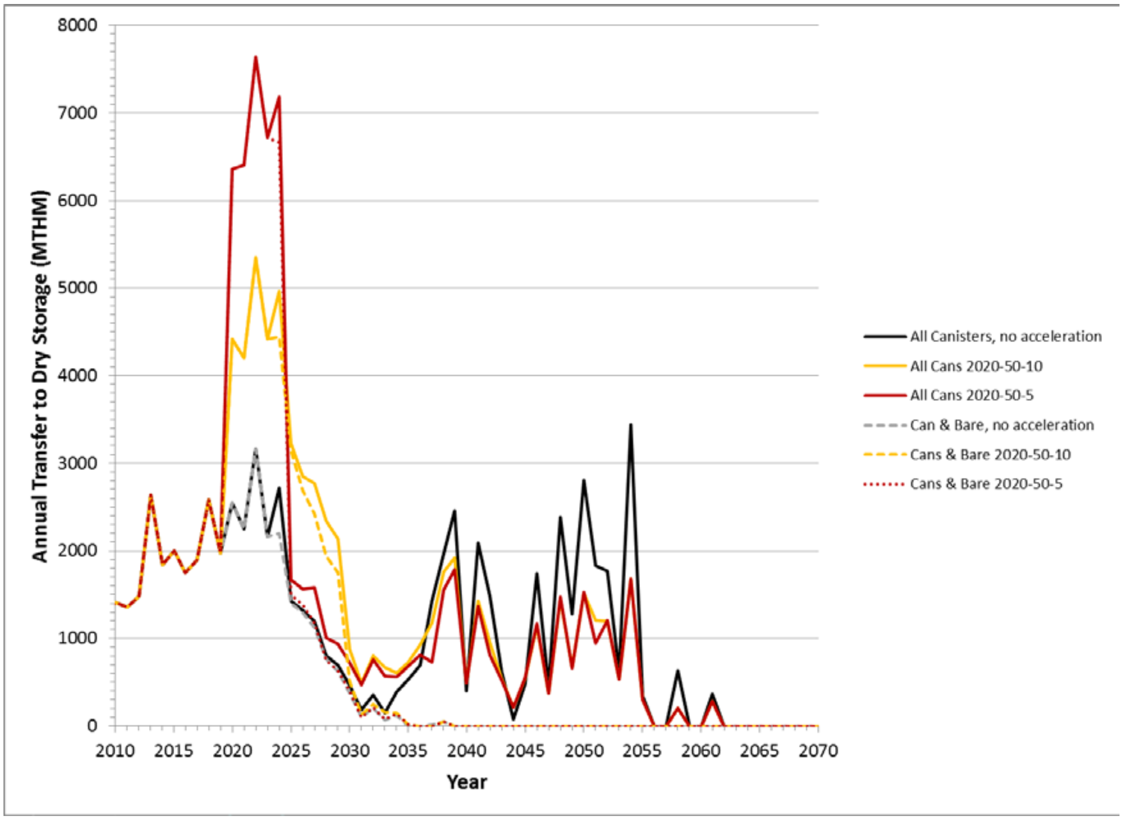

Figure 4. Annual UNF Transfer to Dry Storage – Acceleration and Acceptance Scenarios

The number of fuel site-years (that is, number of sites × years with fuel on-site) post-shutdown is completely unaffected by acceleration. This is because the fuel unloaded from the reactors later in their operational lives can exceed transportation overpack thermal limits and cannot be shipped without additional cooling, and this is independent of prior at-reactor fuel management activities. Thus, the clearing of sites is independent of acceleration strategy.

ISF and Disposal Canister Logistic Results

Summary logistics results for the ISF and a disposal canister packaging facility for the acceptance scenarios evaluated are provided in Table III. These results show that the impacts of accelerating the transfer of UNF from at-reactor pool to dry storage on the configuration and operation of an ISF would be minimal.

The maximum amount of UNF in storage at the ISF, approximately 70,000 MTHM for all scenarios considered, is unaffected by accelerating the transfer of UNF from at-reactor pool to dry storage. When all UNF is stored dry at the ISF, there is no significant effect on the number of canisters that are stored. However for scenarios where bare fuel is received and stored at the ISF the accelerated transfer of UNF to at-reactor dry storage results in a minor increase in the number of canisters in storage at the ISF and a corresponding minor decrease in the amount of bare fuel stored (2,000 – 6,000 MTHM).

