Task Order 12 – Standardized Transportation, Aging, and Disposal Canister Feasibility Study

Appendix C
Evaluated Option Details

RPT-3008859-000

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description

C.O Evaluated Option Details

This Appendix provides the detailed descriptions and data used in the evaluation of Options during the SE evaluations described in Section 6.0 of the main body report. Subsequent to the selection of the recommended Options, the recommended Options were developed in more detail and refined. Minor differences may exist between these descriptions; however, the data used in the evaluations is maintained here for accuracy.

C.1 Lifecycle Costs

Section 12.0 of the main body report provides a discussion regarding the development of the estimated lifecycle costs for each of the STAD Options and also provides costs at Level 1 of the estimate. This section provides the estimated costs at Level 3 of the estimate in Tables C-1 through C-3.

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Table C-1. Lifecycle Costs

			SMALL											
			Option 2 (2/4/13.4" OD/C)			Option 3 (1/1/13.1" OD/U)			Option 3a (1/2/15.0" OD/U)			Option 4 (2/4/ 8.4" sq/C)		
1.1 Upfront Costs (canisters)			$220			$220			$220			$220		
	Design			$120			$120			$120			$120	
	Prototype Testing			$60			$60			$60			$60	
	Licensing			$40			$40			$40			$40	
1.2 Operations Costs			$18,173			$32,942			$26,128			$24,010		
	Hardware			$8,485			$17,251			$13,566			$14,636	
		STAD Canisters			$6,780			$12,931			$10,474			$13,560
		Storage Overpacks			$1,130			$2,874			$2,055			$646
		Handling Frames			$565			$1,437			$1,027			$420
		Handling Equipment			$10			$10			$10			$10
	Dose Control			$20			$20			$20			$20	
	Loading/ unloading			$6,780			$13,793			$11,095			$6,780	
		Utility			N/A			N/A			N/A			N/A
		CSF			N/A			N/A			N/A			N/A
		Repository			N/A			N/A			N/A			N/A
	Transportation (including rail cars, etc.)			$606			$1,416			$1,001			$292	
		Equipment			$168			$126			$126			$42
		Transport			$438			$1,290			$875			$250
	Infrastructure (roads, water, electrical, etc.)			$90			$90			$90			$90	
	Utility Storage Cost			$0			$90			$90			$0	
	CSF storage			$136			$128			$112			$136	
	Repository storage			$60			$60			$60			$60	
	Repository placement			$90			$90			$90			$90	
	Fuel Consolidation			$1,900			$0			$0			$1,900	
	Material Accountability			$4			$2			$2			$4	
	QA Inspection/ Record Keeping			$2			$2			$2			$2	
1.3 D&D Costs			$452			$1,149			$822			$258		

			SMALL											
			Option 2 (2/4/13.4" OD/C)			Option 3 (1/1/13.1" OD/U)			Option 3a (1/2/15.0" OD/U)			Option 4 (2/4/ 8.4" sq/C)		
	Handling Frames			$113			$287			$205			$65	
	Used CSF Overpack Disposal			$339			$862			$616			$194	
		Totals ==>	$18,845			$34,312			$27,170			$24,488		

Table C-2. Lifecycle Costs

			MEDIUM			NEAR TAD-SIZE			TAD-SIZE					
			Option 5 (4/9/ 31.0" OD/U)			Option 6 (12/24/ 43.25" OD/U)			Option 7 (21/44/ 6.25"OD/U)			Option 8 (42/88/ 63.0" sq/C)		
1.1 Upfront Costs (canisters)			$220			$220			$220			$220		
	Design			$120			$120			$120			$120	
	Prototype Testing			$60			$60			$60			$60	
	Licensing			$40			$40			$40			$40	
1.2 Operations Costs			$19,623			$10,903			$7,537			$5,803		
	Hardware			$13,810			$7,611			$5,421			$2,598	
		STAD Canisters			$10,855			$5,546			$4,258			$1,972
		Storage Overpacks			$1,964			$2,055			$1,153			$616
		Handling Frames			$982			$0			$0			$0
		Handling Equipment			$10			$10			$10			$10
	Dose Control			$20			$20			$20			$20	
	Loading/ unloading			$4,418			$1,849			$1,153			$616	
		Utility			N/A			N/A			N/A			N/A
		CSF			N/A			N/A			N/A			N/A
		Repository			N/A			N/A			N/A			N/A
	Transportation (including rail cars, etc.)			$941			$1,001			$559			$287	
		Equipment			$112			$126			$70			$42
		Transport			$829			$875			$489			$245
	Infrastructure (roads, water, electrical, etc.)			$90			$90			$90			$90	
	Utility Storage Cost			$78			$66			$60			$0	
	CSF storage			$112			$112			$80			$136	
	Repository storage			$60			$60			$60			$60	

			MEDIUM			NEAR TAD-SIZE			TAD-SIZE					
			Option 5 (4/9/ 31.0" OD/U)			Option 6 (12/24/ 43.25" OD/U)			Option 7 (21/44/ 6.25"OD/U)			Option 8 (42/88/ 63.0" sq/C)		
	Repository placement			$90			$90			$90			$90	
	Fuel consolidation			$0			$0			$0			$1,900	
	Material Accountability			$2			$2			$2			$4	
	QA Inspection/ Record Keeping			$2			$2			$2			$2	
1.3 D&D Costs			$785			$616			$346			$185		
	Handling Frames			$196			$0			$0			$0	
	Used CSF Overpack Disposal			$589			$616			$346			$185	
		Totals ==>	$20,629			$11,739			$8,103			$6,208		

Table C-3. Lifecycle Costs

Repository Types and STAD Groups	
SMALL	Option 2 - 2 PWR assy/4 BWR assy/13.4" OD/consolidated
	Option 3 - 1 PWR assy/1 BWR assy/13.1" OD/unconsolidated
	Option 3a - 1 PWR assy/2 BWR assy/15.0" OD/unconsolidated
	Option 4 - 2 PWR assy/4 BWR assy/8.4" square/consolidated
MEDIUM	Option 5 - 4 PWR/9 BWR assy/31.0" OD/unconsolidated
NEAR TAD-SIZE	Option 6 - 12 PWR/24 BWR assy/43.2" OD/unconsolidated
TAD-SIZE	Option 7 - 21 PWR/44 BWR assy/66.2" OD/unconsolidated
	Option 8 - 42 PWR/88 BWR assy/63.0" square/consolidated

