Summary of Comments on FCRD-UFD-2012-00219 Rev 1C.pdf

Comments below are from the SRNL Review on Rev 1C

Comment Location	Comment
Executive Summary	
Page IV	
1st para	"All disposal concepts developed internationally and in this report fit into this categorization scheme." No only the enclosed modes developed in this report fit. Suggest rewording to clarify "All disposal concepts developed internationally and the enclosed modes in this report fit into this categorization scheme."
	"Enclosed modes include vertical and horizontal borehole emplacement in borings constructed from underground, backfilled alcoves, and deep boreholes." "From" in this sentence does not seem correct. Suggest "Enclosed modes include vertical and horizontal borehole emplacement adjacent to access drifts ~~in borings constructed from underground~~, backfilled alcoves, and deep boreholes.
	"MOX fuel is a particularly hot waste type that could result from current or transitional activities in the nuclear power industry, but may never be generated in large quantities." Should likely note that some MOX fuel will be generated from the materials disposition program i.e. weapons grade Pu MOX. This can also be used as partial justification for our continued inclusion of this alternative fuel cycle from a geologic repository standpoint.
	"3. **Clay/Shale (enclosed)** – SNF or HLW is emplaced …" Why is this one the only description that draws a potential distinction between HLW and SNF. All the concepts described have been developed to handle HLW or SNF. We just chose to cost one on the basis of SNF.

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	Suggest: "3. **Clay/Shale (enclosed)** – Waste in carbon steel packages is emplaced in blind, steel-lined horizontal borings constructed from access drifts. The lined boreholes are backfilled at the time of emplacement with a clay buffer. " And should we use UNF or SNF? Or note they are used interchangeably in this report since any fuel emplaced in a repository is thought to have little value at the time of disposal.
Page v	
1st para	after "disposal of HLW glass" add "from reprocessing commercial LWR UOX fuel"
Page VII	
	"HLW generated by reprocessing LWR UOX fuel could be emplaced after approximately 10 to 50 years of decay storage " This is the only example where a range is used. All other example ages are point values. Suggest using the point value here which I recall as 30 years. This would be consistent with prior salt repository studies.
Page ix	
	The two paragraphs below should be deleted. The first paragraph describes items which are not in the estimate and which have already covered in the exec summary. The second paragraph is a comparison to other estimates which are not discussed in the report (with the removal of the TSLCC discussion) and should not be mentioned in the exec summary. "It is important to note that the cost estimates in this report are for repositories with relatively simple surface facilities that handle only canistered commercial SNF, or HLW from various

Comment Location	Comment
	sources, that arrives already in waste package-size containers. The costs associated with fabricating waste package size canisters, including internal structures and materials for heat transfer, criticality control, etc., and the costs associated with repackaging the ever-growing inventory of SNF that is stored in sealed, dual-purpose canisters (DPCs) are not included. Facilities, equipment, and personnel required to support these additional necessary operations will increase the costs all of the repository concepts analyzed. Estimates for the Generic Salt Repository, Shale Unbackfilled (open) concept, and Sedimentary Backfilled (open) concept, are within the range of previous life-cycle cost estimates and international estimates."
	Insert after : **"R&D to Revise Thermal Constraints to Allow Higher Temperatures** – This study shows that disposal concepts favoring larger waste packages and smaller repository footprints offer significant economic advantages". "for repository specific attributes as discussed in this report. (These trends are expected to hold true for the life cycle costs of the entire backend of the fuel cycle but such conclusions are left to other studies".
	I believe the additional R&D related recommendation is also warranted. Something along the lines of: "The engineering concepts described in these reference cases were developed sufficiently to allow for initial cost estimation. Additional engineering studies to ensure the dimensions and weights of the proposed waste disposal packages are adequate and that the corresponding drifts diameters, especially where service, access and emplacement drifts intersect, are warranted. Waste package conveyance methods requires additional evaluation, especially potential use shaft hoist systems for large (>12 PWR/21BWR) waste disposal packages. These items have the potential to increase cost substantially. Additional evaluation for the waste package overpack materials of construction (assumed to be carbon steel in this study) is required. "Upgrades" in the quality of the materials of construction (as was the case for an unsaturated oxidizing environment) will have a corresponding impact on

Comment Location	Comment
	the cost of the repository." There are likely other engineering items, Rob and Jim can chime in with their ideas.
Section 4 p 121 last Par	
	Change : "avoid crystallization of the melt." To read "avoid crystallization of the borosilicate glass waste form"
	Change : "The heat output of HLW glass from defense activities is already low (Carter et al. 2012c) partly because of decay storage and in part because the HLW may be derived from experimental SNF with low burnup". To read The heat output of HLW glass from defense activities is already low (Carter et al. 2012c) partly because of decay storage and in part because the DOE borosilicate glass is limited in waste loading by non-radioactive chemical constraints e.g. Al.

