DUKE ENERGY. FLORIDA

Dianne M. Triplett
ASSOCIATE GENERAL COUNSEL
Duke Energy Florida, Inc.

May 27, 2014

VIA ELECTRONIC FILING

Ms. Carlotta Stauffer, Commission Clerk
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, Florida 32399-0850

Re: *Petition of Duke Energy Florida, Inc. for Approval to Construct an Independent Spent Fuel Storage Installation and an Accounting Order to Defer Amortization Pending Recovery from the Department of Energy ; Docket No.* _____

Dear Ms. Stauffer:

Please find enclosed for electronic filing on behalf of Duke Energy Florida, Inc. ("DEF"), DEF's Petition for Approval to Construct an Independent Spent Fuel Storage Installation ("ISFSI") and an Account Order to Defer Amortization Pending Recovery from the Department of Energy Testimony and Exhibits. The filing includes the following:

- DEF's Petition;
- Direct Testimony of Marcia Olivier with Exhibit No. ___ (MJO-1) and Exhibit No. ___ (MJO-2); and
- Testimony of Mike Delowery with Exhibit No. ___ (MRD-1) and Exhibit No. ___ (MRD-2)

299 First Avenue North (33701) Post Office Box 14042 (33733) St. Petersburg, Florida
Phone: 727.820.4692 Fax: 727.820.5041 Email: Dianne.triplett@duke-energy.com

Thank you for your assistance in this matter. Please feel free to call me at (727) 820-4692 should you have any questions concerning this filing.

Respectfully,

Dianne M. Triplett
Associate General Counsel
Dianne.Triplett@duke-energy.com

DMT/mw
Enclosures

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Petition of Duke Energy Florida, Inc. For Approval to Construct an Independent Spent Fuel Storage Installation and an Accounting Order to Defer Amortization Pending Recovery from the Department of Energy	Docket No. _____ Submitted for Filing May 27, 2014

DUKE ENERGY FLORIDA, INC.'S PETITION FOR APPROVAL TO CONSTRUCT AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION AND AN ACCOUNTING ORDER TO DEFER AMORTIZATION PENDING RECOVERY FROM THE DEPARTMENT OF ENERGY

Duke Energy Florida Inc. ("DEF" or the "Company"), pursuant to Sections 366.04(1) and 366.05, Florida Statues, and consistent with the terms of the 2013 Settlement Agreement approved by the Florida Public Service Commission ("PSC" or the "Commission"), respectfully petitions the Commission for approval of the Company's decision to construct and store spent nuclear fuel at Crystal River 3 ("CR3") in an Independent Spent Fuel Storage Installation ("ISFSI") and for an accounting order to defer amortization of the ISFSI portion of the CR3 regulatory asset pending final resolution with the DOE. As demonstrated by the Company's petition and accompanying testimony, the ISFSI, as compared to other options for spent fuel storage, is the most economical alternative for customers, and the proposed regulatory treatment for recovery of the ISFSI costs mitigates the cost to customers.

I. Preliminary Information

1. The Petitioner's name and address are:

   Duke Energy Florida, Inc.
   299 1st Ave. N.
   St. Petersburg, Florida 33701

2. Any pleading, motion, notice, order, or other document required to be served upon DEF or filed by any party to this proceeding should be served upon the following individuals:

Dianne M. Triplett
Dianne.triplett@duke-energy.com
Duke Energy Florida, Inc.
299 1st Avenue North
St. Petersburg, Florida 33701
727- 820-4962 / (727) 820-5519 (fax)

Matthew Bernier
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Duke Energy Florida, Inc.
106 E. College Avenue, Ste. 800
Tallahassee, FL 32301
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Duke Energy Florida, Inc.
106 E. College Avenue, Ste. 800
Tallahassee, FL 32301
(850) 521-1421 / (850) 521-1437 (fax)

3. DEF is the utility primarily affected by the request in this Petition. DEF is an investor-owned electric utility, regulated by the Commission, and is a wholly owned subsidiary of Duke Energy Corporation. The Company's principal place of business is located at 299 1st Avenue North, St. Petersburg, Florida 33701.

4. DEF serves approximately 1.7 million retail customers in Florida. Its service area comprises approximately 20,000 square miles in 35 of the state's 67 counties, encompassing the densely populated areas of Pinellas and western Pasco Counties and the Greater Orlando area in Orange, Osceola, and Seminole Counties. DEF supplies electricity at retail to approximately 350 communities and at wholesale to Florida municipalities, utilities, and power agencies in the State of Florida.

II. Background

5. In February 2013, DEF decided to retire CR3. Subsequently, the Company had to make a decision as to how to handle the spent fuel at CR3. Because no additional spent

fuel would be generated by the unit, one option was to keep the spent fuel in the spent fuel pool (also known as wet storage). The Company also considered storing the spent fuel in an ISFSI (also known as dry storage). Finally, the Company analyzed whether the fuel should be transported to another Duke Energy facility for offsite storage. As discussed in greater detail below and in the testimony of Mike Delowery, the Company concluded that dry storage was the most economically favorable option.

6. After filing its Notice of Intent to Permanently Cease Operations with the Nuclear Regulatory Commission ("NRC"), the Company filed on December 2, 2013 its Post Shutdown Decommissioning Activities Report ("PSDAR") with the NRC. In support of that filing, DEF commissioned a new nuclear decommissioning cost study. This same study also supported DEF's filing with the Commission, in Docket 140057, for approval of the nuclear decommissioning cost study and annual accrual of $0. The decommissioning cost study does not include the future costs, estimated to be $94 million ($80 million retail after removing co-owners' and wholesale customers' share) to construct the ISFSI. In previous cost studies, the Company assumed that it would have constructed an ISFSI before 2036 (the original planned decommissioning date), because the continued operation of CR3 would have resulted in more spent fuel than could have been stored in the existing spent fuel pool. Thus, in previous cost studies the cost of constructing an ISFSI was not included in the nuclear decommissioning cost estimate. If DEF had included the cost to construct the ISFSI in its current decommissioning cost study, DEF's Decommissioning Trust Fund ("DTF") would not contain sufficient funds, which would result in an immediate need to recover additional dollars from customers to add to the DTF.

7. In addition, most of the costs that the Company expects to incur for the ISFSI project are potentially recoverable from the Department of Energy ("DOE") as damages arising out of the Federal Government's partial breach of its contractual obligations to DEF to pick up the spent fuel from CR3 and store it in a federal repository. Specifically, if the Federal Government had picked up the spent fuel, DEF would not need to incur costs to construct and maintain an ISFSI. DEF has filed lawsuits and expects to continue to file lawsuits against the DOE periodically as costs to design, permit, construct, and implement the ISFSI are incurred.

III. Spent Fuel Management Decision and Project Plan

8. The 2013 Settlement Agreement (see paragraph 5e(1)) contemplated that DEF would be entitled to recover the prudently incurred capital costs for the ISFSI/dry cask storage facility. Accordingly, DEF engaged a number of internal experts to analyze the options. As set forth in more detail in Mr. Delowery's testimony, the Company made conservative cost estimates, ran scenarios that included sensitivities to test the robustness of the assumptions, and made conservative estimates with respect to the date on which the DOE is expected to begin performing under their contract. In summary, when considering the base dry storage option against the base wet storage option under three possible DOE pick up dates (2024, 2036, and 2050), the base dry storage option was favorable to the base wet storage option in all scenarios. And when considering all sensitivities, dry storage was also more favorable than wet storage in all scenarios.

9. Based on all information available today, and using sensitivity analyses to account for certain uncertainties, the Company's decision to store spent fuel at CR3 using an ISFSI is the most cost effective option for customers and therefore is a reasonable and prudent decision. DEF is finalizing its project plan and developing a Class 3 estimate to gain

approval to proceed with construction from the Board of Directors in August 2014. According to the current schedule, DEF will commence some engineering work at the end of 2014, and major construction activities will begin in 2015. DEF anticipates completing the ISFSI construction in 2017 and expects to have all fuel transferred from the storage pool to the ISFSI by 2019.

IV. Costs Incurred to Date and Proposed Regulatory Treatment

10. The Company has already spent $49 million (retail portion) on the ISFSI project and currently projects to spend $94 million more ($80 million retail after removing wholesale and joint owner portions). The dollars already spent are included in the regulatory asset established by the 2013 Settlement Agreement. DEF received an award of $21.1 million in March 2013 for litigated damages claimed from 2006-2010. The retail portion of this award, approximately $17.7 million, will reduce the ISFSI portion of the CR3 regulatory asset upon receipt from the DOE. As indicated above, under the current project schedule, DEF expects to incur the remaining estimated ISFSI construction dollars by 2017. As certain milestones are met and costs have been incurred, DEF intends to seek recovery of these costs from the DOE as breach of contract damages. Given the length of time involved in other court cases against the DOE for previously-incurred damages, it is reasonable to assume that if the final case is filed in 2018, it will not be fully resolved until 2021 at the earliest. This date could change given circumstances outside the Company's control. The retail portion of any future recoveries of ISFSI construction costs through the litigation process will serve to reduce the ISFSI portion of the CR3 regulatory asset.

11. Consistent with the 2013 Settlement Agreement (see paragraph 5e(1)), DEF is entitled to increase base rates to recover a return on the ISFSI investment as well as

amortization expense over 240 months beginning on or before January 2017. Because the timing and amount of DOE litigation recoveries are uncertain, and in order to provide rate relief to customers, DEF requests approval to recover only a return on the investment at the time of the base rate increase but defer the amortization expense until such time as all litigation activities have concluded and all litigation proceeds have been received. DEF also requests approval to adjust base rates a final time upon that conclusion to recover a return on and amortization of the remaining unreimbursed balance of the ISFSI investment, after reducing that balance for all DOE recoveries, over the remaining CR3 regulatory asset amortization period. This treatment will lessen the initial rate impact on customers as amortization will be deferred. This treatment is also expected to potentially lessen the final rate impact on customers, because customers will receive the benefit of a lower rate base once all expected DOE recoveries have been applied to the CR3 regulatory asset.

12. In summary, DEF is requesting to 1) defer the amortization expense until all recoveries have been received from the DOE and 2) adjust base rates at that time to reflect those recoveries in the calculation of the revenue requirement and customer rate going forward. The Commission has already authorized deferral accounting and the use of the CR3 regulatory asset in its approval of the 2013 Settlement Agreement, Docket No. 130208-EI, Order No. PSC-13-0598-FOF-EI. DEF simply requests to continue that deferral until final conclusion of DOE litigation and adjust base rates at that time to reflect any recoveries from the DOE.

V. Effective Date

13. The Company wishes to commence construction of the ISFSI in 2014 and implement the requested treatment at the time of the initial base rate increase, on or before January 2017. Therefore, DEF requests an effective date of January 2014.

VI. Conclusion

14. For all the reasons provided above, as supported by the testimonies of Mr. Delowery and Ms. Olivier, DEF respectfully requests that the Commission: (1) approve DEF's reasonable and prudent decision to move forward with construction of an ISFSI to manage spent fuel at CR3; and (2) defer amortization of the ISFSI portion of the CR3 regulatory asset until litigation with the DOE has concluded and all recoveries have been received and adjust base rates going forward accordingly at that time.

Respectfully submitted this 27th day of May, 2014.

s/ Dianne M. Triplett
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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Petition of Duke Energy Florida, Inc. For Approval to Construct an Independent Spent Fuel Storage Installation and an Accounting Order to Defer Amortization Pending Recovery from the Department of Energy	Docket No. _____ Submitted for Filing May 27, 2014

DIRECT TESTIMONY OF MARCIA J. OLIVIER

ON BEHALF OF
DUKE ENERGY FLORIDA, INC.

IN RE: PETITION FOR APPROVAL TO CONSTRUCT AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION AND AN ACCOUNTING ORDER TO DEFER AMORTIZATION PENDING RECOVERY FROM THE DEPARTMENT OF ENERGY

BY DUKE ENERGY FLORIDA, INC.

FPSC DOCKET NO. _____

DIRECT TESTIMONY OF MARCIA J. OLIVIER

I. INTRODUCTION AND QUALIFICATIONS.

Q. Please state your name and business address.

A. My name is Marcia J. Olivier. My current business address is 299 First Avenue North, Saint Petersburg, FL 33701.

Q. By whom are you employed and what are your responsibilities?

A. I am employed by Duke Energy Business Services, Inc. as a Director of Rates and Regulatory Planning - Florida. I am currently responsible for overseeing rate cases, reporting actual and projected earnings surveillance results, monitoring and reporting on the CR3 Regulatory Asset pursuant to the 2013 Revised and Restated Stipulation and Settlement Agreement ("2013 Settlement"), and supporting the CR3 nuclear decommissioning cost study filing with the Commission. I was also involved in the development of the 2013 Settlement. Prior to my current role, I supported the fuel, environmental and energy conservation cost recovery clauses and served as a witness in fuel dockets for five years, from 2008 through 2012.

Q. Please summarize your educational background and professional experience.

A. I hold a Bachelor of Science degree in Accounting and a Bachelor of Science degree in Finance from the University of South Florida and have over 17 years of utility experience, primarily in the regulatory department.

II. PURPOSE AND SUMMARY OF TESTIMONY.

Q. What is the purpose of your direct testimony?

A. The 2013 Settlement allows DEF to petition for recovery of its prudently incurred costs to construct a dry cask storage facility, also known as an independent spent fuel storage installation ("ISFSI"). Because most of the costs that the Company expects to incur for the ISFSI construction project are potentially recoverable from the Department of Energy ("DOE") as damages arising out of the Federal Government's breach of its contractual obligations to DEF to pick up the spent fuel from CR3 and store it in a federal repository, and in order to provide initial and potentially long-term rate relief for customers, DEF is requesting an accounting order to (a) defer the amortization expense until litigation with the DOE has concluded and all DOE recoveries have been received, and (b) adjust base rates going forward at that time to recover the remaining unrecovered balance of the ISFSI.

Q. Do you have any exhibits to your testimony?

A. Yes, I am sponsoring the following exhibits to my testimony:

- Exhibit No. ___(MJO-1), Exhibit 10 from the 2013 Settlement; and
- Exhibit No. ___ (MJO-2), ISFSI Recovery Example.

Exhibit No. ____(MJO-2) is an example that contains hypothetical assumptions for illustration purposes only. Each of these exhibits was prepared under my direction and control, and each is true and accurate.