Assumptions for Cost Estimates		
A1 - Use Option 7 as a base for Task 12 comparison. Option 7 is the approach used in Task 11 CSF.		
A2 - Cost is based on 50,000 MTU storage capacity		
A3 - PWR/BWR Fuel Assembly split = 0.43 PWR and 0.57 BWR		
A4 - Average MTU per FA = 0.29		
A5 - Cost of STAD canisters =		
	$700,000	for Option 7 PWR
	$800,000	for Option 7 BWR
	$600,000	for Option 8 PWR
	$700,000	for Option 8 BWR
	$500,000	for Option 6 PWR
	$600,000	for Option 6 BWR
	$350,000	for Option 5 PWR
	$400,000	for Option 5 BWR
	$200,000	for Option 4 PWR
	$200,000	for Option 4 BWR
	$75,000	for Option 3a PWR
	$100,000	for Option 3a BWR
	$75,000	for Option 3 PWR
	$75,000	for Option 3 BWR
	$100,000	for Option 2 PWR
	$100,000	for Option 2 BWR
A6 - Cost of CSF concrete overpack =		
	$200,000	each, all Options
A7 - Cost of transportation equipment =		
	$168,000,000	for Option 2
	$126,000,000	for Option 3
	$126,000,000	for Option 3a
	$42,000,000	for Option 4

Assumptions for Cost Estimates		
	$112,000,000	for Option 5
	$126,000,000	for Option 6
	$70,000,000	for Option 7
	$42,000,000	for Option 8
A8 - All 50,000 MTU goes through a CSF.		
A9 - There is no D&D for STAD canisters; all canisters eventually go into a repository.		
A10 - Consolidation ratio =		
	2.0	to 1 (e.g. for a 2.0 to 1 ratio, a 21 PWR FA canister holds 42 consolidated FAs)
A11 - Upfront costs are the same for all Options.		
A12 - Cost per transport train =		
	$14,000,000	
A13 - Number of transport trains =		
	12	for Option 2
	9	for Option 3
	9	for Option 3a
	3	for Option 4
	8	for Option 5
	9	for Option 6
	5	for Option 7
	3	for Option 8
A14 - Percentage of extra "assemblies" needed for skeleton remaining after consolidation.		
	0.10	
A15 - Cost of Option 7 CSF operations =		
	$10,000,000	
A16 - Costs of dose control are the same for all Options.		
A17 - Cost multiplier for CSF operations compared to Option 7 (based on average impact weight for STAD impact on CSF normalized to Option 7).		
	1.7	for Option 2
	1.6	for Option 3
	1.4	for Option 3a
	1.7	for Option 4
	1.4	for Option 5
	1.4	for Option 6
	1.7	for Option 8
A18 - Cost for D&D of CSF storage overpacks (all TAD-sized) =		
	$60,000	all Options
A19 - Items not "real discriminators" are same as Option 7.		
A20 - No repository overpacks are included in these estimates.		
A21 - D&D of utility site overpacks are not included in these estimates. Only CSF overpacks are considered.		

Assumptions for Cost Estimates

A22 - Material accountability cost for consolidation =		
	2.0	X cost for non-consolidated approaches.
A23 - Fuel consolidation is at a single CSF and "consolidation" cost estimates include equipment, expanded pool, facilities, etc. specific to consolidation.		
A24 - All UNF is packaged using the same Option, (e.g. no some Option 2 and some Option 8).		
A25 - Fuel consolidation is done at the CSF; not at reactor sites. Consolidation costs, based on work by Dale Lancaster (MOV.199990312.0001), March 1999; R2.		
	$38	$30 /kgU in 1999 dollars from Lancaster work escalated to 2013 dollars.
A26 - Cost per rail shipment based on Task 11 draft report submitted to the DOE =		
	$250,000	
A27 - Number of shipments in STAD from CSF to final destination =		
	1,750	for Option 2
	5,159	for Option 3
	3,500	for Option 3a
	1,000	for Option 4
	3,316	for Option 5
	3,500	for Option 6
	1,957	for Option 7
	978	for Option 8
A28 - Fuel consolidation is done at the CSF, not at utilities.		
A29 - Cost for loading a STAD canister at any location =		
	$200,000	for Option 8
	$200,000	for Option 7
	$180,000	for Option 6
	$150,000	for Option 5
	$100,000	for Option 4
	$90,000	for Option 3a
	$80,000	for Option 3
	$100,000	for Option 2
A30 - Cost of Option 7 utility storage operations =		
-	$50,000,000	
A31 - Cost multiplier for utility storage operations compared to Option 7 (based on average impact weight for STAD impact on CSF normalized to Option 7).		
	N/A	for Option 2
	1.5	for Option 3
	1.5	for Option 3a
	N/A	for Option 4
	1.3	for Option 5
	1.1	for Option 6
	N/A	for Option 8
A32 - Operations cost for infrastructure, etc., Option 7 =		

Assumptions for Cost Estimates		
	$90,000,000	
A33 - Operations cost for utilities, Option 7 =		
	$60,000,000	
A34 - Operations cost for CSF storage, Option 7 =		
	$80,000,000	
A35 - Operations cost for repository storage, Option 7 =		
	$60,000,000	
A36 - Operations cost for repository placement, Option 7 =		
	$90,000,000	
A37 - Operations material accountability for Option 7 =		
	$2,000,000	
A38 - Operations QA inspection/record keeping for Option 7 =		
	$2,000,000	
A39 - Upfront costs, design, for Option 7 =		
	$120,000,000	
A40 - Upfront costs and prototype testing for Option 7 =		
	$60,000,000	
A41 - Upfront costs and licensing for Option 7 =		
	$40,000,000	
A42 - Operations cost and dose control for Option 7 =		
	$20,000,000	
A43 - Percentage of FAs packaged into STADS at reactor sites and transported to the CSF in STADS. The remainder are packaged at the CSF (No STADS are loaded at the utility sites for purposes of transportation costs.).		
	0.20	
A44 - Transportation handling frames are for TAD-sized loads (e.g.,~ 66.25 " OD cylinders). Options 6, 7, and 8 have no handling frames.		
A45 - The number of STADs in a storage/transportation handling frame =		
	12	for Option 2
	12	for Option 3
	12	for Option 3a
	21	for Option 4
	3	for Option 5
	1	for Option 6
	1	for Option 7
	1	for Option 8
A46 - The cost of a handling frame =		
	$100,000	for Option 2 (12 STADs)
	$100,000	for Option 3 (12 STADs)
	$100,000	for Option 3a (12 STADs)
	$130,000	for Option 4 (21 STADs)