The accelerated transfer of UNF from at-reactor pool to dry storage does not have a significant effect on the total number of canisters and/or bolted re-useable transportation casks that would have to be opened so the contents could be placed into disposal canisters. When all UNF is loaded into canisters at the reactor sites, accelerating the transfer of UNF to at-reactor dry storage increases the number of welded canisters that would have to be cut open due to the need to short-load canisters (~200 canisters). For scenarios where bare fuel is received and stored at the ISF the accelerated transfer UNF to at-reactor dry storage results in a minor increase in the number of welded canisters that would have to be cut open (1,300 – 1,600 canisters).

Rough Order of Magnitude Cost Estimates for Accelerated Transfer to Dry Storage Scenarios

The estimated rough order-of-magnitude (ROM) cost of UNF management for each of the accelerated transfer of UNF from at-reactor pool to dry storage scenarios was estimated by applying the methodology and unit cost factors previously developed to the at-reactor logistic results obtained using TSL-CALVIN. Note that the ROM cost estimates are presented on a constant dollar basis.

The estimated at-reactor ROM cost between 2015 and 2030 for the accelerated UNF transfer with a 2015 start and no acceptance is shown in Figure 6. The results show a significant increase in the at-reactor costs that would be incurred due to the accelerated transfer of UNF to dry storage. The estimated 16-year ROM at-reactor UNF management costs would increase by approximately $2.5B for drawing down the inventory of UNF in the pool to 50% capacity and by approximately $4.5B for drawing the inventory down to 25% pool capacity. The 16-year ROM cost estimates were found to be insensitive to when the accelerated transfer of UNF would begin, the rate that the pool inventory would be drawn down, and the minimum fuel age.

Table III. Summary of ISF and Disposal Canister Packaging Logistics

Scenario Description		ISF SNF Management			Packaging SNF Management		
		Maximum Canisters in Storage	PWR Assemblies in Bare Fuel Storage	BWR Assemblies in Bare Fuel Storage	Number of Welded Canisters Opened	Number of Bolted Casks Opened	Total Number of Canisters/ Casks Opened
Shipment of All Canisters to the ISF	No Acceleration	5946			11400		11400
	2020-50-10	6129			11609		11609
	2020-50-5	6179			11657		11657
Shipment of Canisters and Bare Fuel to the ISF: Bare Fuel Storage at the ISF	No Acceleration	709	89854	140758	3982	7023	11005
	2020-50-10	956	86286	132494	5315	5680	10995
	2020-50-5	1194	82022	125354	5646	5361	11007
Shipment of Canisters and Bare Fuel to the ISF: Bare Fuel to Dry Storage at the ISF	No Acceleration	6010			11359		11359
	2020-50-10	6027			11345		11345
	2020-50-5	6027			11356		11356

Notes:

1. All cases assume 3,000 MTHM/yr acceptance and OFF priority allocation
2. Scenario Case Names: Acceleration start (2020), Pool Capacity (50%), Acceleration duration (5 or 10 years)

The estimated at-reactor ROM cost until all UNF is removed from the reactor sites is shown in Figure 7. The results show that the effects of accelerating the transfer of UNF from at-reactor pool to dry storage on the estimated at-reactor lifecycle ROM UNF management costs, on a constant dollar basis are relatively small. Figure 8 shows the cumulative estimated at-reactor ROM cost incurred as a function of time. The results show that most of the additional cost that would be incurred due to the accelerated of UNF from wet to dry storage is incurred during a relatively brief time during the accelerated transfer. However, much of this additional cost becomes deferred after the reactors shut down owing to the fact that some of the fuel handling required to remove UNF from the pools has already been done.

The estimated ROM life cycle costs for the ISF and disposal canister packaging facility costs are shown in Figures 9 and 10, respectively. The results show that there is no significant impact on these systems associated with accelerating the transfer of UNF from at-reactor pool to dry storage. This is expected given that the logistics results shown above are also relatively insensitive. The estimated ROM costs at the ISF depend heavily on the storage mode, rather than UNF management approaches at the reactor sites.