Michael Voegele (04Sep12)

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Executive Summary			
Page vi			
11	(comparing results for crystalline and clay/shale concepts,	The first and fourth bullets are interesting–does it mean that Cs and Sr are drivers no matter whether SNF or	Yes, for the case in which HLW is generated a reprocessing fuel cycle where only U/Pu are

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	particularly the 60 GW-d/MT burnup SNF and WHL from reprocessing)	HLW?	recovered and the remaining fission products including short (e.g. Cs, and Sr) and long-lived (e.g. Am and Cm) are incorporated into the HLW glass. This is in part due to the concentration of the FP from about 1% in UNF to about 14% in HLW. The surface cooling time for a DOE HLW glass may be less since the fission products are not as concentrated in the glass due to chemical constraints (e.g. Al) on these waste forms. Suggest rewording: "HLW generated by reprocessing LWR UOX fuel, and containing short-lived fission products, could be emplaced after 50 to 100 years of decay storage. Other reprocessing wastes could be emplaced after fewer than 50 years. " To read "HLW generated by reprocessing LWR UOX fuel, and containing both long and short-lived fission products, could be emplaced after 50 to 100 years of decay storage. Other reprocessing wastes (e.g. wastes from the capture and treatment of volatile radionuclides) could be emplaced after fewer than 50 years. "
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21	(waste inventory of 140,000 MT)	Is this a single repository? Why invite GC to disallow this?	The cost results shown in Section 5 are for a 140,000 MT repository. This is a generic repository study and as such it should not be subject to the 70,000MT limit imposed by the NWPA (an actual proposal to build such a repository would be limited under current law). The 140,000 MT was selected to be consistent with other UFD studies in which the inventory was based on the current 104 reactor fleet operating for 60 years. This report describes the underground footprint for both a 70,000 and 140,000 MT capacity and cost methods were developed to support multiple repository locations if desired in future studies. "Costs and the associated schedules for all concepts were developed using the same phases and durations derived for two previous salt repository studies (Carter et al. 2011, 2012c). The waste emplacement operations phase of 47 years is determined by the waste inventory (140,000 MT) and the assumed waste emplacement rate of 3,000 MT per year. Cost estimates do not include site screening, selection, or characterization." Append to the same paragraph above "The scope of the cost estimates do not include all functional areas required for the backend of the fuel cycle. Costs for at reactor packaging, centralized storage (if adopted), repackaging to meet the disposal package limitations (discussed above) and transportation are excluded from this study. These

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			attributes are being investigated by others with-in UFD." "This cost study allows evaluation of relative differences between repository concepts given a constant waste inventory, while examining the differences driven by thermal management and major construction differences for the geologic setting investigated. However, life cycle costs for the backend of the fuel cycle may differ and is the subject of other UFD studies. These additional studies should be considered when evaluating cost factors for any programmatic decisions."
22	(discussion of values from Table 5-1)	Check this (high value should be $85B)	Agreed. $85B is the correct value. Change: "The life-cycle cost of a repository for permanent disposal of 140,000 MT of commercial SNF ranges from (approximately) $24 B to $81 B in 2012 dollars" To read: The life-cycle cost of a repository for permanent disposal of 140,000 MT of commercial SNF ranges from (approximately) $24 B to $85 B in 2012 dollars.
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23	(top of page, list of costs not included in estimates)	And check bases for characterization and licensing / compare to Second Repository report.	SRNL – Joe Carter Note Hardin will locate the 2nd repository report in

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			question.
Section 1			
Page 1			
31	(1E4 –yr evaluation horizon for FEPs allows performance models to focus on FEPs acting for much longer time period, e.g., for 1E6 yr)	That's not why EPA did that- it was because of uncertainty and had to leave in 1E6 yr climate, seismicity, ground water rise and volcanism because the NAS said to. NRC added post-1E4 yr corrosion so DOE couldn't screen it out.	SRNL – Joe Carter
32	(assumed mission is disposal of 140,000 MT)	But it's two repositories according to current law.	See response to Voegele #21
Page 120			
89	(end of paragraph after the numbered list)	No, because you are assuming away things that are included in the YM TSLCC.	Agreed the scope does not allow direct comparison to the YM TSLCC. Change: "As such, we can draw on previously published information for typical details (DOE 2008b) and costs (DOE 2008c)." To read "As such, we can draw on previously published information for typical details (DOE 2008b)." Also delete reference DOE 2008c.