Assumptions for Cost Estimates		
	$100,000	for Option 5 (3 STADs)
	N/A	for Option 6
	N/A	for Option 7
	N/A	for Option 8
A47 - Cost for D&D of handling frames =		
	$20,000	for Option 2 (12 STADs)
	$20,000	for Option 3 (12 STADs)
	$20,000	for Option 3a (12 STADs)
	$20,000	for Option 4 (21 STADs)
	$20,000	for Option 5 (3 STADs)
A48 - Storage of STADs at the CSF is in ~ TAD-sized overpacks that accept handling frames.		
A49 - Handling frames are designed to be used with transportation overpacks and interim storage overpacks.		
Key numbers		
KN1 - Numbers of fuel assemblies =		
	172,414	Total unconsolidated.
	74,138	PWRs unconsolidated.
	98,276	BWRs unconsolidated.
	189,655	Total accounting for extra "assemblies" needed to dispose of "skeleton" parts remaining after consolidation.
	81,552	PWRs accounting for extra "assemblies" needed to dispose of "skeleton" parts remaining after consolidation.
	108,103	BWRs accounting for extra "assemblies" needed to dispose of "skeleton" parts remaining after consolidation.
KN2 - Numbers of STAD canisters =		
	1,853	44 PWR capacity (Option 8)
	3,530	21 PWR capacity (Option 7)
	6,178	12 PWR capacity (Option 6)
	18,534	4 PWR capacity (Option 5)
	40,776	2 PWR capacity (Option 2 & 4)
	74,138	1 PWR capacity (Option 3 & 3a)
	1,228	88 BWR capacity (Option 8)
	2,234	44 BWR capacity (Option 7)
	4,095	24 BWR capacity (Option 6)
	10,920	9 BWR capacity (Option 5)
	49,138	2 BWR capacity (Option-3a)
	98,276	1 BWR capacity (Option 3)
	27,026	4 BWR capacity (Option 2 & 4)
KN3 - Numbers of CSF overpacks =		

Key numbers		
	3,082	Option 8
	5,764	Option 7
	10,273	Option 6
	9,818	Option 5
	3,229	Option 4
	10,273	Option 3a
	14,368	Option 3
	5,650	Option 2
KN4 - Numbers of handling frames for storage at CSF =		
	5,650	Option 2
	14,368	Option 3
	10,273	Option 3a
	3,229	Option4
	9,818	Option 5

References

R1 - Kessler, J., Cost Estimate for an Away-From-Reactor Generic Interim Storage Facility (GISF) for Spent Nuclear Fuel, EPRI–1018722 (Palo Alto, CA: Electric Power Research Institute, 2009).
R2 - Fuel consolidation is done at the CSF; not at reactor sites. Consolidation costs, based on work by Dale Langcaster (MOV.199990312.0001), March 1999.

C.2 Radiation Dose

The handling, shipping, storage, and final disposal of the UNF will result in worker radiation doses that need to be controlled. Each of the various loading and consolidation Options presented in this report requires differing approaches to implementing an ALARA program. This is due to each Option having an impact on the dose rates incurred during the various steps, the amount of time required for workers to achieve each step, the resulting number of overpacks required to be handled, and the number of workers required.

The STAD canisters used for all of the Options are thin walled providing minimal shielding. Therefore, the canisters will be placed into shielded overpacks for storage or transportation. A shielded transfer cask will also be needed during preparation of the canister and for transfer of the canister from the UNF pool/canister preparation area to storage or transport. The thickness and structure of the overpacks will be determined by the dose rate of the UNF inside, the required contact, and other dose rates. The required dose rates will be determined based on regulations and ALARA considerations. The size and weight of overpacks are typically limited by the capabilities of cranes and other handling equipment and by size and weight limits for transportation.

The STAD design Options include single and multiple assemblies being placed in a canister; the UNF assemblies being handled without any alteration in their geometry; or the consolidation of UNF resulting in the UNF of two assemblies being placed in the volume of one assembly. Each of these Options impact dose. Loading assemblies without consolidation results in less handling time per assembly, but also requires more canisters. With consolidation, the compacted fuel results in a situation where self-shielding increases so that more fuel may be loaded into a canister without resulting in increased dose. Consolidation has the advantage of moving and storing fewer canisters, but increases the time required to load each canister.

The majority of the radiation dose associated with STAD operations will be incurred during canister loading at the reactor sites, unloading at the CSF including any consolidation and transfer activities, and during final handling at the repository. Transportation and storage are fairly isolated activities and will not involve a great deal of worker interaction. Dose at the reactor sites comes primarily from the work in the UNF pool area, including draining, drying, inerting, and sealing the canisters in preparation for storage and/or transport. It is assumed that the dose rate during these operations will be the same for all Options since the canisters and transfer casks will all be designed to the same dose rate limits.

It is also assumed that all consolidation activities will occur at the CSF. This will involve opening the canisters, removing the UNF, dismantling each assembly, and repacking the pins. The time required for consolidation is unknown. It requires the individual removal of the fuel assembly upper nozzles and fuel pins and placement into a container that grows increasingly tight with each pin added. It is assumed here that the consolidation effort is performed remotely, and that the amount of time and effort to place a fuel assembly into the consolidation equipment is the same as for placing a fuel assembly into a canister. The empty cage will also have to be handled and disposed as radioactive waste, likely being classed as GTCC. The doses incurred by this process, assumedly would be about the same as handling a fuel assembly.

There is also the risk, during the consolidation effort, of radioactive gases escaping when the canister is opened. Control of these gases is essential. Release of these gases into the atmosphere would create an unacceptable situation leading to unnecessary and likely unacceptable doses. It is assumed that gas release will be strictly controlled and prevented from significantly impacting worker dose.

Microshield™ was used to estimate the impact on canister dose rates from consolidation. Two cases were set up, which examined fuel at 46GWD/MTU burnup, and 5 years of decay. The first case examined a single assembly placed in a canister, and the second examined the fuel of two assemblies being consolidated into the same volume. The results showed the same dose rate external to each canister due to the fuel. This demonstrates that the increase in self-shielding that occurs with consolidated fuel compensates for the increase in source. There would also be less dose impact due to the removal of the end fittings, grids, and other non-fuel bearing hardware.

In comparing the risks and benefits of each of the proposed Options, the canister described in Option 7 will be used as a base. This Option describes the Yucca Mountain design, and as such has been extensively examined. It assumes the loading of 21 PWR UNF assemblies or 44 BWR UNF assemblies without consolidation. It does combine the individual STAD canisters into a handling frame with canister overpack. In comparing total dose to this Option, we used a rating system of ‘+’ (greater than), ‘0’ (about the same), or ‘–‘ (lower than). Table C-4 shows the comparisons.

Generally, the canisters that hold more UNF assemblies will have lower overall worker dose. This is due to less time being spent to drain, prepare, and seal the canisters per UNF assembly and less handling. Placing only one or a few assemblies into a canister requires more handling without any corresponding benefit in experienced dose rates.