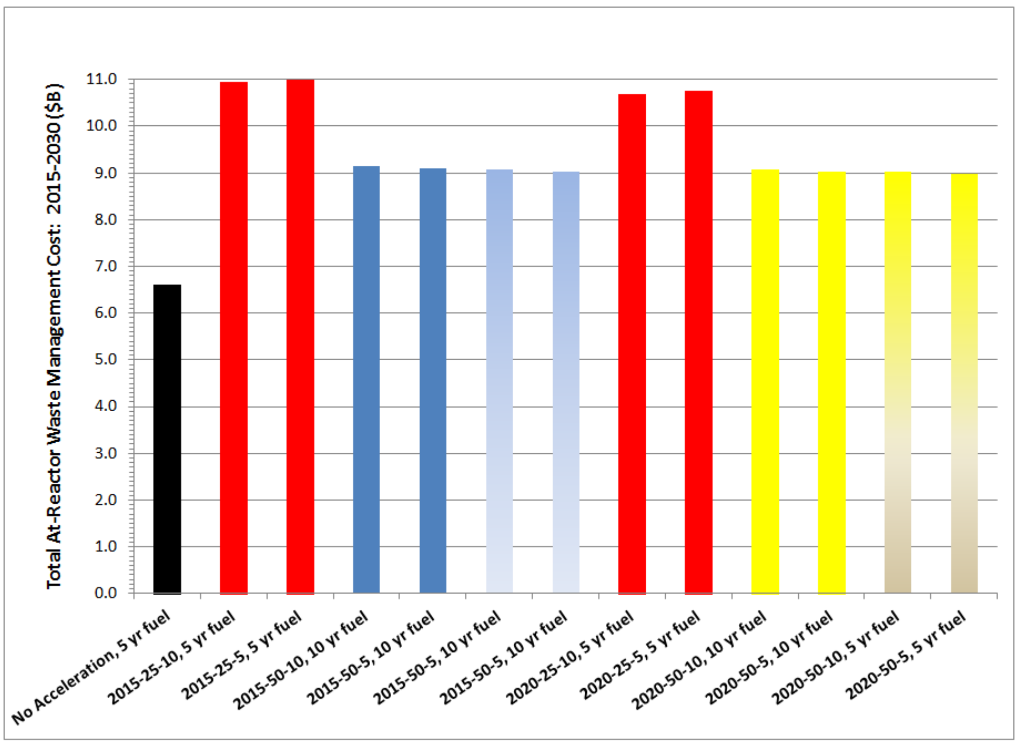

Figure 6. ROM At-Reactor Costs (2015-2030) - Accelerated Transfer, No UNF Acceptance.