Q. Please summarize your testimony.

A. The 2013 Settlement, approved in Order No. PSC-13-0598-FOF-EI on November 12, 2013, allows DEF to petition for recovery of reasonable and prudent projected ISFSI capital costs. The calculation of the revenue requirement for that recovery includes a return on the ISFSI investment as well as amortization expense over a 240 month period. DEF is authorized to increase rates effective the earlier of the first billing cycle for January 2017 or the expiration of the Levy Nuclear Project ("LNP") cost recovery charge. Because DEF has been pursuing and will continue to pursue recovery from the DOE for damages arising out of the Federal Government's breach of its contractual obligations to DEF to pick up the spent fuel from CR3 and store it in a federal repository, there is a potential to reduce the value of the ISFSI investment for any recoveries from the DOE related to the ISFSI project. The 2013 Settlement authorizes DEF to implement an initial rate increase based on projected costs and one adjustment to that initial rate increase based on actual incurred costs. There is no provision in the current settlement for a second base rate adjustment to reflect a lower investment resulting from potential recoveries from the DOE that occur beyond that first adjustment. Therefore, in order to provide initial and potentially long term rate relief for customers, DEF is requesting an accounting order to (a) allow amortization expense to be initially deferred until litigation with the DOE has concluded and

all DOE recoveries have been received, and (b) to adjust base rates an additional time to reflect those recoveries from the DOE, based on the remaining unrecovered investment to be amortized over the remaining amortization period of the CR3 Regulatory Asset.

III. ISFSI CONSTRUCTION COST RECOVERY

Q. How much will the ISFSI construction project cost?

A. As of March 2014, DEF has spent $49 million (retail) to towards the construction of the ISFSI. This is the current balance of the ISFSI portion in the CR3 regulatory asset, which is referred to as "dry cask storage ("DCS")" in the 2013 Settlement [see ¶ 5e(1)]. DEF currently projects to spend an additional $94 million ($80 million retail after removing wholesale and joint owner portions) to complete the construction of the ISFSI from 2014 through 2017. This projected amount does not include carrying charges and this estimate is subject to change.

Q. You recently filed a Nuclear Decommissioning Cost Study in Docket No. 140057. Why haven't you included these costs in that study?

A. In previous cost studies, the Company assumed that it would have constructed an ISFSI before 2036 (the original planned decommissioning date), because the continued operation of CR3 would have resulted in more spent fuel than could have been stored in the existing spent fuel pool. Thus, in previous cost studies the cost of constructing an ISFSI was not included in the nuclear decommissioning cost estimate. If DEF had included the cost to construct the ISFSI in its current decommissioning cost study, DEF's Decommissioning Trust Fund ("DTF")

would not contain sufficient funds, which would result in an immediate need to recover additional dollars from customers to add to the DTF. It is for this reason that the 2013 Settlement provides for recovery of the "reasonable and prudent DCS facility capital costs" through the CR3 Regulatory Asset [¶ 5e(1)].

IV. DOE LITIGATION

Q. How much have you recovered from the DOE to date?

A. DEF filed a lawsuit against the DOE in 2011 for damages incurred between 2006 and 2010. On March 23, 2013, the court awarded DEF $21.1 million associated with the construction of the ISFSI for that time period. The DOE did not appeal the court's decision during the sixty-day appeal window. Therefore, when DEF receives the proceeds, approximately $17.7 million will be allocated to retail customers after removing the CR3 joint owners' share and the wholesale customers' share. The retail portion will be credited to the current balance of the ISFSI portion of the CR3 regulatory asset.

Q. What are your plans for future lawsuits against the DOE?

A. Given the rules that apply to this litigation, DEF will be unable to file for recovery of the damages until after they have been incurred. Said differently, DEF cannot assert future damages in any such lawsuit. Therefore, DEF plans to file periodic lawsuits at future dates. Those dates have not yet been determined, but will be determined given the facts and circumstances at those times. The statute of limitations runs for six years. Once a lawsuit is filed, it generally takes several years for the judge to render a verdict. Then either party has sixty days to appeal.

If a party appeals, this could add an additional two or more years to the case. DEF does not currently plan to file any new lawsuits during any periods with open and ongoing litigation. Assuming there are no lawsuits pending at the time of completion of the ISFSI construction project in 2017, DEF could potentially file its final lawsuit involving the ISFSI project after construction is complete. Then it could take at least three years beyond that time to reach final conclusion of all litigation related to construction of the ISFSI. DEF currently estimates that litigation will not be final until 2021 at the earliest.

Q. Are there any ISFSI construction costs that are not eligible for recovery from the DOE?

A. Yes. We cannot recover AFUDC from the DOE, so that amount will continue to be recovered through the CR3 regulatory asset along with any amounts related to the ISFSI construction that are not successfully recovered from the DOE.

V. PROPOSED TREATMENT

Q. What is the current treatment for the ISFSI project according to the 2013 Settlement?

A. The 2013 Settlement provides for three key elements to the cost recovery associated with the ISFSI: (1) an initial base rate increase upon Commission approval based on projected costs [¶ 5e(1)] "effective the earlier of the first billing cycle for January 2017 or the expiration of the Levy Nuclear Project ("LNP") cost recovery charge" [¶ 5e]; (2) an adjustment to that initial rate increase upon Commission approval based on actual costs "when the DCS facility capital costs

become final" [¶ 5e(1)]; and (3) a true-up through the Capacity Cost Recovery Clause for the difference in revenues received under the initial rate increase as compared to the adjusted rate increase [¶ 5g]. Both the initial and adjusted base rate calculations include amortization expense over a 240 month period [[¶ 5e(1)]. The revenue requirement calculations must be consistent with the "Template for Calculation of the CR3 Regulatory Asset Value and Revenue Requirement" in Exhibit 10 of the 2013 Settlement (see Exhibit ___MJO-1).

Q. Why are you proposing to change this treatment?

A. First, the 2013 Settlement requires DEF to begin amortizing the CR3 regulatory asset over a 240 month period beginning with the initial rate increase. However, any recoveries from the DOE will reduce the investment, and therefore, the amortization expense. In order to lessen the initial rate impact to customers, DEF is requesting to defer that amortization expense until all recoveries from the DOE have been applied to the CR3 regulatory asset. Second, there is currently no provision in the 2013 Settlement that provides for an additional rate adjustment to reflect the potentially lower investment after applying DOE recoveries. Assuming DEF is successful in its litigation efforts, customers would benefit from this additional rate adjustment, because they would pay a lower rate over the remaining amortization period.

Q. What is the treatment that you are requesting?

A. Please refer to Exhibit __(MJO-2), which is an example, with hypothetical dates and dollar amounts, that compares the revenue requirement calculation consistent

with the 2013 Settlement (Column A) to the revenue requirement calculation consistent with the treatment that we are requesting (Columns B-D). Column B shows the initial revenue requirement assuming we defer the amortization expense on the ISFSI in the calculation of the initial rate increase (note that Column B, Line 10 is zero). Therefore, the initial rate increase will only include a return on the rate base at a rate of 8.12% (Column B, Line 7), consistent with the rate of return approved in the 2013 Settlement. Then, after all litigation proceedings against the DOE have concluded and all potential recoveries from the DOE have been received, potentially several years later (see Column C), we propose to recalculate the revenue requirement and adjust rates again to reflect the remaining unrecovered ISFSI investment (see Column D). That calculation will include a return on the remaining unrecovered rate base at 8.12% plus amortization expense over the remainder of the 240 month amortization period of the CR3 regulatory asset, which began on or before January 2017 pursuant to paragraph 5e in the 2013 Settlement. In this example, the historical spend on line 2 is the current balance of the ISFSI project, as of March 2014, in the CR3 regulatory asset. The future spend on line 1 is our current estimate of future spend which is subject to change. This example assumes that DEF is successful in recovering all costs spent on the ISFSI project by 2021. The DOE recoveries and dates in this example are all hypothetical to be used for illustration purposes only, as DEF cannot predict the outcome of litigation against the DOE.

Q. How will multiple recoveries from the DOE over varying timeframes be treated?

A. Any amounts that are recovered from the DOE before or during the ISFSI's initial base rate increase for projected costs and subsequent adjustment for actual costs will reduce the rate base balance, and therefore, will also reduce the revenue requirement and that base rate increase. Any recoveries that are received from the DOE after the first full year in base rates will be applied to the ISFSI investment balance, but no adjustment to base rates will take place until all litigation proceedings have concluded and DEF has received any and all DOE recoveries through that litigation process. Upon that conclusion, DEF will adjust base rates going forward to reflect the appropriate revenue requirement based on the remaining unrecovered ISFSI balance over the remainder of the 240 month amortization period for the CR3 Regulatory Asset.

Q. What is the overall impact of your proposed treatment?

A. The impact is an initial and potentially long term reduction to the base rate increase to recover the cost of constructing the ISFSI from customers. Customers will benefit initially by deferring the amortization expense of the ISFSI investment. Then, assuming we receive a positive outcome through the litigation process, customers will benefit from the additional rate adjustment which will result in a lesser increase to recover the remaining unrecovered balance of the ISFSI investment. Without this accounting order, DEF would simply increase base rates for the first full year of projected revenue requirement and adjust that rate increase after the first full year based on that first full year's actual revenue requirement. Because there are no subsequent rate adjustments provided for in the 2013 Settlement to adjust for recoveries from the DOE, Commission approval

of this request for an accounting order will allow customers to receive the benefit of those future potential recoveries from the DOE.

Q. Does this conclude your testimony?

A. Yes, it does.

Template for Calculation of the CR3 Regulatory Asset Value and Revenue Requirement

Line No.	Pre or Post Retirement Component Classification	*category*	Subject to Cap	Dry Cask Storage
1				
2	Electric Plant In Service	a	$__	
3	Less Accumulated Depreciation	b	$__	
4	Net plant balance	fallout	$__	
5	Write-Down	b	($295m)	
6	Construction Work In Progress (CWIP)			
7	Steam Generator Replacement (SGR) Project	a	$__	
8	Delam Repair Project	b	$__	
9	License Amendment Request (LAR)	b	$__	
10	Dry Cask Storage	d		$__
11	Fukushima	d	$__	
12	Building Stabilization Project	c	$__	
13	Other - CWIP	d	$__	
14	Nuclear Fuel Inventories	a	$__	
15	Nuclear Materials and Supplies Inventories	a	$__	
16	Deferred expenses	e	$__	
17	Cumulative AFUDC (6.00%)	fallout	$__	$__
18	Cost of Removal Reg Asset - CR3 Portion (Order No. PSC 10-0398-S-EI)	b	$__	
19	Total CR3 Regulatory Asset	fallout	$__	$__
20	Rate of Return (Settlement Agreement Exhibit 3: 6% grossed up for taxes)	b	8.12%	8.12%
21	Return	b	$__	$__
22	Amortization expense (20 years)	b	$__	$__
23	Total revenue requirement	fallout	$__	$__

category

a The Intervenor Parties fully and forever waive, release, discharge and otherwise extinguish any and all of their rights to contest DEF's right to recover these costs except that the Intervenor Parties retain the right to challenge whether DEF took reasonable and prudent actions to minimize the future CR3 Regulatory Asset value after February 5, 2013 and to sell or otherwise salvage assets after February 5, 2013 that would otherwise be included in the CR3 Regulatory Asset.

b The Intervenor Parties fully and forever waive, release, discharge and otherwise extinguish any and all of their rights to contest DEF's right to recover these costs.

c The Intervenor Parties fully and forever waive, release, discharge and otherwise extinguish any and all of their rights to contest DEF's right to recover costs incurred by the Company before February 5, 2013. The Intervenor Parties retain the right to challenge the prudence of any costs incurred after and applicable to the period after February 5, 2013 that are submitted for recovery by the Company.

d The Intervenor Parties retain the right to challenge the prudence of any costs submitted for recovery by the Company.

e The Intervenor Parties retain the right to verify that the Company has complied with paragraph 5b of the Revised and Restated Settlement Agreement.

Note: Line 17 of this exhibit reflects the impact of the calculation presented on line 5 of exhibit 11.

Docket No. _____
Witness: Olivier
Exhibit No. (MJO-2)
Sheet 1 of 1

Petition of Duke Energy Florida, Inc. For Approval to Construct an Independent Spent Fuel Storage Installation and an Accounting Order to Defer Amortization Pending Recovery from the Department of Energy

ISFSI Recovery Example
Settlement vs. Requested Treatment
Note: Dates and amounts are hypothetical and for illustration purposes only
($ millions)

			(A)	(B)	(C)	(D)
			Settlement	Requested Treatment (Note 1)		
Line	Description	Ref. Line in 2013 Settement Exhibit 10	Initial Rate Increase 2017-2036 (Note 2)	Initial Rate Increase 2017-2021 (Note 2)	Cumulative DOE Receipts 2017-2021 (Note 3)	Adjusted Rate 2021-2036 (Note 4)
1	Total Future Spend	10	$80.0	$80.0		$80.0
2	Historical Spend Prior to 2014	10	45.5	45.5		45.5
3	Total Spend	10	125.5	125.5		125.5
4	Less DOE Awards	10	(17.7)	(17.7)	(107.8)	(125.5)
5	Add Unrecovered AFUDC	17	18.1	18.1		18.1
6	Total Rate Base	19	125.9	125.9	(107.8)	18.1
7	Rate of Return	20	8.12%	8.12%		8.12%
8	Return	21	10.2	10.2		1.5
9	Amortization Years		20			16
10	Amortization Expense	22	6.3			1.1
11	Revenue Requirement	23	$16.5	$10.2		$2.6

Note 1: DEF's requested treatment assumes all DOE recoveries are received and ligitigation concludes by 2021. Litigation could conclude earlier than 2021 or extend beyond 2021; therefore, this date is for illustration purposes only.

Note 2: "Initial rate increase" includes the adjustment to true-up to actual incurred costs per the 2013 Settlement, Paragraphs 5e(1), 5g and 5h.

Note 3: Assumes DEF is successful in recovering from the DOE the remaining ISFSI construction historical costs of $27.8 million (total historical spend on line 2 of $45.5 million less 2014 award of $17.7 million on line 4) as well as all projected ISFSI construction costs of $80 million on line 1. DEF cannot predict the amount that will be recovered; therefore, this amount is for illustration purposes only.

Note 4: Base rates will be adjusted based on the ending revenue requirement post final DOE litigation consistent with the uniform percentage increase described in the 2013 Settlement, Paragraphs 5g and 5h. This example assumes DEF is successful in recovering all historical and projected ISFSI construction costs from the DOE. Therefore, the remaining rate base is made up of the accumulated unrecovered AFUDC as this is not recoverable from the DOE.

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Petition of Duke Energy Florida, Inc. For Approval to Construct an Independent Spent Fuel Storage Installation and an Accounting Order to Defer Amortization Pending Recovery from the Department of Energy	Docket No. _____ Submitted for Filing May 27, 2014

DIRECT TESTIMONY OF MICHAEL R. DELOWERY

ON BEHALF OF
DUKE ENERGY FLORIDA, INC.

IN RE: PETITION FOR APPROVAL TO CONSTRUCT AN INDEPENDENT SPENT FUEL STORAGE INSTALLATION AND AN ACCOUNTING ORDER TO DEFER AMORTIZATION PENDING RECOVERY FROM THE DEPARTMENT OF ENERGY

BY DUKE ENERGY FLORIDA, INC.