Table C-4: Impact on Worker Doses for Various Options

Option	STAD Description	Notes	Comparison	Ranking
1	1 PWR or 1 BWR	12 STADs in standard canister overpack with internal handling frame as basket.	Requires more handling at the utilities due to placing the assemblies into canisters, and will require about twice the number of overpacks. Expect twice the dose at the utilities and CSF from increased handling times.	++
2	1 PWR/2 BWR Consolidated	Round Well Pipe concept; consolidate @ CSF; 19 STADs = 38 PWR fit in standard canister overpack with internal handling frame as basket.	Requires consolidation which increases the doses from opening overpacks, performing the consolidation, and resealing the overpacks. The consolidated nature allows more assemblies to be shipped and handled per campaign and so at the CSF will cut those doses by two.	++
3	1 PWR or 1 BWR	12 STADs in standard canister overpack with internal handling frame as basket; same canister ID as Option 1 with thinner wall.	The dose for this will be the same as for Option 1. The change in the thickness of the canister should not impact time or dose rates.	++
3a	1 PWR or 2 BWR	12 STADs in standard canister overpack with internal handling frame as basket; 1.9" larger STAD OD than Option 3.	For a PWR, the doses would be the same as for Option 1. For BWRs, there will be a decrease in dose after it leaves the reactor site due to less handling as compared to Option 3.	++(PWR)/ +(BWR)
4	1 PWR/2 BWR Consolidated	Square STAD concept to fit in unique canister overpack and basket; short load possible; consolidate @ CSF; 21 STADs per cask = 42 PWR.	The consolidation of the assembly would increase doses at the CSF. After leaving the reactor site, the dose would be very similar to that of Option 7 due to the number for STADs per cask.	+
5	4 PWR or 9 BWR	3 STADs in standard canister overpack with internal handling frame as basket.	The only dose increase in comparison to Option 7 is that more canisters would have to be sealed, prepped, and loaded at the utilities, and then unloaded at the CSF.	+
6	12 PWR or 24 BWR	No canister overpack or handling frame used.	The only dose increase in comparison to Option 7 is that more casks would have to be sealed, prepped, and loaded at the reactor sites, and then unloaded at the CSF.	+

Option	STAD Description	Notes	Comparison	Ranking
8	42 PWR or 88 BWR	Square canister (can) concept into 1 large STAD with basket; short load possible; consolidate @ CSF; 1 STAD with 21 assemblies = 42 PWR/88 BWR.	The consolidation of fuel would increase dose at the CSF, but lower the overall dose during shipping and handling from Option 7. The benefits are from lower handling of overpacks. There would be some additional dose from handling the metal waste from consolidation.	0

C.3 Repository Robustness

Repository robustness evaluates the compatibility of a STAD Option with the potential requirements of a particular repository type. The compatibility is primarily based on size and heat load. Figure C-1 provides a comparison of STAD Option and repository compatibility.

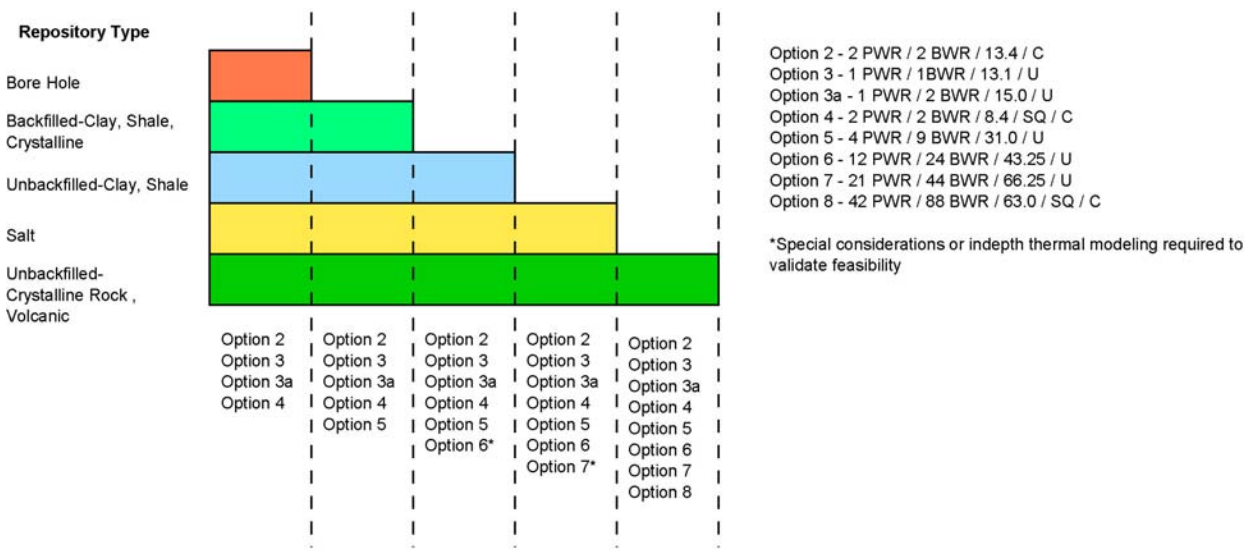

Figure C-1. STAD Option Repository Compatibility

C.4 Consolidated Storage Facility Impact

C.4.1 Purpose

The purpose of this section is to evaluate the impacts that each STAD Option will have on the conceptual CSF. The CSF is described in AREVA Federal Services Report RPT-3008097-000, titled "Task Order 11 – Development of Consolidated Fuel Storage Facility Concepts."[1]

The importance of this section is that it provides key inputs required for the SE evaluation and the choice of a recommended STAD Option. The information provided is beneficial in that it makes available a consolidated evaluation of key impacts of the different STAD designs.

[1]AREVA Federal Services Report RPT-3008097-000, titled "Task Order 11 – Development of Consolidated Fuel Storage Facility Concepts."

C.4.2 Impact Descriptions

The following describes the impacts on the CSFs that were evaluated for each of the STAD Options.

Storage Area Size – Impact of STAD Option on the size (area) required for storage of the canistered UNF in comparison to the CSF storage base case.

Cask Handling Facilities – Impact of the STAD Option on the number of equipment required for operations of the CSF Cask Handling Facilities in comparison to the CSF storage base case.

Storage Operations – Impact of the STAD Option on the personnel and equipment required to transfer the canistered UNF to storage at the CSF in comparison to the CSF storage base case. This does not include impact on the Wet Pool facilities, equipment, or operations.

Wet Pool - Impact of the STAD Option on the facilities, personnel, and equipment required for performing operations in the Wet Pool as required for the Option in comparison to the CSF storage base case.

LLW Generation – Impact of the STAD Option on the quantity and type of LLW generated and on the facilities, equipment, and personnel required to process the LLW generated in comparison to the CSF operations base case.