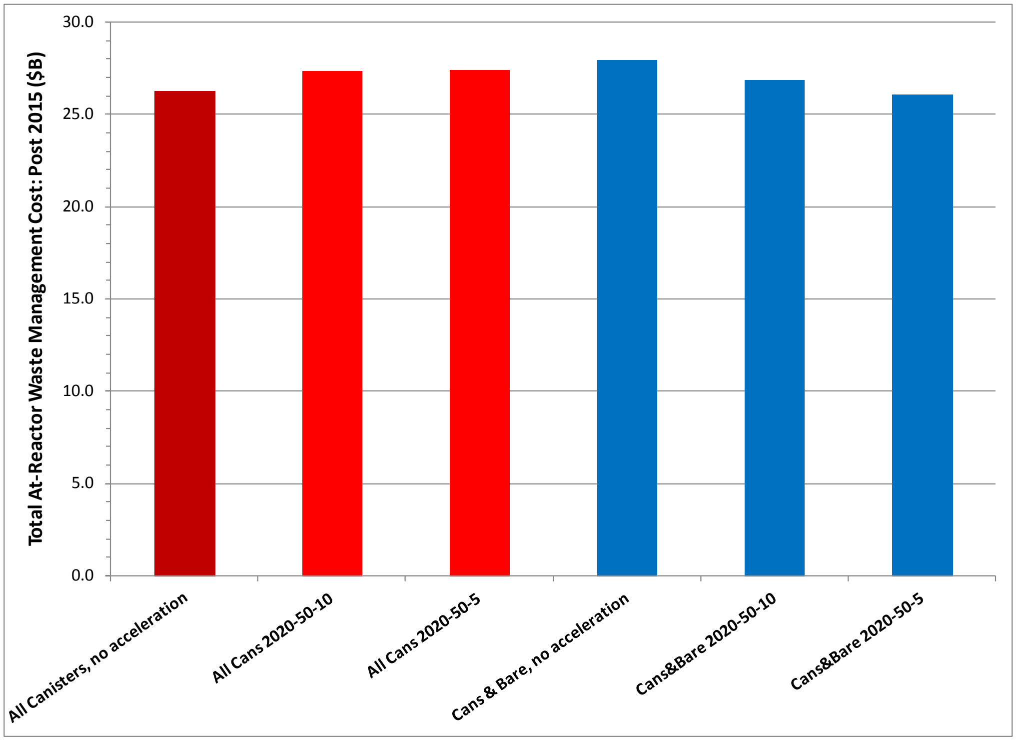

Figure 7. Estimated Lifecycle ROM At-Reactor Costs - Accelerated Transfer, UNF Acceptance.

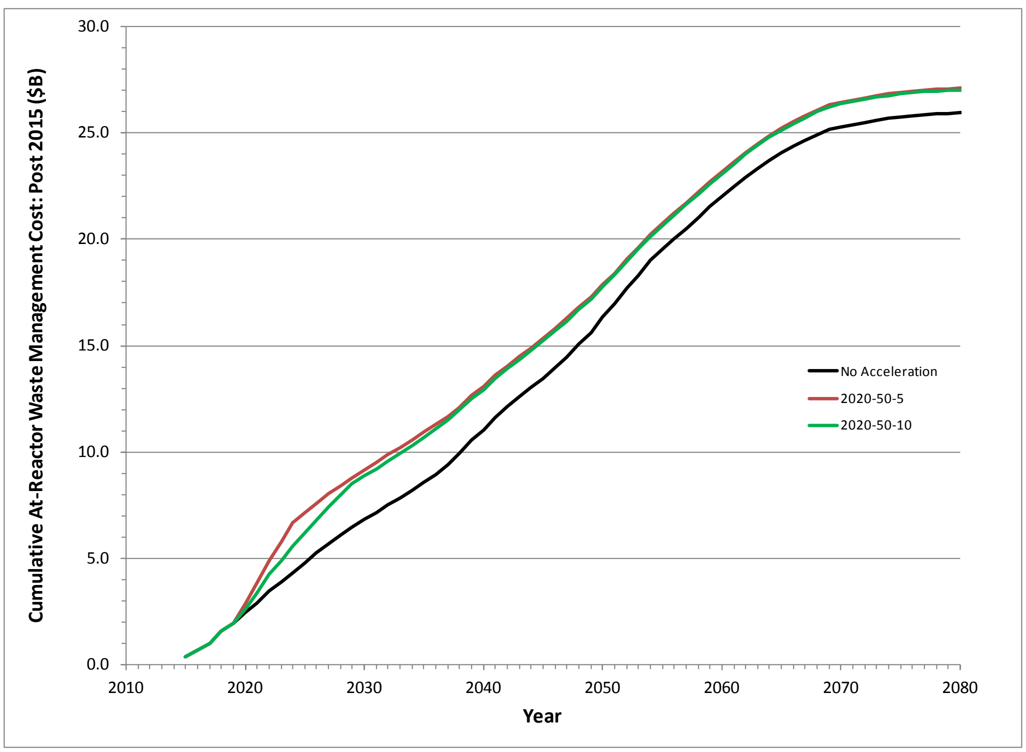

Figure 8. Cumulative ROM At-Reactor Costs Incurrence- Accelerated Transfer, UNF Acceptance