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Page 121			
91	(first paragraph on estimation)	I really think you need an up front justification for why an analysis of a single repository is appropriate	Change: "This study assumes an annual emplacement rate of 3,000 MT per year, which will require approximately 47 years for disposal of the total inventory. " To read: "This study assumes a total SNF emplacement of 140,000 MT at an annual emplacement rate of 3,000 MT per year, which will require approximately 47 years for disposal of the total inventory. The 140,000MT was used in this study to be consistent with other UFD studies and is based upon operating the existing 104 nuclear reactors for 60 years each. This "no replacement" nuclear power generation capability results in the lowest total inventory to be disposed. Section 4 and 5 develop the underground footprint for both 70,000 and 140,000MT capacity repositories. The cost methodology developed in section 5 is modular to allow cost studies for multiple repositories although only

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			the results for a single repository are presented." Make the last sentence a new paragraph.
Section 5			
Page 145			
109	(Section 5)	I suggest that this section include strong statements to prevent someone from taking these very preliminary numbers and directing the future program efforts based solely on these numbers. There is a sense presented that the assumptions are not strictly consistent across the estimates, and for this point in time, they probably can't be. I don't really know what to do about it, but I'm concerned that these numbers will be misused.	Append the following" "Estimates for design, construction start-up, operations, closure and monitoring costs (lumped together as the DCSOCMC) are determined using four schedule phases (Carter et al. 2012b). Table 5-1 summarizes the design, construction, start-up, operations, closure and monitoring cost (DCSOCMC) range for each of the five disposal concepts, for 140,000 MT commercial SNF. Estimates for DCSOCMC do not include activities associated with siting, licensing, and waste transport to the repository." With: "The scope of the cost estimates does not include all functional areas required for the backend of the fuel cycle. Costs for at reactor packaging, centralized storage (if adopted), repackaging to meet the disposal

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			package limitations (discussed above) and transportation are excluded from this study. These attributes are being investigated by others with-in UFD." "This cost study allows evaluation of relative differences between repository concepts given a constant waste inventory, while examining the differences driven by thermal management and major construction differences for the geologic setting investigated. However, life cycle costs for the backend of the fuel cycle may differ and is the subject of other UFD studies. These additional studies should be considered when evaluating cost factors for any programmatic decisions." Also delete: **"Comparison to Previous Cost Estimates** Comparing costs for SNF disposal between international programs, or comparing recent estimates with older ones, is difficult because published estimates are structured differently and may not include the same elements. For example as discussed above and in Section 4, the estimates generated in this report do not include siting,

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			characterization, or licensing-related activities, or the cost of canistering SNF for disposal and transporting it to a repository. Hence, the comparisons presented below are rough estimates that show mainly that cost ranges for reference cases in this report are typical of previous estimates published for disposal programs in the U.S. and other countries." And consider deleting the remaining parts of this section. Even in the revised draft 1C it is difficult to know what is included in the international program cost numbers and this topic would seem to warrant a more extensive study and examination than there few paragraphs provide.
Page 146			
110	(Table 5-1, O&M row)	Don't understand the large range.	This range (about a factor of 3) reflects several factors including the differences in the waste package count to be handled. This varies from 16,000 to 83,000 or about a factor of five. Most of the mining is also in the O&M costs which also varies by a factor of six (Table 4.6-3) . While this range is large it appears to reflect the different geologic requirements correctly.
111	(Table 5-1, Monitoring row)	Don't understand the large range. And why is monitoring separate from performance confirmation?	We used performance monitoring to capture the cost during design, construction and operation associated with laboratory and field testing activities. The monitoring phase captures the cost in the 75 year time period after repository closure. The range in part reflects the extent of underground excavation.
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112	(Table 5.1-3, first row)	Except what?	Good catch – thank you. Change the table from : "Service, Access and Emplacement Drift, Except ($ per lineal foot) " To: Service, Access and Emplacement Drift, Except for Steel Lined Shale Emplacement Drift (below) ($ per lineal foot)
Page 158			
113	(Section 5.5)	Still would like an explanation of what this is if it isn't performance confirmation.	Monitoring reflect post closure costs.
Page 163			
115	(Section 6.1.5)	Have you considered that this strategy might unnecessarily complicate the licensing of the repository by creating state or other federal authority oversight roles?	This appears to be a catch 22. Most repository supporters are advocating volunteer host sites with local and state agency participation in the approval process. It is also noted that as long as the waste is radioactive waste (e.g. SNF, HLW, GTCC, LLW) and not mixed waste the role of the states can be negotiated. If RCRA waste is included then the state role is more formal.