Other – Any impacts STAD Options may impose on the operations and/or facilities of the CSF not described above.

C.4.3 Impact Ratings

The impacts of the different STAD Options are rated on a relative scale of 0 (no impact) to 5 (greatest impact) as described below.

0 – No impact

1 – Low impact on either operations or cost

2 – Low impact on both operations and cost

3 – Moderate impact on both operations and cost

4 – High impact on either operations or cost; low to moderate impact on other

5 – High impact on both operations and cost

C.4.4 Assumptions for Impacts and Ratings

Assumption 1 – The base case for the facilities and operations of the CSF are described in the main body report.

Assumption 2 – The base case for UNF received at the CSF is UNF packaged in 10 CFR Part 72 licensed DSCs. Nominal capacities of the DSCs are 32 PWR UNF assemblies or 69 BWR UNF assembles. For the impact evaluation, all UNF packaged in STADs is received at the CSF, as

described in Table C-5 later in this section, including where multiple STADs are placed into a DSC-type overpack.

Assumption 3 – All STADs, whether placed into DSC-type overpacks or not, are transported in transportation casks similar to those that are currently licensed under 10 CFR Part 71 for transportation of Part 72 DSCs in current use for UNF storage at commercial reactor sites.

Assumption 4 – The handling of STADs at the CSF will be performed using equipment similar to that used for handling Part 72 DCSSs received at the CSF.

Assumption 5 – STAD concrete storage modules/overpacks will be similar to those used for Part 72 DCSSs.

C.4.5 Impact Evaluations

OPTION 2 – 2 PWR/4 BWR/13.4OD/C

Storage Area Size – This Option would increase the size of the CSF compared to the base case since an equivalent 24 PWR UNF assemblies could be placed into each storage module compared with the base case of 32. This is judged to be low impact resulting in an impact rating of 2.

Cask Handling Facilities – For all STAD Options using consolidated UNF, it is assumed that the UNF will be received at the CSF packaged in Part 72-licensed DSCs; same as the base case. The DSCs will most likely be placed into short-term storage prior to transport to the wet pool where the UNF will be consolidated. Additional equipment will be required to support the double handling and additional dry storage overpacks, etc. This Option is therefore considered to have an impact rating of 3.

Storage Operations – This Option will have a significant impact on storage operations. Most UNF will be handled multiple times: placed into short-term storage; removed from storage and transported to the wet pool; consolidated; and then placed into longer-term storage. This will increase the number of personnel required as well as training requirements. This Option is considered to have a high impact on storage operations and is given an impact rating of 5.

Wet Pool – This Option requires the use of wet pools for significant operations. This Option requires that every UNF assembly received at the CSF uses the wet pool for removal from the container used for its shipping and/or storage, consolidation, and then preparation for longer-term storage at the CSF. Performing these operations on a production basis, as well as allowing wet-pool use for remediation and inspections will require increases in both the number of wet pools and the size of the pools. This Option has a high impact on both wet pool operations and cost. Therefore, this Option is given an impact rating of 5.

LLW Generation – Considerable additional LLW will be generated by the consolidation process including: DSCs used for transport and short-term storage, fuel assembly baskets, and resins and filters used during the normal course of pool operations. Compared with the CSF base case, the additional LLW associated with this Option will significantly increase operating costs for its disposal, will require additional facilities to handle the LLW, and will also require an

increase in personnel assigned to radioactive waste (radwaste) handling duties. This Option is considered to have a high impact on LLW generation and is given an impact rating of 5.

Other – Licensing: The CSF site license will need to include the operations and safety evaluations required to allow consolidation of the UNF on a production basis. Consolidation operations on this scale have not been licensed before in the U.S. This will require additional analyses to support the site license and could potentially increase the license review time.

OPTION 3 –1 PWR/1 BWR/13.1OD/U

Storage Area Size – This Option will require that the CSF storage area be increased by a factor of about (32/12) or 2.67. This equates to approximately 500 acres to store the 6,700 additional storage modules required by this Option. There is no other Option that has a larger impact on the size of the CSF storage area. This Option is therefore considered to have an impact rating of 5.

Cask Handling Facilities – Given the additional packages that will need to be processed (approximately 2.67 times more), additional Cask Handling Facilities will need to be built, extra shifts will need to be worked, or a combination of added facilities and work shifts will be needed to maintain the assumed UNF throughput. No other Option has a larger impact on the handling facilities. This Option is therefore considered to have an impact rating of 5.

Storage Operations – Since more UNF "packages" will need to be handled than the base case, this Option will require additional personnel. The operations associated with placing the UNF into storage, (i.e. transfer of the STADs in the DSC-type overpack from a transportation cask to a storage module), will be similar to the base case. The increase in the number of storage modules will require additional equipment and personnel for both thermal and performance monitoring. This Option is considered to have a moderate impact on storage operations and is given an impact rating of 3.

Wet Pool – This Option does not require the use of the wet pool for any additional operations in comparison with the base case. There should be no increase in the required size of the wet pool. Therefore, there is no impact on the cost or operations of the wet pool and this Option is given an impact rating of 0.

LLW Generation – Some additional LLW will be generated during handling operations since the number of packages being processed is increased from the base case. Similarly, additional LLW will be generated during decommissioning operations as a result of the increase in storage modules. The additional LLW is considered to have a moderate impact on cost and operations. Therefore, this Option is given an impact rating of 3.

Other – N/A

OPTION 3a – 1 PWR/2 BWR/15.0OD/U

Storage Area Size – This Option will require a significant increase in storage area size but has a lesser impact than Option 3 because of the increase in BWR assemblies. This Option is therefore considered to have an impact rating of 4.

Cask Handling Facilities – This Option has slightly less impact than Option 3 because of the increase in BWR assemblies. This Option is therefore considered to have an impact rating of 4.

Storage Operations – This Option has the same impact as Option 3. Therefore, this Option is considered to have a moderate impact on storage operations and is given an impact rating of 3.

Wet Pool – This Option has the same impact as Option 3. Therefore, this Option is given an impact rating of 0.

LLW Generation – This Option will generate slightly less LLW than Option 3 but is still considered to have a moderate impact on cost and operations associated with LLW generation. Therefore, this Option is given an impact rating of 3.

Other – N/A

OPTION 4 – 2 PWR/4 BWR/8.4SQ/C

Storage Area Size – This Option could reduce the size of the CSF storage area since equivalent 42 PWR/84 BWR UNF assemblies could be placed into each storage module compared with the base case of 32 PWR/69 BWR UNF assemblies. Therefore, there is no impact to storage area size or cost resulting in an impact rating of 0.

Cask Handling Facilities – This Option will have the same impact as Option 2. This Option is therefore considered to have an impact rating of 2.