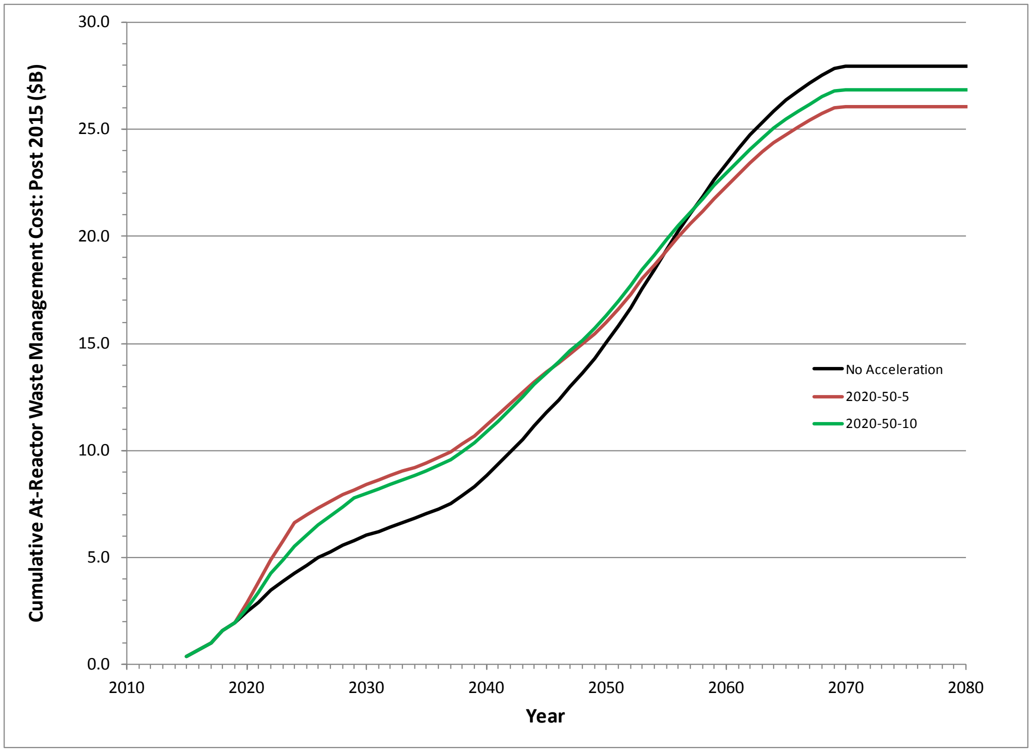

Figure 8 (cont.). Cumulative ROM At-Reactor Costs Incurrence- Accelerated Transfer, UNF Acceptance Above: Acceptance of all UNF in Canisters. Below: Acceptance of Bare Fuel and UNF in Canisters.

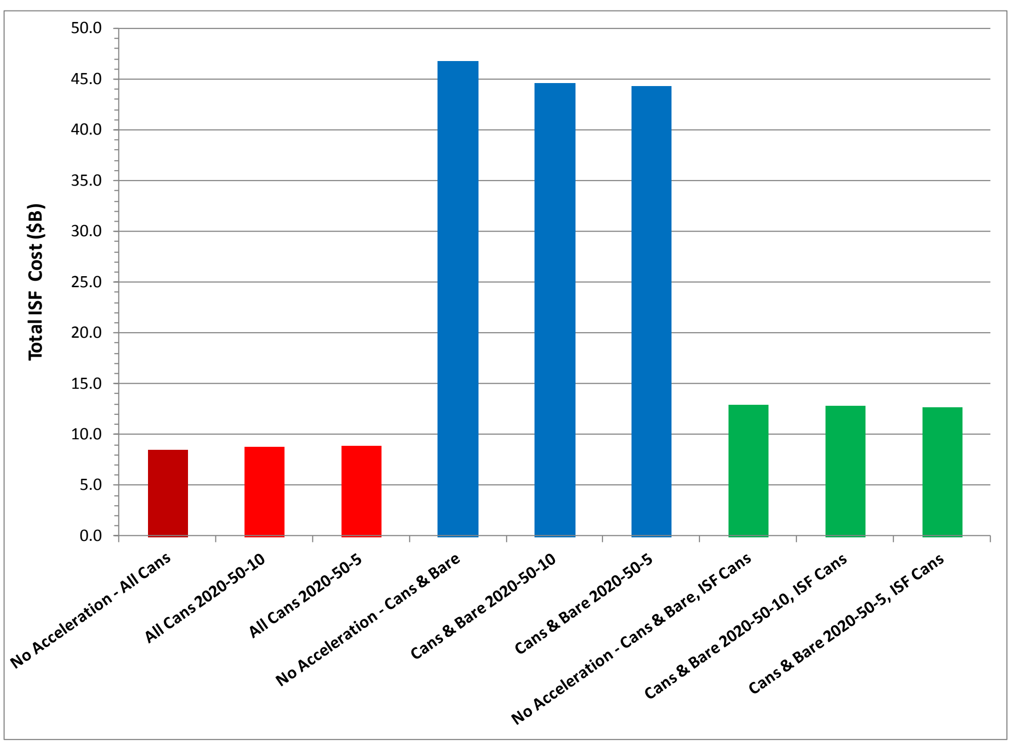

Figure 9. Estimated Lifecycle ROM ISF Costs - Accelerated Transfer, UNF Acceptance