William Halsey (10Oct12)

	Comment Location	Comment	Assignments
High-Level Comments			
5	(general)	The cost estimate section raises the potential for misinterpretation, misapplication, and intentional misuse, and could raise more questions than it answers. A statement of its purpose, application, and limits to its application should be included in the	Agree. Recommend inserting the proposed text in the exec summary just under the cost estimation summary.

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		Summary, Sections 4, 5, 6, and Appendices as appropriate. The authors and sponsor can determine appropriate wording, but a suggestion would be something like: *"An evaluation of cost factors for the disposal concepts has been conducted to inform on how design features and thermal load management issues affect relative costs. This evaluation is useful to see what design features and thermal issues tend to drive relative costs across the range of disposal concepts. Application of these cost factors beyond their intended context should be avoided."*	
Section 4			
Page 120			
22	Page 120, beginning of Section 4:	You should have a brief section here stating the working assumptions for the cost analysis, such as; the capacity basis (140,000MT), regulatory framework, scope of analysis (not site characterization, transport or repackaging, decay storage, etc), source of ventilation requirements, etc. The ventilation flow rates in this section are not all the same (even in m3/sec per drift), so some explanation should be provided, such as a common velocity.	Agree. See MDV 91 Change: "This study assumes an annual emplacement rate of 3,000 MT per year, which will require approximately 47 years for disposal of the total inventory. " To read: "This study assumes a total SNF emplacement of 140,000 MT at an annual emplacement rate of 3,000 MT per year, which will require approximately 47 years for disposal of the total

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			inventory. The 140,000MT was used in this study to be consistent with other UFD studies and is based upon operating the existing 104 nuclear reactors for 60 years each. This "no replacement" nuclear power generation capability results in the lowest total inventory to be disposed. Section 4 and 5 develop the underground footprint for both 70,000 and 140,000MT capacity repositories. The cost methodology developed in section 5 is modular to allow cost studies for multiple repositories although only the results for a single repository are presented." Make the last sentence a new paragraph. Hardin to provide response to the second comment on ventilation flow rates.
23	Page 120, last sentence on the page:	HLW waste from defense activities is derived from "Pu production reactors" or naval reactors, not experimental reactors.	Agree the term Defense HLW should be replaced with DOE-HLW as used in the UFD Inventory report which is broader .
Page 137			
26	Page 137, Section 4.6	Here and in Table 4.6-2, you bring in a 70,000 MT repository. This seems out of context. There is no sensitivity study on capacity. (A thought for the future?)	See response to Halsey #22.
Page 145			
28	Section 5	This is a place you need the cost caveat!	Agree comment is similar to MDV 109. Append the following"

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			"Estimates for design, construction start-up, operations, closure and monitoring costs (lumped together as the DCSOCMC) are determined using four schedule phases (Carter et al. 2012b). Table 5-1 summarizes the design, construction, start-up, operations, closure and monitoring cost (DCSOCMC) range for each of the five disposal concepts, for 140,000 MT commercial SNF. Estimates for DCSOCMC do not include activities associated with siting, licensing, and waste transport to the repository." With: "The scope of the cost estimates does not include all functional areas required for the backend of the fuel cycle. Costs for at reactor packaging, centralized storage (if adopted), repackaging to meet the disposal package limitations (discussed above) and transportation are excluded from this study. These attributes are being investigated by others with-in UFD." "This cost study allows evaluation of relative differences between repository concepts given a constant waste inventory, while examining the

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Page 166			
34	Page 166, Section 6.3:	Add caveat to explain how cost factors inform on concepts and thermal issues.	Suggest repeating this paragraph in section 6.3 as well. "This cost study allows evaluation of relative differences between repository concepts given a constant waste inventory, while examining the differences driven by thermal management and major construction differences for the geologic setting investigated. However, life cycle costs for the backend of the fuel cycle may differ and is the subject of other UFD studies. These additional studies should be considered when evaluating cost factors for any programmatic decisions."