Storage Operations – This Option will have an impact similar to Option 2. The impact will be slightly less than Option 2 since 42 equivalent PWR assemblies will be placed in each storage module compared with 38 for Option 2. This is not judged to be a significant change; therefore, this Option is considered to have a high impact on storage operations and is given an impact rating of 5.

Wet Pool – This Option will have an impact similar to Option 2. The impact will be slightly less than Option 2 since 42 equivalent PWR assemblies will be placed in each storage module compared with 38 for Option 2. This is not judged to be a significant change; therefore, this Option is considered to have a high impact on wet pool operations and is given an impact rating of 5.

LLW Generation – This Option will have the same impact as Option 2. This Option is therefore considered to have a high impact on LLW Generation and is given an impact rating of 5.

Other – Licensing: The CSF site license will need to include the operations and safety evaluations required to allow consolidation of the UNF on a production basis. Consolidation operations on this scale have not been licensed before in the U.S. This will require additional analyses to support the site license and could potentially increase the license review time.

OPTION 5 – 4 PWR/9 BWR/31.0OD/U

Storage Area Size – This Option will require a significant increase in storage area size but has a lesser impact than Option 3 because of the increase in BWR assemblies; the same impact as Option 3a. This Option is therefore considered to have an impact rating of 4.

Cask Handling Facilities – This Option has slightly less impact than Option 3 and the same impact as Option 3a because of the increase in BWR assemblies. This Option is therefore considered to have an impact rating of 4.

Storage Operations – This Option has the same impact as Option 3 or Option 3a. Therefore, this Option is considered to have a moderate impact on storage operations and is given an impact rating of 3.

Wet Pool – This Option has the same impact as Option 3 or Option 3a. Therefore, this Option is given an impact rating of 0.

LLW Generation – This Option will generate slightly less LLW than Option 3 and the same as Option 3a, but is still considered to have a moderate impact on cost and operations associated with LLW generation. Therefore, this Option is given an impact rating of 3.

Other – N/A

OPTION 6 – 12 PWR/24 BWR/43.2 OD/U

Storage Area Size – This Option has the same impact as Option 3a. This Option is therefore considered to have an impact rating of 4.

Cask Handling Facilities – This Option has the same impact as Option 3a. This Option is therefore considered to have an impact rating of 4.

Storage Operations – This Option has the same impact as Option 3 or Option 3a. Therefore, this Option is given an impact rating of 3.

Wet Pool – This Option has the same impact as Option 3a. Therefore, this Option is given an impact rating of 0.

LLW Generation – This Option will generate the same amount of LLW as Option 3a. Therefore, this Option is given an impact rating of 3.

Other – N/A

OPTION 7 – 21 PWR/44 BWR/66.2 OD/U

Storage Area Size – This Option has less impact than Option 3a, but will still require a significant increase in storage area size. This Option is therefore considered to have an impact rating of 3.

Cask Handling Facilities – This Option has a similar but somewhat lesser impact compared to Option 3a. This Option is therefore considered to have an impact rating of 3.

Storage Operations – This Option has a similar but somewhat lesser impact compared to Option 3 or Option 3a. Therefore, this Option is considered to have a low impact on storage operations and cost and is given an impact rating of 2.

Wet Pool – This Option has the same impact as Option 3a. Therefore, this Option is given an impact rating of 0.

LLW Generation – This Option will generate a small increase in LLW compared with the base case. It is expected to have a low impact on the cost and operations associated with LLW and the Option is given an impact rating of 2.

Other – N/A

OPTION 8 – 42 PWR/88 BWR/63.0 SQ/C

Storage Area Size – Similar to Option 4, this Option would reduce the size of the CSF storage area since an equivalent 42 PWR UNF assemblies could be placed into each storage module compared with the base case of 32. Therefore, there is no impact to storage area size or cost resulting in an impact rating of 0.

Cask Handling Facilities – This Option will have the same impact as Option 2. This Option is therefore considered to have an impact rating of 2.

Storage Operations – This Option will have an impact similar to Option 4. This Option is considered to have a high impact on storage operations and is given an impact rating of 5.

Wet Pool – This Option will have an impact similar to Options 2 and 4. The impact will be slightly less than Option 2 since 42 equivalent PWR assemblies will be placed in each storage module compared with 38 for Options 2 and 4. This is not judged to be a significant change; therefore this Option is considered to have a high impact on wet pool operations and is given an impact rating of 5.

LLW Generation – This Option will have the same impact as Options 2 and 4. This Option is therefore considered to have a high impact on LLW Generation and is given an impact rating of 5.

Other – Licensing: The CSF site license will need to include the operations and safety evaluations required to allow consolidation of the UNF on a production basis. Consolidation operations on this scale have not been licensed before in the U.S. This will require additional analyses to support the site license and could potentially increase the license review time.

C.4.6 Impact Evaluation Summary Table

Table C-5 summarizes the impact ratings discussed above. A column is provided for the summation of the impact ratings. The summation can be used to judge the overall impact on the CSF of each STAD Option relative to the other Options.

Table C-5. STAD Option CSF Impact Rating Summary

			CSF Impact Rating						
Option No.	STAD Designation	Notes	Storage Area Size	Cask Handling Facilities	Storage Ops	Wet Pool	LLW Gen	Other	Sum
2	2PWR/4BWR/13.4OD/C	Round Well Pipe concept; consolidate @ CSF; 12 STADs = 24 equivalent PWR/ 48 BWR FAs fit in a standard cask overpack with internal handling frame as basket	2	3	5	5	5	Licensing	20
3	1PWR/1BWR/13.1OD/U	12 STADs = 12 PWR/12 BWR FAs in a standard cask overpack with internal handling frame as basket	5	5	3	0	3		16
3a	1PWR/2BWR/15.0OD/U	12 STADs = 12 PWR/24 BWR FAs in a standard cask overpack with internal handling frame as basket; 1.9" larger STAD OD than Option 3	4	4	3	0	3		14
4	2PWR/4BWR/8.4SQ/C	Square STAD concept to fit in unique cask and basket; short load possible; consolidate @ CSF; 21 STADs = 42 equivalent PWR/84 BWR FAs per cask	0	2	5	5	5		17

			CSF Impact Rating						
Option No.	STAD Designation	Notes	Storage Area Size	Cask Handling Facilities	Storage Ops	Wet Pool	LLW Gen	Other	Sum
5	4PWR/9BWR/31.0OD/U	3 STADs = 12 PWR/27 BWR FAs in a standard cask overpack with internal handling frame as basket	4	4	3	0	3		14
6	12PWR/24BWR/43.2OD/U	1 STAD per cask overpack due to size and weight constraints	4	4	3	0	3		14
7	21PWR/44BWR/66.2OD/U	Yucca baseline design; early utility use	3	3	2	0	2		10
8	42PWR/88BWR /63.0SQ/C	Square canister (can) concept into 1 large STAD with basket; short load possible; consolidate @ CSF; 1 STAD = 42 PWR/88 BWR FAs to fit in a standard cask overpack	0	2	5	5	5		17

C.5 Reactor Site Impact

C.5.1 Purpose

The purpose of this section is to evaluate the impacts that each STAD Option will have on reactor site facilities and operations. This section provides input relative to the types of impacts the STAD Options will have on reactor sites, as well as the degree of impact for each Option. These are key inputs required for the SE evaluation and the choice of recommended STAD Options.