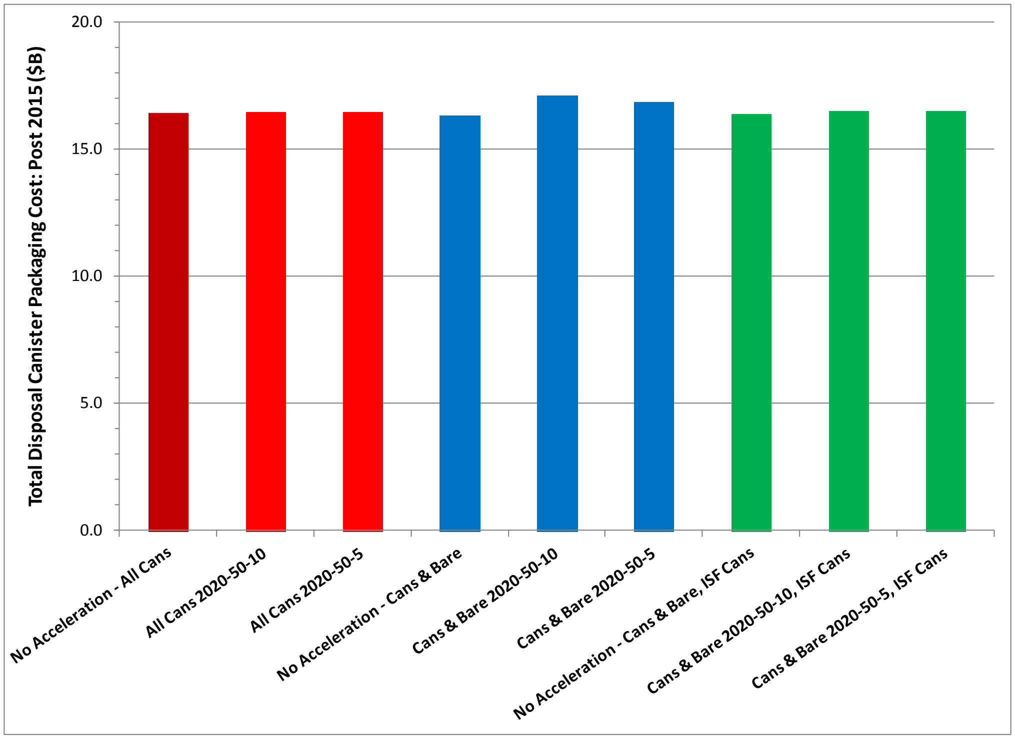

Figure 10. Estimated Lifecycle ROM Disposal Canister Facility Costs - Accelerated Transfer, UNF Acceptance.

CONCLUSIONS

This evaluation assessed the potential impact on the waste management system of accelerating the schedule of fuel transfer from reactor pools to dry storage casks. The primary focus of this evaluation is on the potential impacts on an ISF or a facility for packaging UNF into disposal canisters. However, the impacts of accelerating the transfer of UNF to dry storage on at-reactor UNF management were considered in that they affect the boundary condition between at-reactor UNF management and the rest of the waste management system.

We find that 1) The number of fuel handling operations required at operating sites within available transfer windows would likely be unachievable for the more aggressive transfer scenarios (e.g., storage pool draw-down to 25% capacity or work to a 5-year schedule). 2) The impact on site fuel management can result in cost increases of more than 50% within a ~16-year window from accelerated transfer start. 3) The accelerated transfer of UNF to at-reactor dry storage would have a minor impact, if any, on down-stream waste management functions and associated costs. 4) Acceleration would increase the number of DPCs that would be loaded with UNF in the near term, but would not significantly alter the waste stream that that would have to be handled at the ISF or a facility for packaging UNF into disposal canisters. Thus, accelerating the transfer of UNF from at-reactor pool to dry storage would not significantly affect the configuration and operation of either an ISF or a facility for packaging UNF into disposal canisters. 5) While the overall total lifecycle at-reactor waste management cost, as measured in current dollars, would not be significantly affected, the near-term impact (through 2030) on at-reactor waste management costs would increase significantly. 6) At-reactor long-term management costs are “pulled forward,” essentially behaving as early decommissioning costs which are largely recouped after reactor shut-down.

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