FPSC DOCKET NO. _____

DIRECT TESTIMONY OF MICHAEL R. DELOWERY

I. INTRODUCTION AND QUALIFICATIONS.

Q. Please state your name and business address.

A. My name is Mike Delowery. My current business address is 400 South Tryon Street, Charlotte, NC 28202.

Q. By whom are you employed and in what capacity?

A. I am employed by Duke Energy, Inc. and currently serve as the acting Vice President of the Project Management and Construction ("PMC") department. I was appointed the acting Vice President, PMC, when Mr. John Elnitsky, the prior Vice President, PMC, was asked to take on a strategic role with the coal ash taskforce. Prior to being appointed as acting Vice President, PMC, I was the General Manager, Projects, of the PMC department. Duke Energy Florida, Inc. ("DEF" or the "Company") is a fully owned subsidiary of Duke Energy.

Q. What are your responsibilities as the acting Vice President of Project Management and Construction?

A. As the acting Vice President, PMC, I report directly to Mr. Dhiaa Jamil, Executive Vice President, Energy, and President, Duke Energy Nuclear. In this role I am the senior manager who has oversight responsibility for the Decommissioning of the Crystal River Unit 3 ("CR3") plant (including the Independent Spent Fuel Storage Installation ("ISFSI") project), the CR3 Extended Power Uprate ("EPU") project wind-down, the Decommissioning Transition Organization ("DTO"), and the CR3 Investment Recovery Project ("IRP"). I also have responsibility over new power plant construction and retrofit of existing fossil and hydro-electric power plants for Duke Energy. Prior to my current role I was the General Manger of Projects in the PMC department. Prior to that I was the Decommissioning Planning Manager at CR3 and in that role I was responsible for the development of the decommissioning plan following the decision to retire CR3, for regulatory submittals to the United States Nuclear Regulatory Commission ("NRC"), and for implementation of closeout of CR3 major project activities.

Q. Please summarize your educational background and professional experience.

A. I hold a Bachelor of Science in Mechanical Engineering from Drexel University and have over 22 years of experience in the nuclear power plant industry. I initially joined Progress Energy in May 2011 and was the General Manager responsible for the potential repair of the CR3 containment building. In February 2014 I was appointed to my current position.

Prior to joining Duke Energy, I worked for Florida Power & Light ("FP&L") where I held various management positions including project director of the St.

Lucie Nuclear Power Plant Extended Power Uprate, maintenance director, project director of the St. Lucie Nuclear Power Plant steam generators and reactor head replacement projects, and manager of projects. Prior to joining FP&L, I held a number of positions at Exelon and completed a rotational assignment with the Institute of Nuclear Power Operations ("INPO") as a senior evaluator of equipment reliability for both domestic and international nuclear power stations.

II. PURPOSE AND SUMMARY OF TESTIMONY.

Q. What is the purpose of your direct testimony?

A. In connection with updating its nuclear decommissioning cost study after the decision to retire CR3 on February 5, 2013, the Company undertook an analysis of various spent fuel management options to determine the best way to store spent fuel until the Department of Energy ("DOE") takes possession of the spent fuel and transports it to a federal repository. My testimony explains which options were considered, how DEF undertook the analysis to decide among the options, and the results of that analysis.

Q. Do you have any exhibits to your testimony?

A. Yes, I am sponsoring the following exhibits to my testimony:

- Exhibit No. ___ (MRD-1), Spent Fuel Management Options Analysis Report, dated November 26, 2013; and
- Exhibit No. __(MRD-2), ISFSI Level 2 Project Schedule.

These exhibits were prepared by the Company, and they are generally and regularly used by the Company in the normal course of its business, and they are true and correct to the best of my information and belief.

Q. Please summarize your testimony.

A. Given the decision to retire CR3, the Company conducted an analysis to determine the most cost effective manner to store spent fuel at CR3. DEF considered storing the fuel in the existing spent fuel storage pool, storing the fuel in a to-be-constructed ISFSI, and moving the spent fuel to another location for off-site storage. After conducting a detailed quantitative and qualitative analysis of the options, DEF selected the ISFSI option as the best and most cost-effective manner in which to store the spent fuel at CR3 until the DOE picks up the fuel. DEF tested the robustness of its economic analysis by performing sensitivities around several key assumptions, and under all sensitivities, the ISFSI option remained the most cost effective. The Company therefore is moving forward with implementing the ISFSI project.

III. SPENT FUEL MANAGEMENT OPTIONS ANALYSIS FOR CR3.

Q. Before the Company's February 5, 2013 decision to retire CR3, how did the Company intend to store the spent fuel from CR3?

A. Starting in 2008, the Company began planning to construct an ISFSI to store the spent fuel at CR3. Because the unit was expected to operate until 2036, which would generate more spent fuel than could be stored in the existing spent fuel

pool, the Company had to build an ISFSI to accommodate the additional spent fuel. Implementation of the project began in 2010, but it was suspended in 2012 so that the Company could focus on repairing the damaged containment building.

Q. How did the decision to retire CR3 impact the ISFSI project?

A. Because the plant is no longer generating spent fuel, the spent fuel pool could physically accommodate the existing fuel assemblies. However, because there are benefits and costs to different options for spent fuel management, DEF undertook an analysis of the various options to ensure that it made the appropriate decision. The results of this analysis are contained in the Spent Fuel Management Options Analysis Report, dated November 26, 2013, which is attached as my Exhibit No. __(MRD-1).

Q. What options did DEF consider for spent fuel management?

A. DEF considered three options: (1) maintain the fuel in the existing spent fuel pool (wet storage); (2) construct an ISFSI (dry storage); and (3) transfer the fuel offsite for storage at another location. Regarding the first option, there are two variations: maintain the current spent fuel pool as is or leave the spent fuel in the current spent fuel pool but implement alternate systems for forced cooling. The latter variation reduces operating and maintenance ("O&M") expenses by reducing the overall reliance on existing plant systems. For purposes of this evaluation, DEF used the latter variation.

Regarding the second option of dry storage, there are also two variations. The first would involve reducing the original concrete pad size to accommodate the

reduced number of canisters. The second variation would involve moving the concrete pad to another location on site, which may reduce physical interference concerns during dismantlement of CR3. After consideration of the decommissioning timeline and the assumed DOE spent fuel pick-up date of 2036, DEF determined that the spent fuel should be removed from the site before major plant dismantlement. Even if the DOE pick up date is delayed, there still will not be significant efficiency improvements achieved by relocating the ISFSI. This is because the current ISFSI location is not directly adjacent to any major plant structures.

Finally, with respect to the third option of transportation of the spent fuel offsite for storage, DEF considered three variations of this option. One variation involved storage of the spent fuel in another pool within the Duke Energy system. The next variation involved storage of the spent fuel in another ISFSI within the Duke Energy system. Finally, DEF considered storage at a newly constructed ISFSI at the Levy County site. DEF eliminated the first variation because no other Duke Energy facility has sufficient room in its spent fuel pool to accommodate additional fuel from CR3. DEF also eliminated the third variation given the timing uncertainties regarding the Levy project. For purposes of this options analysis, DEF therefore only considered offsite shipping to another ISFSI within Duke Energy.

Q. How did DEF begin its analysis of these three options?

A. DEF first completed a qualitative evaluation of the options based on certain criteria. Those criteria were: (a) industrial safety; (b) regulatory complexity; (c)

flexibility and adaptability; and (d) public acceptance. These factors, and how each option was evaluated, are described in more detail in section 5.0 of my Exhibit No. __ (MRD-1).

Q. What were the results of the qualitative analysis?

A. The results of the qualitative analysis are summarized in the table on page 16 of 51 of my Exhibit No. __ (MRD-1). As can be seen in that table, the wet and dry storage options were comparable on the qualitative factors, while the offsite storage option was much less favorable.

Q. What did the Company do next in its analysis of the options?

A. Given the qualitative results for the offsite storage option, DEF focused on this option to determine if it should continue to analyze it as compared with the wet and dry fuel options. The offsite storage option would include many of the same costs as would be needed for the on-site ISFSI construction, as well as other costs that would not be included in the on-site option (including transportation, higher near-term O&M and Security costs due to need to maintain wet storage for a longer period of time, and environmental planning costs). The expected savings result from reductions in on-site labor once all fuel is off-site. DEF performed a simplified economic analysis based on these changes in costs and determined that the costs for this option from 2019 through 2024 were $150 million higher than the on-site option, as compared to cost savings of $78 million from 2025-2036 (the DOE expected pick up date). Given these unfavorable economics and the low ranking on the qualitative criteria, DEF eliminated this option at this point in

the analysis and did not include it in the detailed economic analysis. A more detailed summary of this step is found on pages 16 through 18 of 51 of my Exhibit No. __ (MRD-1).

Q. With the elimination of the offsite storage as an option, what did DEF do next?

A. DEF then proceeded to complete an economic analysis of the wet and onsite dry storage options. Because the qualitative analysis was not dispositive, and both options each meet the project requirements, the Company made its recommendation based on which option was most cost effective for DEF and its customers.

Q. How did DEF complete the economic analysis?

A. DEF first developed an updated cost estimate for both the ISFSI construction and the ongoing O&M costs associated with the wet storage option. Given various uncertainties with respect to the cost assumptions, DEF then ran various sensitivities to test the accuracy of the analysis. For example, because the assumed O&M cost for maintaining the spent fuel pool were higher than the average cost estimated in previous CR3 decommissioning studies, DEF ran a sensitivity analysis to show the impact of lower O&M costs. To complete the economic analysis, DEF also had to assume start and end dates regarding when the DOE removing spent fuel from the CR3 site. To account for uncertainties associated with this factor, DEF evaluated different date scenarios.

Q. What were the results of the economic analysis?

A. The analysis showed that, no matter what DOE pick up date was used, the net present value of the dry storage option was higher than that of the wet storage option. The lowest delta between the two options occurs assuming the earliest DOE pick up date (2024) which is also the least likely date. The sensitivity analyses similarly resulted in favorability for the dry storage option over the wet storage. The complete economic analysis can be found in Attachment 2 of my Exhibit No. __ (MRD-1).

IV. CURRENT PROJECT STATUS

Q. What is the Company currently doing to implement the ISFSI project?

A. The Company is now refining the project estimate and schedule to move from decision making to begin construction. The project team intends to develop a Class 3 estimate that will be presented to the Board of Directors for approval of a notice to proceed at the August 2014 meeting.

Q. Has any of this work changed any of the estimates used in the analysis report described above?

A. Not materially. The estimates continue to be consistent with the options analysis report. We remain confident in the assumptions used to make the decision to construct the ISFSI.

Q. What is the current ISFSI project schedule?

A. Under the current Level 2 schedule, construction and procurement will begin in September of 2014. Construction of the ISFSI project will be complete in 2017, and DEF will finish loading of canisters and transfer of spent fuel from the pool to the ISFSI by fourth quarter 2018. Please see my Exhibit No. (MRD-2) for a detailed schedule.

Q. Was DEF's decision to construct an ISFSI for the storage of spent fuel at CR3 reasonable and prudent?

A. Yes. As explained above, we engaged in a thorough process to gather information from all stakeholders and subject matter experts so that the options could be fully vetted. Constructing an ISFSI is more economically favorable than the wet storage option in all base cases considered, and when all sensitivities are considered. This is the best decision for our customers.

Q. Does this conclude your testimony?

A. Yes, it does.

Spent Fuel Management Options Analysis Report

Crystal River Unit 3 Nuclear Plant

November 26, 2013

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Spent Fuel Management Options Analysis Report
Executive Summary

Purpose

With the decision to decommission the Crystal River 3 (CR3) Nuclear Plant, Duke Energy identified the need to evaluate spent fuel management options for the plant. CR3 is being placed in a SAFSTOR (SAFe STORage) condition and will be fully decommissioned within the 60 year period required by the Nuclear Regulatory Commission. Therefore, the spent fuel must be maintained safely onsite at CR3 or transported for safe storage at another location until the federal government takes possession of the fuel.

The purpose of this document is to provide Senior Management a recommendation for storage of the spent fuel at Crystal River Unit 3 until the Department of Energy ultimately takes possession of the fuel and transports it to a federal repository. The options considered in this evaluation include leaving the fuel in the spent fuel pool (wet storage), implementing an Independent Spent Fuel Storage Installation, (dry storage) or transporting the fuel off site for storage at another location.

Background

In 2008, Crystal River Unit 3 began the design of an Independent Spent Fuel Storage Installation (ISFSI) at a location adjacent to the east berm of the plant. The original purpose of the project was to allow spent fuel to be packaged and removed from the spent fuel pool, thereby providing adequate space for spent fuel to be discharged from the reactor vessel during refueling outages for the remainder of plant life. Implementation of the project began in 2010 with site preparations, including grading and drainage, ancillary building removal and warehouse additions/extensions, security fence modifications, and auxiliary building structural modifications. In addition, a new single failure-proof fuel handling crane was purchased, as well as ten dry shielded canisters (DSCs) and twelve horizontal storage modules (HSMs). However, the project was suspended in 2012 as the plant focused on repairing the damaged containment building.

In February of 2013, Duke Energy made the decision to decommission Crystal River Unit 3. Since the plant is no longer generating additional spent fuel, implementing an ISFSI to create additional space in the pool for an extended operating plant life is no longer required. However, there are currently 1319 fuel assemblies stored in the spent fuel pool that must be stored safely and securely until the Department of Energy (DOE) takes possession of the fuel and transfers it to a federal repository.

There are several options available for storing the fuel until the DOE takes possession. These options include:

- Keep the fuel in the spent fuel pool (wet storage)
- Place the fuel in an ISFSI onsite (dry storage)
- Transfer the fuel offsite for storage at another location

To help make an informed recommendation for the spent fuel management strategy, a team of Duke Energy subject matter experts was assembled to evaluate the options. The most attractive options were then compared in an economic analysis, with the ultimate recommendation being supported by cost assessments (initial project cost and longer term O&M costs), as well as risk and other factors.

Option Evaluation Methodology

The process for making a recommendation for the management of CR3's spent fuel involved two distinct activities. The first was an evaluation of identified options to determine which methods of fuel storage provide the greatest benefit, and lowest risk, to the company. This evaluation, titled "Options Decision Analysis", is contained in Attachment 1 of this document. The purpose of this document was to evaluate the options of onsite wet, onsite dry, and offsite storage, along with variations of these options, against identified, non-monetary requirements and criteria, and narrow the options down to only those considered worthy of future consideration.

The three primary options for spent fuel storage that were considered in the decision analysis are:

1) store the spent fuel in the spent fuel pool
2) store the spent fuel onsite in an ISFSI
3) transport the spent fuel to another Duke facility for offsite storage.

Alternate wet storage (Nuclear Island concept) was used as the method of wet storage in the evaluation, as this was identified as the recommended wet storage method in a separate evaluation.