C.5.2 Impact Descriptions

The following describes the impacts on a reactor site that were evaluated for each of the STAD Options.

Loading Operations – Impact of STAD Option on the personnel, equipment, and facilities needed for the operations associated with loading the STAD and placing it into dry storage at the utility site. This impact is evaluated in comparison to the base case for dry cask storage of UNF at the reactor site. The base case for dry cask storage is similar to that assumed for the CSF: use of a 10 CFR Part 72-licensed DCSS that can store 32 PWR UNF assemblies or 69 BWR UNF assemblies in each unit.

ALARA – Impact of the STAD Option on the radiation dose to workers during activities at the utility site associated with use of the STAD including loading the STAD, moving the STAD to its storage area, and storage operations. This impact is evaluated in comparison to the base case for dry cask storage of UNF at the utility site.

Reactor Site Operations – Impact of the STAD Option on the overall operations associated with the reactor site including normal operations, radiation protection, maintenance, and engineering. This impact is evaluated in comparison to the base case for dry cask storage of UNF at the utility site.

Plant Mods (Modifications) – Comparison of the plant modifications required for use of the STAD Option in comparison to the base case for dry cask storage of UNF at the utility site.

LLW Generation – Impact of the STAD Option on the quantity and type of LLW generated and on the facilities, equipment, and personnel required to process the LLW generated. This impact is evaluated in comparison to the base case for dry cask storage of UNF at the utility site.

Reactor Site Storage – Impact of the STAD Option on the size of the facility required for storage of the packaged UNF. This impact is evaluated in comparison to the base case for dry cask storage of UNF at the utility site.

C.5.3 Impact Ratings

0 – No impact

1 – Low impact on either operations or cost

2 – Low impact on both operations and cost

3 – Moderate impact on both operations and cost

4 – High impact on either operations or cost; low to moderate impact on other

5 – High impact on both operations and cost

C.5.4 Assumptions for Impacts and Ratings

Assumption 1 – The base case for comparison assumes:

a. The utility has the infrastructure to transfer UNF from wet storage in a UNF pool to dry cask storage in accordance with 10 CFR Part 50 and 10 CFR Part 72.

b. The utility currently has UNF in dry cask storage utilizing a 10 CFR 72-licensed, 32 PWR/69 BWR DCSS.

c. The utility regularly transfers UNF to dry cask storage.

Assumption 2 – All UNF, except for Options 2, 4, and 8, will be packaged in their respective STADs and DSC-type overpacks at the utility and placed into dry storage using concrete overpacks similar to those used for 10 CFR 72-licensed DCSSs. The packaged UNF will then be transferred from the dry storage overpacks to transportation casks and shipped to the CSF.

Assumption 3 – UNF that is to be stored in the Options 2, 4, and 8 STADs will be initially loaded into conventional 10 CFR 72 DCSSs at the utilities, stored on site for a period of time, and then shipped to the CSF. The 10 CFR 72 DSC will be opened at the CSF, the UNF consolidated, and then the UNF will be placed into the STAD.

Assumption 4 – All STADs, whether placed into 10 CFR 72-type overpacks or not, are transported in the transportation casks similar to those licensed for use to transport 10 CFR 72 DSCs.

Assumption 5 – UNF already in dry storage in 10 CFR 72-licensed DCSSs will be shipped to the CSF as is and re-packaged into STADs at the CSF.

C.5.5 Impact Evaluations

OPTION 2 – 2 PWR/4 BWR/13.4OD/C

Consolidation of the UNF will only occur at the CSF. If this Option is used, UNF will be loaded at the utilities in standard Part 72-licensed DCSSs and then shipped to the CSF. Therefore, this Option has no additional impacts on operations at utilities compared with the base case.

OPTION 3 – 1 PWR/1 BWR/13.1OD/U

Loading Operations – This Option has a high impact on the cost and operations associated with loading. This Option requires that loading operations (including UNF placement, handling, drying, inerting, and closure welding) be performed for 32 PWR to 69 BWR times more for each nominal DSC. Further, it requires that, as a minimum, 2.67 times more transfers (32/12)

from the UNF pool to dry storage take place. Therefore, this Option is given an impact rating of 5.

ALARA – Total dose associated with UNF transfer to dry storage is directly related to the number of operations required for the transfer. As discussed above, this Option requires a significant number more operations than the base case and will have a high impact on ALARA. Therefore, this Option is given an impact rating of 5.

Site Operations – The increase in the number of operations associated with loading and transferring the UNF will have an impact on overall site operations. Additional security, radiation protection, operations, maintenance, and engineering personnel will be required. The additional time required for loading activities will limit access to the UNF pool. This Option is considered to have a high impact therefore it is given an impact rating of 5.

Plant Modifications – Minor plant modifications and some additional welding and rigging/lifting equipment may be required to support loading operations. This is considered to be low impact and therefore this Option is given an impact rating of 1.

LLW Generation – There will be an increase in LLW generation as a result of the additional activities and materials used for loading these STADs. The increase should not be significant; this Option is given an impact rating of 1.

Site Storage – This Option will require approximately 2.67 times more space than the base case, which would increase a typical storage area from about 2.5 acres to 6.7 acres. This will have a significant impact on siting dry storage areas and providing services, such as security. Therefore, this Option is given an impact rating of 5.

OPTION 3a – 1 PWR/2 BWR/15.0OD/U

Loading Operations – This Option has the same impact as Option 3 for PWR utilities, but is reduced for BWR utilities. The impact for BWR utilities is still significant. Therefore, this Option is given an impact rating of 4.5.

ALARA – This Option has the same impact as Option 3 for PWR utilities, but is reduced for BWR utilities. The impact for BWR utilities is still significant. Therefore, this Option is given an impact rating of 4.5.

Site Operations – This Option has the same impact as Option 3 for PWR utilities, but is reduced for BWR utilities. The impact for BWR utilities is still significant. Therefore, this Option is given an impact rating of 4.5.

Plant Modifications – This Option has the same impact as Option 3 for PWR or BWR utilities. Therefore this Option is given an impact rating of 1.

LLW Generation – This Option has the same impact as Option 3 for PWR or BWR utilities. Therefore, this Option is given an impact rating of 1.

Site Storage – This Option has the same impact as Option 3 for PWR utilities, but is reduced for BWR utilities. The impact for BWR utilities is still significant. Therefore, this Option is given an impact rating of 5.

OPTION 4 – 2 PWR/4 BWR/8.4SQ/C

Consolidation of the UNF will only occur at the CSF. If this STAD Option is used, UNF will be loaded at the utilities in standard Part 72-licensed DCSSs and then shipped to the CSF. Therefore, this Option has no additional impacts on operations at utilities compared with the base case.

OPTION 5 – 4 PWR/9 BWR/31.0OD/U

Loading Operations – This Option has a reduced impact compared with Option 3a, but the impact still remains high compared with the base case. Therefore, this Option is considered to have a moderate-high impact on loading operations and is given an impact rating of 4.

ALARA – This Option has a reduced impact compared with Option 3a, but the impact still remains high compared with the base case. Therefore, this Option is considered to have a moderate-high impact on ALARA and is given an impact rating of 4.

Site Operations – This Option has a reduced impact compared with Option 3a, but the impact still remains high compared with the base case. Therefore, this Option is considered to have a moderate-high impact on site operations and is given an impact rating of 4.

Plant Modifications – This Option has the same impact as Options 3 and 3a. Therefore this Option is given an impact rating of 1.

LLW Generation – This Option has the same impact as Options 3 and 3a. Therefore, this Option is given an impact rating of 1.

Site Storage – This Option will require a significant increase in storage area size compared with the base case. It has a lesser impact than Option 3 because of the increase in BWR assemblies and the same impact as Option 3a. This Option is therefore considered to have an impact rating of 5.

OPTION 6 – 12 PWR/24 BWR/43.2 OD/U

Loading Operations – This Option has a reduced impact compared with Option 5, but the impact still remains high compared with the base case as about 2.67 times (32/12) the canisters will require loading. Therefore, this Option is considered to have a moderate-high impact on loading operations and is given an impact rating of 4.

ALARA – This Option has a reduced impact compared with Option 5, but the impact still remains significant compared with the base case. Therefore, this Option is considered to have a moderate impact on ALARA and is given an impact rating of 3.

Site Operations – This Option has a reduced impact compared with Option 5, but the impact still remains significant compared with the base case. Therefore, this Option is considered to have a moderate impact on site operations and is given an impact rating of 3.

Plant Modifications – This Option has the same impact as Option 5. Therefore this Option is given an impact rating of 1.

LLW Generation – This Option has the same impact as Options 5. Therefore, this Option is given an impact rating of 1.

Site Storage – This Option will require a significant increase in storage area size compared with the base case. It has a lesser impact than Option 3 because of the increase in BWR assemblies and the same impact as Options 3a and 5. This Option is therefore considered to have an impact rating of 5.

OPTION 7 – 21 PWR/44 BWR/66.2 OD/U

Loading Operations – This Option has a reduced impact compared with Option 6, but the impact still remains significant compared with the base case as about 1.5 times (32/21) the canisters will require loading. Therefore, this Option is considered to have a moderate impact on loading operations and is given an impact rating of 3.

ALARA – This Option has a reduced impact compared with Option 6, but the impact still remains significant compared with the base case. Therefore, this Option is considered to have a moderate impact on ALARA and is given an impact rating of 3.

Site Operations – This Option has a reduced impact compared with Option 6, but the impact still remains significant compared with the base case. Therefore, this Option is considered to have a moderate impact on site operations and is given an impact rating of 3.

Plant Modifications – This Option has the same impact as Option 6. Therefore this Option is given an impact rating of 1.

LLW Generation – This Option has the same impact as Option 6. Therefore, this Option is given an impact rating of 1.

Site Storage – This Option will require a significant increase (approximately 50 percent) in storage area size compared with the base case. It has a lesser impact than Options 3, 3a, or 5 because of the increase in assemblies per storage unit. This Option is therefore considered to have an impact rating of 4.

OPTION 8 – 42 PWR/88 BWR/63.0 SQ/C

Consolidation of the UNF will only occur at the CSF. If this STAD Option is used, UNF will be loaded at the utilities in standard Part 72-licensed DCSSs and then shipped to the CSF. Therefore, this Option has no additional impacts on operations at utilities compared with the base case.

C.5.6 Impact Evaluation Summary Table

Table C-6 summarizes the impact ratings discussed above. A column is provided for the summation of the impact ratings. The summation can be used to judge the overall impact on the CSF of each STAD Option relative to the other Options.

Table C-6. STAD Option Reactor Site Impact Rating Summary

			Reactor Site Impact Rating						
Option No.	STAD Designation	Notes	Ldg. OPs	ALARA	Site Ops	Plant Mods	LLW Gen	Site Store	Sum
2	2PWR/4BWR/13.4OD/C	Round Well Pipe concept; consolidate @ CSF; 12 STADs = 24 equivalent PWR/ 48 BWR FAs fit in a standard cask overpack with internal handling frame as basket	0	0	0	0	0	0	0
3	1PWR/1BWR/13.1OD/U	12 STADs = 12 PWR/12 BWR FAs in a standard cask overpack with internal handling frame as basket;	5	5	5	1	1	5	22
3a	1PWR/2BWR/15.0OD/U	12 STADs = 12 PWR/24 BWR FAs in a standard cask overpack with internal handling frame as basket; 1.9" larger STAD OD than Option 3	4.5	4.5	4.5	1	1	5	20.5
4	2PWR/4BWR/8.4SQ/C	Square STAD concept to fit in unique cask and basket; short load possible; consolidate @ CSF; 21 STADs = 42 equivalent PWR/84 BWR FAs per cask	0	0	0	0	0	0	0

			Reactor Site Impact Rating						
Option No.	STAD Designation	Notes	Ldg. OPs	ALARA	Site Ops	Plant Mods	LLW Gen	Site Store	Sum
5	4PWR/9BWR/31.0OD/U	3 STADs = 12 PWR/27 BWR FAs in a standard cask overpack with internal handling frame as basket	4	4	4	1	1	5	19
6	12PWR/24BWR/43.2OD/U	1 STAD per cask overpack due to size and weight constraints	4	3	3	1	1	5	17
7	21PWR/44BWR/66.2OD/U	Yucca baseline design; early utility use	3	3	3	1	1	4	15
8	42PWR/88BWR /63.0SQ/C	Square canister (can) concept into 1 large STAD with basket; Short load possible; consolidate @ CSF - requires large production pools; 1 STAD with 21 canisters = 42 PWR/88 BWR to fit in a standard cask overpack	0	0	0	0	0	0	0