Relocating the ISFSI to another onsite location, to minimize potential impact on decommissioning and dismantlement activities, was considered. However, the planned decommissioning timeline and an assumed DOE spent fuel pick-up date of 2036 indicate that the spent fuel will be removed from site prior to major dismantlement activities, negating this concern. Even if the timeline changes such that dismantlement precedes removal of spent fuel, the potential impact is judged to be small. Therefore, ISFSI at the current location was used in the decision analysis.

Storing the CR3 spent fuel in another site's spent fuel pool was evaluated as not being a viable option, as no Duke Energy plant has the long-term capacity for both their fuel as well as CR3's fuel. Also, transporting fuel to the Levy County site was eliminated, as there are currently uncertainties as to the timing of the Levy project. Therefore, ISFSI storage at another site was selected as the scope of this option.

Information associated with these options was reviewed in order to determine which option(s) met the project requirements and were worthy of further consideration. Based on the evaluation criteria, the off-site storage option was determined to be the least attractive option. Additional evaluation of this option, including known incremental costs and regulatory complexity, ultimately resulted in eliminating this option from further review.

Both of the remaining options were identified as having key risk elements to consider. For dry storage, potential dismantlement of the spent fuel pool prior to the removal of fuel from site would adversely impact the ability to (i) remediate dry storage problems, should they occur, or (ii) repackage fuel onsite for offsite transportation in DOE-provided casks. Delay in the anticipated DOE pick-up date would add to this risk. To mitigate this risk, CR3 intends to maintain the ability to recover the functionality of the spent fuel pool (or other approved contingency) until all fuel is removed from site.

Regardless, this risk has been added to the ISFSI Project Risk Matrix for further evaluation and disposition (if dry storage is implemented). The key risk for the wet storage option is largely opposition from some environmental groups to pool storage due to perception that dry storage does not require active cooling and is therefore safer. Concerns with spent fuel pools due to events such as the Fukushima earthquake and tsunami lead to increased scrutiny and opportunities for additional regulations.

Based on the qualitative criteria in the decision analysis, both onsite wet storage and onsite dry storage were considered as comparable options and were recommended for further evaluation in an economic analysis.

The economic analysis is the second key activity used for selecting a recommended option. This analysis, titled "Spent Fuel Storage Decision Business Case", is included as Attachment 2 of this document. This analysis compared the currently projected total project and ongoing costs associated with the wet and dry storage options, assuming various dates for the DOE to take possession of all of the fuel. The DOE date is a key variable in the economic analysis, and is estimated to range from 2024 to 2050 or later, with 2036 being a reasonable median date based on historical performance and current regulatory climate (see Attachment 3 for DOE pickup date discussion). The economic analysis shows that, based upon the current assumptions and estimates, the date at which dry storage (ISFSI) becomes more economically attractive than wet storage (i.e., the "break even" date) is 2024, and in 2036 the dry storage option is favorable by over $159 million (net present value, 2013 dollars).

It should be noted that there are several uncertainties in the economic analysis, such as the estimated ongoing O&M costs for each option (including security costs), future regulations and licensing issues, source of funding (tax implications), and the previously mentioned DOE pick-up date. Sensitivity cases were performed on many of these uncertainties to determine if they affected the conclusion of the year 2036 case, with the results indicating that dry storage continued to be favorable. In order for wet storage to become the favorable option, a much earlier DOE pick-up date and significant reduction in assumed wet storage O&M costs, without corresponding offsetting reductions in assumptions for dry storage costs, would need to occur.

Recommendation

Based on an evaluation of multiple spent fuel storage options, both wet storage and dry storage were determined to be acceptable technical options. An economic analysis of these options determined that dry storage is considerably more favorable, particularly when assuming a reasonable median date for the DOE to fulfill their obligation to take possession of CR3's spent fuel. Sensitivity cases performed to evaluate the impact of uncertainties in the model, based on the median DOE spent fuel pickup date of 2036, also support this conclusion. Therefore, the recommendation of this study is to implement the onsite dry storage option (ISFSI) for spent fuel management at Crystal River 3.

It is recognized that a differing professional opinion (DPO) exists regarding this recommendation (see page 6 of 6). The concerns identified in the DPO have been addressed by the refinement of the cost estimates for both the wet and dry storage options as reflected in pages 11 – 14 of Attachment 2, and by stating our intent to maintain the ability to recover the spent fuel pool, or implement an alternate approved contingency, until all spent fuel is removed from site. Therefore, the recommendation to implement the dry storage option at Crystal River 3 is still considered appropriate based on the results of the sensitivity analyses, the categorization of the risks, and the contingency plans for addressing the need to repackage the fuel.

Attachments:

1. Spent Fuel Management Options Decision Analysis, dated 10/4/13
2. Crystal River Nuclear Station Spent Fuel Storage Decision Business Case, dated 10/4/13 (with 11/21/13 update)
3. Estimation of Pickup Date for Crystal River 3 Used Fuel, Rev. 1, dated 9/27/13

Differing Professional Opinion (Steve Nesbit)

Based on the economic evaluation, dry storage is the lowest cost for most scenarios (including all scenarios associated with a reasonably expected spent fuel pickup date). However, I believe the current recommendation is premature. Once done, dry storage cannot be undone, at least without much effort and expense. The probability of problems arising with welded canister dry storage systems is extremely low. Nonetheless, without a spent fuel pool available the operational consequences, expense and adverse public opinion associated with a dry storage problem requiring remediation would be significant. Moreover, the spent fuel contract with DOE requires us to load our used fuel into the casks DOE provides for transportation offsite. Some repository concepts DOE is considering can only accept a small number (e.g., four) fuel assemblies per waste package. DOE could require us to unload our dry storage systems prior to offsite shipment – a major undertaking with a spent fuel pool available and much more challenging without a spent fuel pool. Moreover, some of the analyses providing input to this decision are still preliminary and some of the important parameters (such as annual operations and maintenance costs) have a high degree of uncertainty associated with them. Accordingly, prior to making a decision to implement dry storage at Crystal River 3 my recommendation is to (i) resolve key uncertainties to the extent practical, (ii) finalize cost analyses, and (iii) identify and cost out dry storage risk mitigation measures.

Spent Fuel Management
Options Analysis Report
Crystal River Unit 3 Nuclear Plant

Attachment 1
Options Decision Analysis

Spent Fuel Management
Options Decision Analysis
November 26, 2013

1.0 Summary

With the decision to decommission Crystal River 3 (CR3) Nuclear Plant, Duke Energy identified the need to evaluate spent fuel management options for the plant. CR3 is being placed in a SAFSTOR (SAFe STORage) condition and will be fully decommissioned within the 60 year period required by the Nuclear Regulatory Commission. Therefore, the spent fuel must be maintained safely onsite at CR3 or transported for safe storage at another location until the federal government takes possession of the fuel.

To help identify which spent fuel management strategy provides the best solution, a team was organized to evaluate spent fuel management options. The team consisted of the following members:

Jay Verbos	Principal Engineer, Spent Fuel Management
Gary Walden	Program Manager, Spent Fuel Storage
Mary Shipley	Investment Engineering
Rounette Nader	Fleet Decommissioning SME
Steve Nesbit	Director, Nuclear Policy and Support
Jimmy Glenn	Manager of Spent Fuel Management
Craig Miller	CR3 Design Engineer
Magdy Bishara	CR3 Nuclear Plant Projects Manager
Keith Henshaw	CR3 Lead Project Engineer
Sheila Westcott	CR3 Project Manager
Dan Krysalka	CR3 Project Controls Supervisor
Ray Allen	CR3 Design Engineering Supervisor
Ted Williams	CR3 Design Engineering Manager
Patti Haines	CR3 Major Projects Engineer
Ken Wilson	CR3 Licensing Supervisor
David Mayes	CR3 Major Projects Engineer

The team defined the problem and identified the minimum requirements and criteria for the decision analysis, and agreed upon three options for spent fuel management:

1) Store the spent fuel in the spent fuel pool
2) Store the spent fuel onsite in an ISFSI
3) Transport the spent fuel to another Duke facility for offsite storage.

The team reviewed information associated with the three options, including variations of the options, in order to determine which option(s) met the project requirements and were worthy of further consideration. Based on the evaluation criteria, both onsite wet storage and onsite dry storage were considered to be plausible alternatives, and offsite storage was determined to be the least attractive option. The evaluation criteria evolved after the initial team evaluation meeting to eliminate certain subjective criteria, such as fleet impact and emergent technical issues, and incorporate quantitative cost information to inform the decisions and recommendations within the document.

The conclusion of the decision analysis remains unchanged from the initial team evaluation: the most favorable options are onsite wet storage and onsite dry storage. Based on a simplified cost evaluation of offsite shipping, this option was eliminated from further consideration.

The onsite wet and onsite dry storage options are recommended for further comparison in a separate economic analysis.

2.0 Introduction and Problem Statement

The CR3 ISFSI Project was conceived to support an operating power plant. With the decision to decommission the plant, other options became worthy of consideration for spent fuel management, such as 1) storing the spent fuel offsite, with the advantages of reduction of staff and the potential to remove all physical structures at CR3 prior to the Department of Energy (DOE) taking possession of the spent fuel, and 2) storing the spent fuel in the pool until the DOE takes possession as required by the Nuclear Waste Policy Act. This decision analysis documents a qualitative evaluation of the spent fuel management options, including variations of these options, and provides a recommendation of specific options to be included in a quantitative economic analysis.

3.0 Objective and Methodology

The purpose of this document is to provide an options evaluation that will be used, along with an economic analysis, to provide a recommendation for spent fuel management at Crystal River 3.

The decision analysis team identified the three basic options for evaluation in this analysis: 1) store the spent fuel in the pool, 2) store the spent fuel in an ISFSI onsite, or 3) transport the spent fuel for offsite storage.

3.1 Minimum Requirements

To be considered for the analysis, each option had to meet three strategic requirements:

1) Licensable (for Federal/State regulatory compliance)
2) Safe (nuclear safety)
3) Achievable (technically)

3.2 Evaluation Criteria

The following spent fuel management criteria were defined as the operational objectives for the evaluation:

1) Maximize industrial safety (radiological safety and handling complexity)
2) Minimize regulatory complexity (includes licensing and approvals)
3) Maintain flexibility/adaptability (changing requirements for packaging/transport)
4) Maximize public acceptance (environmental concerns, transportation routes, accidents)

As discussed in Section 1.0, two criteria – Impact on Fleet and Emergent Technical Issues – were originally used, but were subsequently removed based on input from an independent reviewer. The elimination of the two criteria did not impact the assessment of the relative merits of the three options.

4.0 Description of Options Evaluated

4.1 Spent fuel management **Option 1 – Store the fuel in the existing spent fuel pool.** The option includes two variations:

1) Wet Storage – Do Nothing - Leave the spent fuel in the spent fuel pool, using forced cooling systems as designed until the federal government fulfills its contractual obligation to remove fuel from the site. There would be no change in the current spent fuel cooling practice and security requirements of the pool and associated systems with this approach.

2) Wet Storage w/ Alternative Wet Storage modifications – Leave the spent fuel in the spent fuel pool and use alternate systems for forced cooling. This approach has multiple variations using different plant systems, or new systems, to cool the spent fuel and potentially reduce the personnel requirements for operations, maintenance and security by reducing the overall footprint of the remaining systems.

A Business Case Decision Analysis (Reference 3) previously evaluated several wet storage options and determined that a form of Alternate Wet Storage (Nuclear Island) is the preferred wet option. Therefore, for any discussions in this document, and in the separate economic analysis, the team uses “Alternate Wet Storage” as the only wet storage alternative.

4.2 Spent fuel management **Option 2 - Store the spent fuel in an ISFSI onsite (Dry Fuel Storage).** This option would remove the fuel from the pool and store it on a concrete pad until the DOE takes possession. Spent fuel is loaded into dry shielded canisters (DSCs) in the pool and removed for subsequent draining and drying. The canisters are then welded shut to provide a containment boundary for radionuclides and placed within steel-reinforced concrete horizontal storage modules (HSMs). The HSMs provide shielding and missile protection for the spent fuel in the DSCs. This dry fuel storage option includes two variations:

1) Reducing the original concrete pad size to accommodate the reduced number of DSCs. The original ISFSI project required 80 DSCs and HSMs for extended plant life, but the current 1,243 spent fuel assemblies and 76 fresh fuel assemblies (total of 1,319 fuel assemblies) will only require 46 DSCs and HSMs.

2) Moving the concrete pad as described in item 1 above to another location on site. The issue to be considered is whether relocating the ISFSI to a more remote location would reduce physical interference concerns and allow for more efficient dismantlement of the plant structures.

Based on the planned decommissioning timeline and the assumed DOE spent fuel pick-up date of 2036, the spent fuel will be removed from site prior to large scale plant dismantlement, resulting in minimal impact on decommissioning activities. However, potential delays in the DOE pick-up date could result in plant dismantlement prior spent fuel removal. Since the current ISFSI location is not directly adjacent to any plant structures, and the closest structures are office and warehouse type facilities which can be removed relatively easily, there is not expected to be any significant efficiency improvements associated with relocating the ISFSI. Therefore, the current location of ISFSI will be used in this decision analysis and in the separate economic analysis. It is noted that there may be other business considerations for moving the ISFSI, such as alternate use of the current

CR3 property. Any such reasons are speculative and are beyond the scope of this decision analysis, and therefore have not been considered.

Note that although there are no schedule-driven reasons to relocate the ISFSI, a sensitivity case was nonetheless included in the economic analysis to assess the impact of relocation (see Attachment 2 of the Options Analysis Report).

4.3 Spent fuel management **Option 3 – Transportation of the spent fuel offsite for storage.** This option includes the following variations which all assume storage until the federal government takes possession of the fuel:

1) Storage in another spent fuel pool within the Duke system – Further investigation revealed that there are no pools in the Duke fleet that can accommodate the additional full complement of fuel from CR3 without impacting the receiving site's spent fuel storage needs. Fuel could be accepted into a fuel pool at another site in the near term. However, in the longer term, dry fuel storage would be needed at the receiving site.

2) Storage in another ISFSI within the Duke fleet. This variation will involve transportation across state lines may take several years to plan and execute with federal and state agencies prior to shipment. A potential delay in this option is that the transportation license submittal currently under NRC review would only allow transport of a loaded canister with fuel ≥15 years old. All CR3 fuel will meet this age requirement by September, 2024. The team also discussed transporting fuel in single purpose transportation casks where the fuel would go into the pool of the receiving site, and then to onsite dry fuel storage at a later date. Shipping the fuel in DSCs to another site for dry storage was determined to be more favorable. Since none of the other Duke sites have an ISFSI large enough to accommodate CR3's fuel in addition to their own, this variation would involve expansion of an existing ISFSI or construction of a new ISFSI.

3) Storage at a newly constructed ISFSI at the Levy County (FL) site. This variation includes the above mentioned transportation issues, but also involves NRC requirements to license the Levy County site for spent fuel storage plus all the design and implementation of an ISFSI.

The offsite shipping variations named above can be reasonably consolidated to one option for these purposes. The option for fuel to be shipped and stored at Levy can be eliminated, as there are currently uncertainties as to the timing of the Levy project. In the first option to store fuel at another Duke plant's spent fuel pool, it is stated that no plant has long term capacity for both their fuel and CR3 fuel, and that dry storage at the receiving site would be necessary. Therefore, the most reasonable alternative for offsite shipping would be that fuel would be directly shipped to an ISFSI at another Duke site.

For the purpose of this analysis and discussion, the offsite shipping option, if chosen, would most likely be as follows:

- Site, Design, and Build ISFSI (or ISFSI extension) at the receiving site by 2023
- Fuel shipments from CR3 to receiving Duke site would begin in 2023 (although older fuel could be shipped sooner if an ISFSI pad is available to receive it)

- Fuel shipments would be complete at the end of 2024 (when newest fuel is ≥15 years old)

4.4 Assumptions

1) The Department of Energy (DOE) or a newly formed federal agency will ultimately take possession and dispose of the spent fuel. This is assumed for these purposes to occur in 2032 in accordance with Attachment 3 of the Options Analysis Report, with the last of the CR3 spent fuel assemblies being collected in 2036. Note that there is a great deal of uncertainty around any date for fuel removal. The Options Analysis Report states that fuel theoretically could be completely removed as early as 2024, or it could take until 2050 or later to get all fuel off site.

2) The current decommissioning timeline assumes major dismantlement activities commence after the spent fuel is removed from site (2036 per above assumption).

3) The Auxiliary Building structural steel upgrades required to meet the new loads related to the replacement crane and movement of the DSC's in the transfer cask applies to all options.

4) The steel platform work in the Decontamination Pit, which is required for welding the DSC covers prior to storage or shipment, applies to all options.

5) The installation of the new, single-failure proof fuel handling crane in the Auxiliary Building applies to all options. This modification is required to fulfill the commitment identified in FSAR Section 9.6.4.7, which states that CR3 will modify the Auxiliary Building crane to comply with single failure proof criteria prior to the first spent fuel cask lift.

6) Modifications for purge & welding gas lines to support a cask loading campaign apply to all options.

7) The onsite dry storage option in the existing design location is based on the approved ISFSI project, with the exception of number of DSCs/HSMs (46 instead of 80), and size of subsurface grouted area and ISFSI pad length (reduced to correspond with fewer DSCs/HSMs).

8) There are currently 1,319 fuel assemblies in the spent fuel pool, including 76 new assemblies. It is possible that the new fuel may be returned to the fuel manufacturer or shipped to another site. Additionally, the DOE has no contractual obligation to take possession of new fuel. However, as no decision has yet been made on the disposition of the 76 new fuel assemblies, they are assumed to be treated similar to the spent fuel, and are included in the total number of assemblies.

9) The ISFSI project plan and cost estimate includes activities for detection of failed fuel assemblies, as well as provisions for storage of failed fuel assemblies within the DSCs.

10) TLG has provided estimates that the ongoing O&M estimates for onsite wet storage will be approximately $29M/year, and approximately $10M/year for onsite dry storage. These numbers are based on security staffing levels provided by CR3, as well as non-security O&M cost data from other shutdown nuclear plants. See the economic analysis (Attachment 2) for additional information on estimated O&M costs.

11) The security staffing levels provided by CR3 to TLG are based on current plant design and planned security modifications for both wet and dry onsite storage. The impact of

reducing these levels, through benchmarking efforts and/or additional security modifications, is evaluated in a sensitivity case in the economic analysis.

12) If dry storage onsite is the selected option, it is assumed that construction will re-commence in 2014 and all fuel will be transported to the ISFSI pad by June 2018.

13) Costs for ISFSI demolition are consistent with the estimate provided in the 2011 CR3 Submittal of Program for Maintenance of Irradiated Fuel and Preliminary Decommissioning Cost Analysis.

14) It is assumed that the DSCs planned for use at CR3 will be licensed for transportation of spent fuel (currently under NRC review).

5.0 Qualitative Evaluation of Options Based on Selected Criteria

5.1 Industrial Safety

Definition: Industrial safety recognizes the radiological safety of both the public and workers, and the handling complexity of moving spent nuclear fuel.

Option 1, retention of fuel in the pool, was deemed the most advantageous option. It is understood that the fuel will ultimately be handled for offsite shipment with all three options. However, this option delays handling of the fuel, which allows time for radioactive decay and a lower source term for workers.

Option 2, dry fuel storage onsite, was seen as slightly less attractive than wet storage due to the increased fuel handling activities during the implementation of the dry fuel storage campaign vs. leaving the fuel in the pool. Also, an ISFSI entails a large construction effort involving heavy lifts, welding, concrete placement, subsurface grouting, and placement/compaction of structural fill. Although more opportunities exist in this option compared to Option 1 for an industrial safety event, the team recognizes that these construction activities can be accomplished safely using standard construction practices and experience.

Option 3, transporting the fuel offsite, was seen as the least attractive alternative, due to the additional handling, transportation and exposure of spent fuel to workers and the public. However, it should be noted that the NRC website (http://www.nrc.gov/waste/spent-fuel-transp.html) states “Over the last 40 years, thousands of shipments of commercially generated spent nuclear fuel have been made throughout the United States without causing any radiological releases to the environment or harm to the public.”

5.2 Regulatory Complexity

Definition: Regulatory complexity relates to the NRC requirements for spent fuel management in pools and dry storage, and considers federal and state transportation requirements for containers of spent fuel. The importance of this criteria is that regulatory complex projects are more prone to delays than projects that do not require multiple, complicated licensing actions.

Option 1, retention of fuel in the pool, has the potential for regulatory questions associated with CR3's spent fuel pool. CR3 utilizes Boral as the neutron absorbing material in the "B" pool spent fuel racks. The NRC may require testing of this material in the future to ensure adequate quantities of neutron absorber remain (CR3 is not currently required to perform testing of this material). It is also recognized that CR3 has notified the NRC of the intent to use dry fuel storage and received a license amendment related to upgrading the crane for the heavy loads.

Option 2, dry fuel storage onsite, was considered the most advantageous because of the relatively straightforward compliance to ISFSI requirements and licensing vs. the other options. Note that any regulatory issues related to the CR3 spent fuel pool apply to this option as well until all fuel is removed from the pool.

Option 3, transporting the fuel offsite, has the most regulatory complexity because of the increase of licensing activity involved with transportation packages and carrying out a transportation campaign. The DSCs chosen for fuel storage of CR3 ISFSI are not currently licensed for transportation. However, transport licensing these canisters is currently under NRC review with acceptance expected in the near future. Note that this option also would have similar regulatory issues as dry storage on site, since dry storage would be built at the receiving facility. Also note that any regulatory issues related to the CR3 spent fuel pool apply to this option as well until all fuel is removed from the pool.

5.3 **Flexibility and Adaptability**

Definition: Options that preserve the ability to deal with the evolving interface with the federal government are rated the highest.

The federal policy for spent fuel management is presently changing and uncertain, so the timing and mode of pickup by DOE is not yet known.

Option 1, retention of fuel in the pool, is considered the most advantageous. Leaving the spent fuel in the pool provides the most flexibility for future contractual and programmatic requirements for storage and shipment, as the shipping container would be selected based on DOE requirements.

Option 2, dry fuel storage onsite was seen as the least favorable option. Current dry shielded canisters may not meet future transportation requirements. The federal government is not, at present, contractually bound to accept fuel from the site in DSCs and this could lead to the need to open the DSCs and put the fuel into different containers for transportation offsite. The fuel may also need to be repackaged if material degradation or other issues develop with the DSCs. If the spent fuel pool is decommissioned/dismantled prior to removal of fuel from the site, the ability may be lost to remediate dry storage problems or repackage the fuel onsite. However, this is only a concern if early decommissioning is planned. Though not an NRC requirement, CR3 intends to maintain the ability to recover the functionality of the spent fuel pool (or other approved contingency) until all spent fuel is removed from site, thereby addressing this concern.

The DOE standard contract may require pick up and transfer of spent fuel in a DOE-provided cask that has yet to be developed. It is clearly recognized by the DOE and the industry that many sites have already implemented an ISFSI and removed their spent fuel pools. It is reasonable to expect appropriate accommodations will be provided by an interim or final repository.

A review of dry cask storage operating experience has identified multiple fabrication, welding, and loading issues that were discovered and resolved prior to placing the canisters in storage. Only a few issues were identified during the storage phase – such as blocked air vents or leaking seals – all of which were rectified without the need to repackage the fuel. Therefore, the probability of needing to repackage the fuel is considered small.

Although not specifically written for spent fuel storage containers, NRC Information Notice 2011-20 addresses concrete degradation by Alkali-Silica Reaction (ASR) at Seabrook Station. This IN is applicable to the concrete storage modules planned for use at CR3. The Vendor's specification for the HSMs addresses this concern by performing the proper ASTM tests to ensure that only non-reactive aggregates are used in the construction of the modules.

If for some reason the spent fuel pool cannot be recovered, options exist for addressing a leaking DSC or the need to repackage fuel. A dry transfer system could be utilized to repackage fuel without the use of a pool. Although such a system has yet to be licensed at a domestic reactor site, the NRC has reviewed the design and has issued an Assessment Report for a dry transfer system, and has identified what additional information would be required for site-specific licensing. Therefore, although not required if the spent fuel pool remains a viable option for potential repackaging of spent fuel as discussed above, the framework is in place for pursuing a dry transfer system if needed. Other options such as placing the DSCs in transport casks and shipping to other sites, or transferring a leaking DSC to a new HSM with a secondary leak-tight container, also exist.

Option 3, transporting the fuel offsite was viewed as neither the best nor worst alternative with respect to flexibility. Though transporting fuel to an offsite ISFSI without a spent fuel pool would not provide more flexibility than an onsite ISFSI, transportation to another site with a spent fuel pool (e.g. Oconee or Harris) would preserve the ability to meet future regulatory requirements (i.e. allows repair of stored canister or repackaging into a different canister for ultimate disposal, if required).

5.4 **Public Acceptance**

Definition: This criterion recognizes the need to gain public confidence that any option for spent fuel management will protect public health and safety, security, and the environment. A project that is well understood and accepted by the public is much more likely to be successful and have fewer barriers to successful completion.

Option 1, retention of the fuel in the pool was not viewed as highly as dry storage onsite because of perception by some members of the public and some legislators that dry fuel storage is safer than storage in the pool. However, it should be noted that "The NRC believes spent fuel pools and dry casks both provide adequate protection of the public health and safety and the environment. Therefore, there is no pressing safety or security reason to mandate early transfer of fuel from pool to cask." (Ref. NRC web site http://www.nrc.gov/waste/spent-fuel-storage/faqs.html).

Option 2, dry fuel storage onsite, is considered the most advantageous due to current public perception of dry storage providing greater personal and environmental safety than wet storage. Perceived spent fuel pool safety issues raised in conjunction with the Fukushima accident make dry storage preferable to some lawmakers also, though the Fukushima issues associated with spent fuel cooling are not applicable to the CR3 spent fuel pool. In fact, the decay heat of the CR3 fuel has dropped sufficiently that even in the extremely unlikely scenario of a complete loss of spent fuel pool water, air cooling will be adequate to prevent extensive zircaloy oxidation and cladding failure.

Option 3, transporting the fuel offsite was seen as the least desirable due to the high potential for interveners and media concerns associated with spent fuel shipping.

5.5 Qualitative Evaluation Results

The below table summarizes the relative ranking of the three options for each of the criteria described above.

	Industrial Safety	Regulatory Complexity	Flexibility / Adaptability	Public Acceptance
Option 1: Wet Storage	1	2	1	2
Option 2: Dry Storage	2	1	3	1
Option 3: Offsite Storage	3	3	2	3

The results indicate that Option 1 (onsite wet storage) and Option 2 (onsite dry storage) are comparable options, with Option 3 (offsite storage) being much less attractive. Prior to performing a detailed economic analysis, further discussion of Option 3 is warranted.

6.0 Discussion of Offsite Shipping Option

The offsite shipping option includes the following:

- Site, Design, and Build ISFSI (or ISFSI extension) at receiving site by 2023
- Fuel shipments would begin in 2023
- Fuel shipments would be complete at the end of 2024 (last fuel shipped after 9/2024 to allow 15 years of cooling)

Generally speaking, the offsite shipping scenario described above includes many of the same costs as the dry fuel storage Option 2, such as:

- Auxiliary Building Mod costs
- Site, design, permit, and build an ISFSI (actual costs will differ from CR3 due to site-specific conditions and requirements)

- Contractor pool to truck services at CR3
- Contractor installation equipment
- DSC/HSM costs (42 DSCs for fuel, plus 4 DSCs for non-fuel items)

Additional Costs in the offsite shipping option that were not a part of the dry fuel storage option include:

- Transportation of spent fuel ($31 million - shipping only, from Contractor quote)
- Higher O&M/Security costs from 2019 through 2024 (~$20 million/yr x 6 years per preliminary estimates) due to the need to maintain wet storage until all fuel is shipped.
- 2 HSM canister transfer stations at each site (from Contractor estimate) – this would include design and construction of these facilities.
- Contractor fuel handling and on-site transfer at receiving site (e.g. transfer cask, ancillary equipment, and labor)
- Rail car costs
- Transportation planning and permitting costs
- Environmental Permitting costs (for new ISFSI at receiving site, and for transfer stations)

The primary benefit of selecting the offsite shipping option would be that all fuel is off site earlier than would be the case for the remaining options. This would allow a cost reduction in on-site labor after all fuel is offsite. In this offsite shipping scenario, all fuel is offsite at the end of 2024, and cost savings would be seen starting in 2025. To determine whether the offsite shipping option merits further consideration, a simplified cost analysis is performed below to compare the expected savings against the extra costs required to implement this option.

Expected Cost Savings for Offsite Shipping

(Note: All monetary values in next three paragraphs are quoted in 2013 dollars)

Preliminary estimates are that the cost per year for CR3 to remain in dry storage is approximately $15 million. Preliminary estimates for the cost per year for CR3 to be in a dormant condition after all fuel is offsite is $8.5 million. This means that the offsite shipping option would save CR3 $6.5 million per year starting in 2025. The yearly costs savings would apply over a 12 year period from 2025 through 2036, which is the date the DOE is assumed to remove the last of the spent fuel from site in the on-site storage alternatives (See Ref. 2 for basis). This yields a cost savings of $78 million in years 2025-2036. Costs to implement the option should be compared to this anticipated cost savings.

Expected Costs for Offsite Shipping

From preliminary estimates, the differential O&M cost between Alternate Wet Storage and Dry Storage is approximately $20 million per year, after full implementation of all modifications for both options. Therefore, in this offsite shipping scenario and under the current assumptions, since the plant would be in a wet storage configuration until the last fuel assembly is removed from site, an additional O&M cost of $120 million would be incurred (based on 6 years of wet storage between the projected ISFSI implementation date (early 2019) and the last fuel assembly removal date (late 2024)). In addition to this cost, the transportation of spent fuel would add $31 million (basis – Contractor quotation). That brings

the added cost from associated with the offsite shipping option to >$150 million between years 2019 and 2024 before considering design and construction of HSM transfer facilities at CR3 and at the receiving site, fuel handling on site, transportation planning and permitting costs, environmental permitting, rail car costs, etc.

Elimination of Offsite Shipping Option:

Without including costs for the items above that are not yet estimated, it can be seen that costs are already greater than $150 million in years 2019 through 2024, which far exceeds the expected costs savings of $78 million, in years 2025-2036. Considering this simplified cost comparison, and considering the low ranking during the qualitative assessment, this option will be eliminated from further consideration and will not be included in the detailed economic analysis by Investment Engineering.

7.0 Economic Analysis

An economic analysis of Options 1 and 2 was performed as a separate activity and is not included in this analysis (See Attachment 2).

8.0 Conclusion and Recommendation

Based on the qualitative evaluation of the selected criteria, the team has identified that wet storage and dry storage (ISFSI) each meet the project requirements and are comparable options for spent fuel management. The final recommendation should consider the economic analysis to determine which option is most cost effective for the company.

9.0 References

1. Crystal River Nuclear Station Spent Fuel Storage Decision Business Case, dated 10/4/13 w/ 11/21/13 update (Attachment 2 of this Report)
2. Estimation of Pickup Date for Crystal River 3 Used Fuel, dated 9/27/13 (Attachment 3 of this Report)
3. CR3 Passport Action Request 624976, AI-4003 Business Case Decision Analysis, Spent Fuel Pool Cooling Options

Spent Fuel Management
Options Analysis Report
Crystal River Unit 3 Nuclear Plant

Attachment 2
Business Case

Spent Fuel Storage Decision
Crystal River Nuclear Plant
Initial Business Case

BACKGROUND

The original purpose for the Independent Spent Fuel Storage Installation (ISFSI) Project was to enable the then operating Crystal River Nuclear Plant (CR3) to maintain full core offload capability by allowing older spent fuel to be removed from the spent fuel pool and placing it in dry storage. The capability to fully offload the core would have been lost after the Refueling Outage (RO)-17, which was scheduled to take place in the fall of 2011. Dry storage was necessitated because even though the Department of Energy (DOE) is contractually obligated to remove the fuel from the site, they have been in partial breach since 1998. There is no active DOE spent fuel management program and, therefore, no definitive schedule for DOE to begin removing the fuel from the site.

During RO-16 the containment building had multiple delamination events occur, which resulted in an extended plant outage. This delayed the ISFSI project due to schedule and resource constraints, as well as an extension of the time when full core offload would be lost. Due to the extended outage the Senior Management Committee decided (February 22, 2012) to suspend the ISFSI project while the evaluations were being conducted on the repair options for the containment building. A suspension plan was developed to provide the details needed for the re-start of the ISFSI project, when appropriate. On February 5, 2013 the company announced that CR3 will be decommissioned. As part of the decommissioning activities, the ISFSI Project was authorized to validate original assumptions regarding the capacity and location of the ISFSI, develop a class 3 cost estimate, and update project schedules.

The ISFSI was originally sited and designed to support an operating unit through the period of extended operation, but the cessation of operations changed the original purpose of the project. With no additional fuel being generated, only the existing fuel requires long term storage. Earlier decision analysis resulted in the identification of two primary spent fuel management options which required further detailed cost analysis. This business case provides an evaluation of the two primary alternatives for storage of the Crystal River fuel: (1) build and store the spent fuel on an ISFSI (dry storage) constructed at CR3 and (2) maintain the spent fuel in its current residence in the spent fuel pool (wet storage). Both options keep the fuel at the Crystal River site prior to presumed eventual DOE removal.

The ISFSI project team and various subject matter experts, identified uncertainties that could impact the alternative that would be most beneficial to the company. Some of these uncertainties will have a fairly short term resolution and for some the resolution time is uncertain. In light of these uncertainties, the purpose of this analysis is to develop an order of magnitude economic comparison between the primary spent fuel management options. A listing of the key uncertainties that have been identified and the proposed means for mitigating them is provided below:

1. Final results from the 2013 TLG Services (TLG) Decommissioning Cost Study are not yet available as inputs into the this financial analysis. Estimates of O&M costs associated with both the wet and dry storage options were provided by TLG using the best information available at this time. When the final Decommissioning Cost Study is issued an evaluation will be performed to determine if the financial evaluation should be updated.
2. The operations and maintenance costs provided for analysis are much higher than the average costs provided by other shutdown nuclear plants. There is ongoing analysis that may allow the modeled security costs to be lowered. Security costs are a significant driver of long term costs, and could be better characterized after looking at potential station modifications and operating experience (OE) from other sites. As a result, a sensitivity analysis was performed to evaluate potentially lower wet storage ongoing operating costs.
3. Tax issues that may change the source of funding for the projects contained in this analysis are not fully understood at this time. The source of funding for projects, nuclear decommissioning trust fund (NDTF) versus corporate funds, may have a significant effect on the outcome of the financial analysis. Corporate Tax is pursuing resolution to this issue.
4. As noted above, there are significant uncertainties regarding the timing of DOE removing fuel from the Crystal River site both in terms of start and end dates. Therefore several different DOE fuel pickup date scenarios were evaluated as part of this analysis.
5. ISFSI Location – This business case uses the ISFSI cost inputs assuming the location originally contemplated (inside the protected area). There are ongoing discussions regarding the potential re-siting of the ISFSI to be more conducive to a decommissioning plant rather than an operating plant. The ISFSI design, licensing and construction cost inputs will be different if the decision is made to relocate the ISFSI. As a result sensitivity analysis was performed to evaluate potential relocation of the ISFSI.

DESCRIPTION OF ALTERNATIVES

Alternative 1 (Long Term Dry Storage of Spent Fuel in an On-site ISFSI)

The Crystal River 3 Dry Spent Fuel Storage Project will design and construct a new ISFSI to safely store spent fuel in licensed storage canisters until DOE removes the fuel from the site. This ISFSI is assumed to be at the original location inside the protected area.

Advantages:

- Dry storage is a passive cooling system which requires little interaction, monitoring, or active support equipment apart from ongoing security requirements. Cost associated with on-going storage operations, once the fuel is loaded, are relatively low.
- Dry storage is a stable storage configuration utilized by most other decommissioned plants.
- If fuel remains on site beyond the decommissioning delay period, an ISFSI would allow the rest of the site to be returned to greenfield, leaving a smaller final foot print and smaller area to maintain until DOE picks up fuel.
- Dry storage would likely provide the quickest way to remove all the fuel from the spent fuel pool as compared to possible DOE performance, which may provide an economic advantage by allowing a more rapid reduction in the security force.

Disadvantages:

- There are large initial costs to build the storage facility (ISFSI) and procure and load the canisters versus maintaining the fuel in the spent fuel pool which does not require large site modifications.
- Licensees are required to maintain the ability to unload a canister if needed. Once the fuel is unloaded, and the spent fuel pool is dismantled, a contingency plan needs to be developed to reopen a canister.
- There could be potential issues with DOE picking up canistered fuel or fuel in canisters not licensed for transportation. This would require repackaging the fuel into a container suitable for transportation – a challenging proposition without an on-site spent fuel pool.

Alternative 2 (Long Term Wet Storage of Spent Fuel in the Spent Fuel Pool)

This option represents the status quo in that it would leave the Crystal River spent fuel in its current location in the spent fuel pool indefinitely until eventual pick-up by DOE or some other option that may present itself in the interim. This option requires the maintenance of an active cooling system. For equipment and security purposes this option would consolidate the pool and its supporting equipment into a “nuclear island” concept. The “nuclear island” includes modifications to the spent fuel pool cooling system to reduce its locations in the plant and ongoing operations and maintenance costs.

Advantages:

- Lower upfront costs because fewer modifications are required immediately.
- Provides greater flexibility in that it maintains all options indefinitely (including dry storage) and would allow implementing the dry storage alternative if later warranted.
- Requires no specific licensing action by NRC as it represents the current status.
- Relatively simple to implement.
- Requires little to no handling of fuel to transition into long term storage mode.

Disadvantages:

- Higher long term O&M costs (currently estimated at approximately $20M/year greater than dry storage) due to the need to maintain spent fuel pool cooling equipment plus higher expected security costs.
- Eliminates the option to decommission the fuel storage building and other areas of the plant that provide physical or mechanical support to the spent fuel pool until all fuel is removed from the pool if decommissioning of the site is pursued prior to removal of all fuel.
- If wet storage is chosen now, but dry storage is decided on later, the knowledge base of the ISFSI Project team will be lost.

KEY ASSUMPTIONS

1. Rates used in financial analysis associated with building the ISFSI. Corporate funds will be used to construct an ISFSI because guidance from the Tax Department indicates that capital costs associated with modifying or building additional wet storage, or the building of an ISFSI would be deductible under IRC §165. If the Company expects to seek DOE reimbursement related to such costs, then they would not be eligible for reimbursement from the qualified nuclear decommissioning trust fund.
    - Composite Tax Rate PEF: 38.58%
    - Allowance for Funds Used During Construction (AFUDC): 6%
    - Escalation Rate: 2.5% for project costs
    - PEF Hurdle Rate: 6.4%
    - Property Tax Rate: 0.157387%, provided in letter to Mr. William A. Cloutier (TLG) from Christopher A. Rop on September 18, 2013.

2. Discount Rate of 4.87% applied for financial analysis of items paid for from the NDTF provided by John Heffernan (Corporate Finance). All items not associated with construction of the ISFSI are assumed to be paid for from the NDTF.

3. Wet and dry storage ongoing operating costs were estimated by TLG Services using data provided by CR3 as well as industry data. Wet storage costs include: security, utility staff, Site O&M (non-labor), Spent Fuel Pool O&M (non-labor) purchased electricity, Nuclear Insurance, NRC fees, Health Physics supplies,

disposal of dry active waste (DAW) generated, property taxes, Emergency Planning fees, maintenance supplies and bituminous roof replacement. Dry fuel storage costs include: security, utility staff, Site O&M (non-labor), purchased electricity, Nuclear Insurance, NRC fees, Health Physics supplies, disposal of DAW generated, property taxes, Emergency Planning fees, maintenance supplies, bituminous roof replacement and ISFSI O&M (non-labor). To account for potential changes in these figures, this Business Case includes sensitivity analysis related to estimated wet storage costs.

These estimates are not final and are likely to change when then the final TLG cost study is complete. These costs represent total site O&M costs under each scenario.

Wet Storage (2013 $'s)
$35,067,820/year (security = $15.7M/year of the total)

Dry Storage (2013 $'s)
$14,967,749/year (security = $4.6M/year of the total)

4. Assumed dates for all fuel shipped off site – These dates were taken from the recommendations in "Estimation of Pickup Date for Crystal River 3 Used Fuel", Revision 1, dated September 27, 2013, by S. P. Nesbit.
   2024 – Earliest date considered feasible based on pilot consolidated storage scenario.
   2036 – Either a protracted consolidated storage scenario or a nominal Yucca Mountain scenario.
   2050 – Based on DOE's stated intention of having another repository in service by 2048.

5. Estimates for the ISFSI construction and wet storage project costs (does not include ongoing O&M) were provided by the CR3 ISFSI Project team.

6. Estimates for the ISFSI decommissioning and dismantling costs (license termination and site restoration) were provided by TLG.

7. Potential reimbursement from the DOE associated with spent fuel storage costs was not considered in the financial evaluation.

FINANCIAL ANALYSIS and RESULTS

The base dry storage and wet storage options were analyzed assuming a 2024, 2036 and 2050 date for all fuel removed from the site by DOE. Three dates were analyzed because the date of final DOE removal of all fuel from the site is a key variable affecting the relative cost of the two spent fuel storage options.

	TPC*	2024 Fuel Offsite** NPV (2013 $'s)	2036 Fuel Offsite** NPV (2013 $'s)	2050 Fuel Offsite** NPV (2013 $'s)
Base Dry Storage	($183,450,000)	($202,577,243)	($324,410,813)	($428,076,127)
Base Wet Storage	($33,237,765)***	($229,163,534)	($506,172,450)	($746,539,677)
Delta NPV (Dry Storage minus Wet Storage)		**$26,586,291**	**$181,761,637**	**$318,463,550**

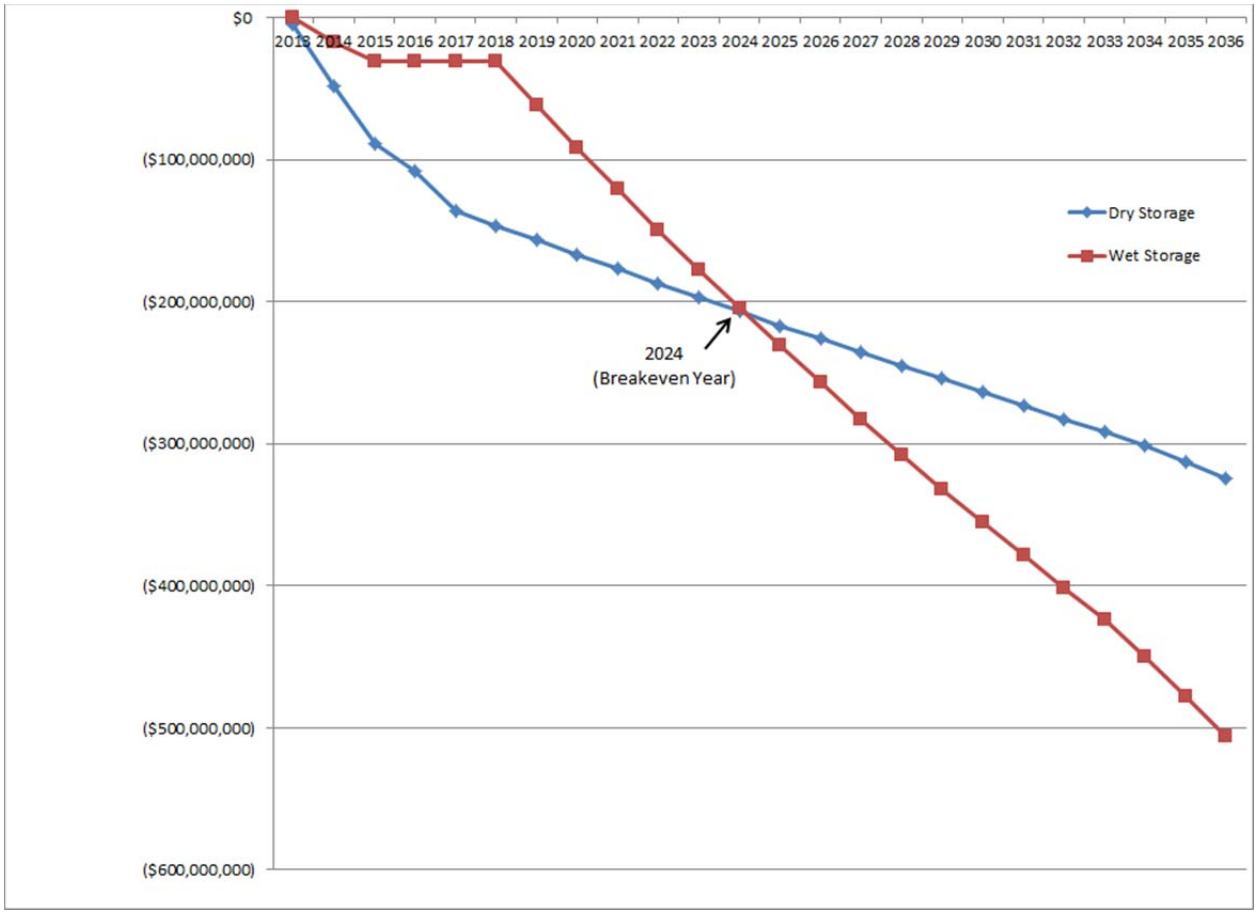
*Total Project Costs excluding AFUDC. TPC does not include ongoing O&M costs.
**Net Present Values (NPV) exclude allocations, stores loading and AFUDC; NPVs are in 2013 dollars.
***This cost estimate includes nuclear island, fuel handling crane and Auxiliary Building modifications.

The table above for the Base Dry Storage and the Base Wet Storage options shows that the Dry Storage case is $26.6M favorable in 2024, $181.8M favorable in year 2036 and $318.5M favorable in year 2050.

See pages 11-14 for updated results based on latest TLG cost estimate

The cumulative NPVs were calculated for each year of the study period for the wet and dry storage alternatives. The cumulative NPV chart below represents the break-even point where Dry Storage vs. Wet Storage becomes more favorable. The break-even point using Base Dry Storage and Base Wet Storage assumptions is year 2024. This shows that, using the base assumptions, if DOE has not removed all fuel from the CR3 site by 2024, Dry Storage is the most cost effective option. As noted above, however, there are also non-economic considerations that must be considered for either option.

Cumulative NPV
Dry Storage vs. Wet Storage



SENSITIVITY ANALYSIS

Sensitivity analyses were performed to show the potential effect of certain uncertainties that have been identified on both the dry and the wet storage options. Sensitivities were analyzed at the 2036 all fuel off site date because this is considered the reasonable median date for complete removal of fuel by the DOE.

If sensitivities were evaluated at a different date for all fuel removed from the site, some variables would make the wet storage option favorable compared to dry storage.
The sensitivity tables below show that for all the sensitivities addressed dry storage is the most cost effective option.

ISFSI Sensitivities:

- Change location of the ISFSI – Construction of the ISFSI was moved out 2 years, $35M additional costs were added in each of the first two years to simulate the estimated additional costs associated with moving the ISFSI.
- Cost increase of 25% for ISFSI construction.

Case	2036 ISFSI Option*	2036 Base Wet*	ISFSI minus Wet Storage
Base ISFSI	($324,410,813)	($506,172,450)	$181,761,637
Move ISFSI outside PA	($374,798,993)	($506,172,450)	$131,373,457
ISFSI cost increases by 25%	($348,387,641)	($506,172,450)	$157,784,809

*Net Present Values (NPV) exclude allocations, stores loading and AFUDC; NPVs are in 2013 dollars.

Wet Storage Sensitivities:

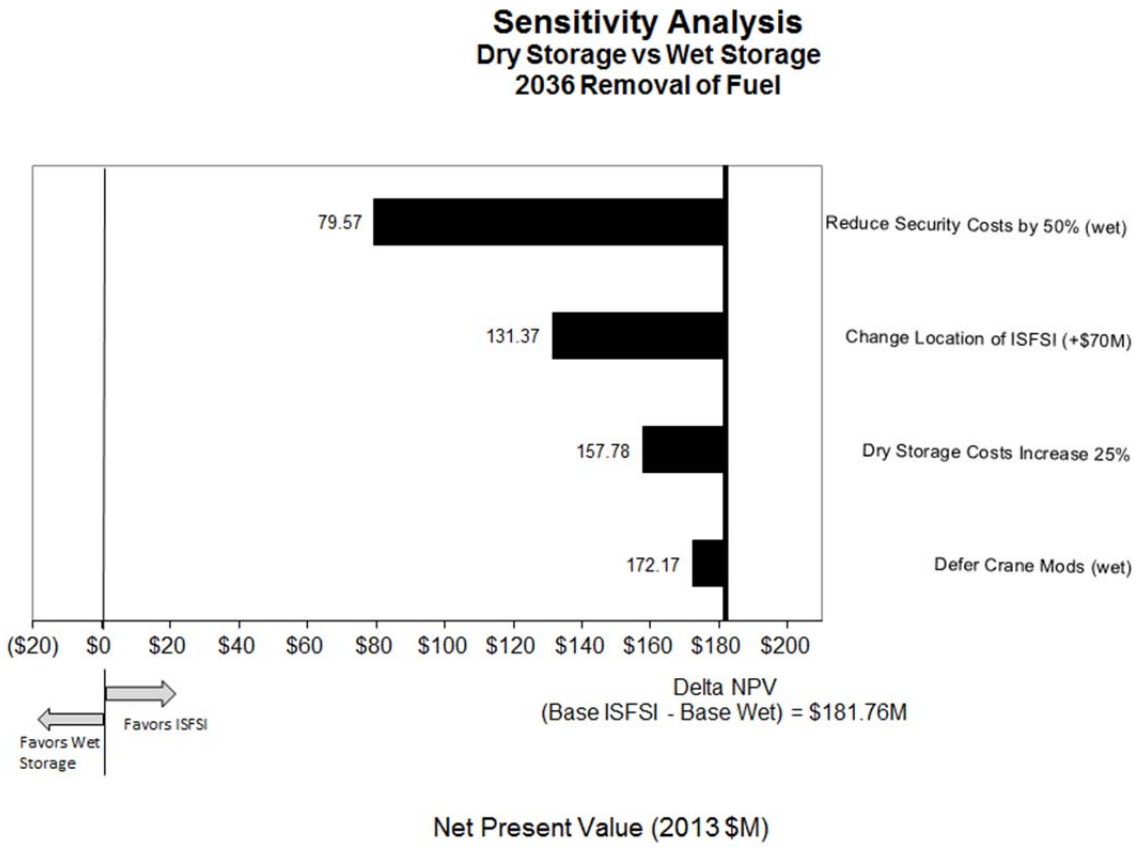
- Decrease yearly security costs by 50% ($7.9M/year decrease). Security costs account for approximately 45% of the ongoing operating and maintenance costs assumed in the base wet storage analysis.
- Defer modifications to the fuel handling crane and auxiliary building – Modifications were deferred until the 2 years directly before removal of the fuel from the site.

Case	2036 Wet Option*	2036 Base ISFSI*	ISFSI minus Wet Storage
Base Wet	($506,172,450)	($324,410,813)	$181,761,637
Reduce security costs by 50% from ongoing O&M (Wet)	($403,977,145)	($324,410,813)	$79,566,332
Defer Crane Mods (Wet)	($496,577,240)	($324,410,813)	$172,166,427

*Net Present Values (NPV) exclude allocations, stores loading and AFUDC; NPVs are in 2013 dollars.

The below tornado chart (Sensitivity Analysis) is based on a delta NPV between the base dry storage and the base wet storage alternative (+181.76M); represented by the vertical line in the below chart. It is at this point that each sensitivity item will be evaluated to determine the impact to the overall decision (bars moving to the right from the vertical line represents a greater favorable delta for the dry storage alternative when compared to the wet storage alternative; bars moving to the left of the vertical line, without crossing the $0 point, still represents a favorable delta for the dry storage alternative, but reflects the value that is being eroded for the dry storage alternative). However, no single sensitivity item had an impact that would cause a change in the overall decision (crossing at the $0 point).

The largest single sensitivity (driver) was the reduction of security costs by 50% for the wet storage alternative. Even with the assumed 50% reduction in security costs dry storage is still the favorable option over wet storage.



INVESTMENT ENGINEERING RECOMMENDATION

The economics are favorable for building an ISFSI over the wet storage option based on the assumptions stated in this analysis. The economics are also favorable for building an ISFSI in all of the sensitivity cases that were analyzed. Sensitivities were analyzed at the 2036 all fuel off site date because this is considered the earliest likely date for complete removal of fuel by the DOE. DOE removal of all fuel from the site by 2024, which represents the breakeven between the wet and dry options is considered a highly unlikely date. As discussed previously, there are many uncertainties associated with this analysis. Some of these uncertainties have the potential to be resolved in the fairly short term, specifically:

- Draft TLG Decommissioning Cost Study will be complete in October 2013
- CR3 Security is pursuing industry OE to determine if assumed costs can be reduced
- Tax issues associated with the decommissioning trust fund will be understood
- location of the ISFSI can be validated

Other uncertainties, such as the date of DOE removal of fuel from the site, are unlikely to be resolved. While some reduction in pickup date uncertainty could occur over the next several years, at least some will inevitably remain.

This evaluation shows that building an ISFSI is the favorable option, given the inputs and assumptions included herein. It must be recognized that as the uncertainties are resolved the analysis results may be impacted, however, based on the sensitivities that were evaluated it is currently believed that it is unlikely that the ISFSI option would become unfavorable.

Prepared By: Matt Slupilla Date: 10/4/13

Approved By: James M. Baughman, Jr. Date: 10/4/13

CR3 Wet vs. Dry Fuel Storage Decision

This form is to document either the exemption of the BM-500 graded approach requirement for a detailed business case or the additional review of the previously approved economics for an existing business case due to changes in project scope, schedule, cost, or performance. Some examples of these exceptions are: nuclear fuel, preventive maintenance, required inspections (such as reactor vessel ISI), emergency work, and like for like replacements (equipment broken or worn out). The exception is due to the assumption that the expenditure is required to operate the unit, with no options available to evaluate.

☐ Business Case Exemption

Check all of the following that apply:

- ☐ Project is already approved and in progress with committed resources, contracts, & or funding.
- ☐ Project has already had regulatory commitments made dictating the detailed scope, schedule, & costs.
- ☐ Project is emergency work, a like for like replacement, & or preventive maintenance.
- ☐ Project does not have any delay, non-modification, or "Do Nothing" options.
- ☐ Project has no additional technical options of significance for the design & or products used.

Comments:

■ Business Case Additional Review

Comments:

See attached discussion of revised input assumptions.

Prepared By: Mary Shipley Date 11/21/2013

Approved By: Mitch Baughman Date 11/21/2013

Re-Assessment of the Crystal River Nuclear Plant Wet Storage vs. Dry Storage Business Case

The October 4, 2013, Spent Fuel Storage Decision, Crystal River Nuclear Plant Initial Business Case, committed to re-assess the business case results to determine if the final TLG Services (TLG) Decommissioning Cost Study would change the recommendation of the business case. This re-assessment is based on the Site-Specific Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant, Rev. B, dated November 2013.

The specific inputs to the business case that have changed from the original business case are:

- Discount Rate of 4.87% applied for financial analysis of items paid for from the NDTF provided by John Heffernan (Corporate Finance) has been updated to 5.10%. Provided in 11/13/2013 email from John Heffernan.

- Revised O&M values provided by Sheila Westcott in 11/21/2013 email

	Initial Business Case	**Revised Estimate**
Wet Storage	$35,067,820 (security = $15.7M/year of the total)	$29,033,546 (security = $12.1M/year of the total)
Dry Storage	$14,967,749 (security = $4.6M/year of the total)	$10,026,817 (security = $3.4M/year of the total)

- ISFSI decommissioning and dismantlement cost from Site-Specific Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant, Rev. B, dated November 2013 is now $3.9M (previously $2.5M).

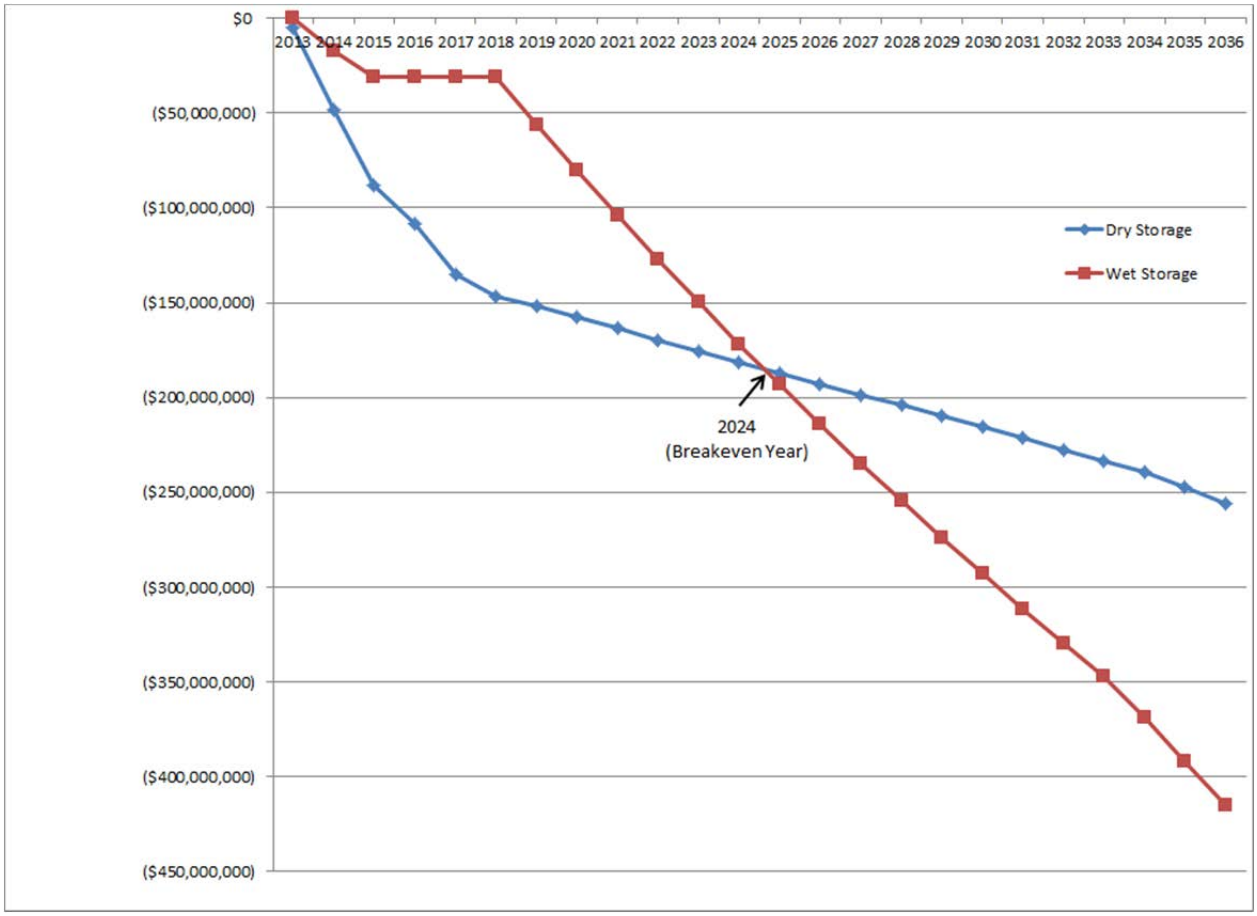
Evaluation of the base dry versus base wet scenarios were evaluated for year 2036 using the updated input assumptions.

	Original Business Case 2036 Fuel Offsite NPV (2013 $'s)	**Revised Analysis** 2036 Fuel Offsite NPV (2013 $'s)
Base Dry Storage	($324,410,813)	($256,163,819)
Base Wet Storage	($506,172,450)	($415,361,363)
Delta NPV(Dry Storage minus Wet Storage)	**$181,761,637**	**$159,197,544**

The above table shows that with the updated assumptions that the delta NPV was reduced by $22.6M from the original business case assumptions; Dry Storage case is still favorable by $159.2M.

The original business case showed that the break-even point using Base Dry Storage and Base Wet Storage assumptions was year 2024. Using the new assumptions the break-even point remains in 2024.

Cumulative NPV
Dry Storage vs. Wet Storage



Based on the above evaluation of the updated input assumptions, the conclusions in the October 4, 2013, Spent Fuel Storage Decision, Crystal River Nuclear Plant Initial Business Case remain valid.

Wet vs Dry Storage Cost Breakdown

Crystal River 3 Wet v. Dry Storage Steady-State Carrying Costs	Annual Costs with Contingency			
	Wet	Dry	Difference	% of total
Security	$12,120,831	3,433,372	$8,687,458	46%
Utility Staff	$9,136,321	2,865,036	$6,271,285	33%
Site O&M (non-labor)	$3,640,279	1,933,868	$1,706,411	9%
Spent Fuel Pool O&M (non-labor)	$900,795	0	$900,795	5%
Purchased Electricity	$222,357	$111,171	$111,186	1%
Nuclear Insurance	$572,569	$527,286	$45,283	0%
NRC Fees	$324,431	$310,045	$14,386	0%
Health physics supplies	$278,009	$128,470	$149,539	1%
Disposal of DAW generated	$23,110	$10,419	$12,691	0%
Property Taxes	$1,448,421	$233,631	$1,214,790	6%
Emergency Planning Fees	$96,255	$96,248	$7	0%
Maintenance supplies	$172,510	$172,498	$12	0%
Bituminous roof replacement	$97,308	$97,301	$7	0%
Florida LLRW Inspection Fee	$353	$160	$193	0%
ISFSI Operating Costs		$107,314	($107,314)	-1%

Totals	$29,033,546	$10,026,817	$19,006,729	

Spent Fuel Management
Options Analysis Report
Crystal River Unit 3 Nuclear Plant

Attachment 3

Estimation of Pickup Date for Crystal River 3 Used Fuel

Estimation of Pickup Date for Crystal River 3 Used Fuel
September 27, 2013

Original Prepared by: S. P. Nesbit (July 12, 2013)

Reviewed by: R. S. Edwards, J. I. Glenn, R. K. Nader, L. S. Nichols, M. B. Sewell, M. H. Shipley, F. J. Verbos, G. R. Walden

Revision 1 Prepared by: S. P. Nesbit (September 27, 2013)

Reviewed by: R. S. Edwards, J. I. Glenn, R. K. Nader, L. S. Nichols, M. B. Sewell, M. H. Shipley, F. J. Verbos, G. R. Walden, Sheila Westcott

Purpose

Provide an estimate or estimates of the date by which all used fuel will be removed from the Crystal River site by the Department of Energy (DOE). The estimate or estimates will be a key input into cost analyses of alternatives for spent fuel management at Crystal River.

In addition, provide perspective on the degree of uncertainty associated with the aforementioned estimate or estimates, and provide recommendations for dealing with the uncertainty.

Revision 1 (i) updates and clarifies the body of the document and (ii) adds Appendix A to provide a recommended date for fuel pickup for use in the CR3 Decommissioning Plan.

Background

In February 2013 Duke Energy notified the Nuclear Regulatory Commission (NRC) of Duke Energy's intent to cease power operation of the Crystal River Unit 3 (CR3) nuclear power reactor (Reference 1). Since that time, Duke Energy has established a Crystal River Decommissioning Transition Organization and begun the decommissioning planning process. Nuclear power plant decommissioning cannot be completed until all used nuclear fuel and Greater Than Class C ("GTCC") radioactive waste is shipped offsite. Removal of used fuel and GTCC waste is a responsibility of the Department of Energy (DOE), as discussed below. DOE currently has no schedule or plans to remove used fuel from CR3 or any other nuclear power plant. A key factor in decommissioning planning is establishing a used fuel management plan, with the primary options being (i) continued onsite storage in the spent fuel pool (wet storage), (ii) transfer of the used fuel into dual purpose storage and transportation systems[1] emplaced on

[1] This paper uses the terminology "dual purpose systems" to refer to dry storage systems that are also designed and licensable for offsite transportation. For canister systems like the NUHOMS-32P,

an independent spent fuel storage installation (ISFSI) on the CR3 site, and (iii) offsite transport of the used fuel to wet or dry storage on another Duke Energy site. With respect to onsite storage, wet storage has higher annual costs (maintaining the spent fuel pool and associated systems and providing security) while dry storage has higher upfront costs (construction of the ISFSI and purchase of the dual purpose systems). Therefore, an economic comparison of used fuel management options requires an estimate of how long the used fuel must be stored prior to removal by DOE.

The Nuclear Waste Policy Act of 1982 (NWPA) (Reference 2) established DOE responsibility for management and disposition of used fuel from commercial nuclear power reactors in the United States. Pursuant to the NWPA, DOE entered into Standard Contracts[2] with all domestic nuclear power plant operators. Key elements of the contracts included the following.

- Periodic payments from power plant operators to DOE at a rate of $0.001 per net kilowatt-hour of nuclear electricity generated.
- One-time fees covering nuclear electricity generation prior to the beginning of the periodic payments.
- A commitment from DOE to begin removing used fuel from reactor sites in 1998.
- Terms and conditions for the removal of the fuel.

Duke Energy and its predecessors and all other nuclear power plant operators in the United States have fulfilled their obligations under the contract; DOE has not. DOE has yet to remove used fuel from a United States reactor site in accordance with a Standard Contract. When it became apparent that DOE would not fulfill its contracts, nuclear power plant operators sued the government. DOE used a variety of legal arguments to avoid liability for its failure to perform. However, the courts have consistently found DOE to be in partial breach of its contracts and ordered the government to pay damages to the contract holders for expenses incurred as a result of the partial breach. Typically, these damages are costs arising from onsite used fuel storage (e.g., costs associated with dry storage of used fuel as onsite fuel pools filled to the point of losing full core reserve capacity). Some utilities settled with DOE and thereby established a mechanism for annual reimbursement of reasonably incurred damages; others have not settled and must periodically file lawsuits to collect damages. There has been no settlement under the CR3 contract; a round of litigation is ongoing for CR3 cost recovery for the period from January 1, 2006 through December 31, 2010.

The NWPA, as amended, directed DOE to develop a geologic repository for the disposal of used fuel at Yucca Mountain, Nevada. This would involve obtaining a construction authorization from the NRC, constructing an underground repository and associated surface facilities, obtaining an operating license from the NRC, and transporting used fuel from reactor sites to the repository for ultimate disposal. In addition, DOE made efforts in the late 1980s and early 1990s to develop a monitored retrievable storage facility (MRS) for used fuel. The intent was to begin shipping fuel from reactor sites to the MRS, where it would remain until the repository could accept it. However, DOE was not able to site the MRS facility and discontinued efforts to do so.

transportation requires placing the dry shielded canister into a transportation overpack and attaching impact limiters for further protection against a postulated transportation accident.

[2] The used fuel contracts with all power plant operators are essentially identical; there are no substantive differences among them with respect to terms and conditions.

DOE did develop and, in 2008, submit to the Nuclear Regulatory Commission (NRC) a license application to construct a geologic repository at Yucca Mountain. The NRC staff review of the license application was well-advanced and the adjudicatory hearing process was beginning when, in 2010, DOE announced that it would terminate all work on Yucca Mountain. DOE petitioned the Atomic Safety and Licensing Board (ASLB) assigned to the Yucca Mountain licensing proceeding to terminate the license application with prejudice (i.e., barring subsequent resubmittal). The ASLB found, however, that termination of the Yucca Mountain application would be contrary to the NWPA and did not allow DOE to terminate the application. Nevertheless, DOE shut down all work on Yucca Mountain and the NRC terminated its safety review and ended the adjudicatory hearing process. Plaintiffs have filed suit to force NRC to resume its license review. Arguments in the matter were completed in 2012, but the court stayed the matter for approximately a year. On August 13, 2013 the U. S. Court of Appeals found in favor of the plaintiffs and granted their petition for a writ of mandamus (Reference 3). In the absence of congressional direction to the contrary, the court ordered the NRC to continue the Yucca Mountain licensing process as long as funds are available to do so. The NRC subsequently indicated it will comply with the ruling rather than appeal it. There are some appropriated funds available to DOE and NRC to continue the license review, but not nearly enough money to complete licensing hearings. Moreover, political reality (the steadfast opposition of the Senate Majority Leader and the Obama Administration) indicates that appropriation of additional funds to support licensing is unlikely any time in the near future, if ever. Also, restarting the Yucca Mountain project at this point would take years, because the personnel working on the project have been reassigned or terminated and the project infrastructure has been dismantled.

Since the termination of Yucca Mountain, DOE has made no substantive progress on an alternative approach for disposing of used fuel and satisfying the terms of the Standard Contracts. In 2010 the Secretary of Energy constituted a “Blue Ribbon Commission” (BRC) to make recommendations on the nuclear fuel cycle and the management of nuclear waste. In January 2012 the BRC issued its final report (Reference 4). Included in the report were numerous recommended elements of a new used fuel management policy, including the following.

- Development of a facility or facilities for consolidated storage of used fuel, pending disposal.
- Establishment of a new management entity for the used fuel program.
- Reform of funding so that money collected for used fuel management would be available solely for that purpose.
- Use of a consent-based siting process for one or more consolidated storage facilities and repositories.

Subsequently in 2012, Congress directed DOE to report on its plans for implementation of the BRC recommendations. In January 2013, DOE issued a report with its planned approach (Reference 5), including the following activities.

- Begin operating a pilot consolidated storage facility for used fuel from shutdown plants in 2021.
- Begin operating a larger scale consolidated storage facility for used fuel from all commercial power plants in 2025.
- Begin operating a geologic repository for disposal of used nuclear fuel in 2048.

- Transfer responsibility for management of used fuel to a new entity, such as a federally-chartered corporation.
- Provide access to the money collected for used fuel management and disposal for the purposes of used fuel management and disposal.

DOE, however, maintains that is does not now have legal authorization under the current NWPA to pursue any of these aspirational goals. Therefore, DOE is waiting for Congress to pass legislation authorizing and funding the work.

There are political, legal and economic drivers for action on the part of the federal government to carry out its obligation to remove used fuel from reactor sites. Action is required by the NWPA and lawsuits have been filed in court to compel action. Representatives of states and communities with nuclear power plants and DOE facilities storing high-level radioactive waste (previously designated for disposal at Yucca Mountain) have pressured DOE for action. The NRC's current moratorium on reactor and ISFSI licensing and relicensing arises from a court remand of the NRC's Waste Confidence Decision, and rejuvenation of the government's used fuel management program would serve to bolster the NRC's expected finding of Waste Confidence in 2014. Damages payments resulting from utility lawsuits and settlements cost the government about $1.6 billion through 2012 and have been forecast to cost $19 billion through 2020, with damages accruing at $500 million per year thereafter (Reference 6, p. 2).

There have been recent legislative initiatives from the Senate of the United States intended to get the government's used fuel management program moving again. In 2012 then-Senator Bingaman introduced legislation that would implement many of the BRC recommendations. That legislation was never voted out of committee. In late June 2013, Senators Wyden, Alexander, Feinstein and Murkowski introduced similar legislation intended to reform the management and funding of the government used fuel management program. In addition, the legislation provides for a consent-based siting process for consolidated used fuel storage facilities and repositories (Reference 7). The initial focus of the legislation would be on developing a pilot storage facility to consolidate used fuel from shutdown nuclear power reactors. In contrast, the House of Representatives has spawned no initiatives related to the BRC recommendations, but instead has consistently voted for appropriations to continue the Yucca Mountain licensing process.

Scenarios for Fuel Pickup

Two scenarios under which the federal government would begin to fulfill its statutory and contractual obligation to remove used fuel from commercial nuclear power reactor sites are outlined below.

1. Yucca Mountain: The federal government resumes the Yucca Mountain licensing process and obtains a license to construct the repository. Surface facilities at the repository are constructed, including a staging area to store and repackage used fuel prior to emplacement underground. The government applies for and receives a license to operate the repository. At that point, shipments of used fuel begin. Consistent with

authority provided to the government in the NWPA, first shipments include used fuel from plants that have permanently ceased power operations[3], including CR3.

2. Consolidated Storage: Congress takes the necessary action[4] to enable DOE (or a successor organization) to develop a consolidated storage facility for used nuclear fuel. DOE enters into an agreement with a community and other affected units of government under which the community agrees to host the facility. DOE or a successor organization applies for and receives a license from the NRC to construct and operate an ISFSI. The ISFSI begins to accept fuel, with priority given to shutdown reactor sites, including CR3.

There are certainly other scenarios under which the government could begin to perform on its obligations, such as developing a repository other than Yucca Mountain, developing a reprocessing facility, and developing a consolidated storage facility on a federal site outside of consent-based siting. However, in the present environment the two scenarios outlined above appear to be the most likely to result in removal of the used fuel from CR3. Each scenario is evaluated in the following section.

Evaluation of Scenario 1 – Resumption and Completion of the Yucca Mountain Project

The Yucca Mountain Project was terminated due to the steadfast opposition and political power of Senator Harry Reid, Democrat from Nevada and Senate Majority Leader. As long as Senator Reid remains in his position of power, it is highly unlikely that the Yucca Mountain Project will be allowed to go forward. Moreover, having terminated the project at Senator Reid's urging, it is considered unlikely the Obama Administration would reverse course politically, absent a compelling reason to do so.

In contrast, the House of Representatives, currently controlled by the Republican Party, strongly supports the Yucca Mountain Project, and resolutions to fund the project get large majorities, with significant numbers of Democrats joining almost all Republicans in support. Republican leaders in the house (e.g., Representatives Shimkus and Upton) have thus far opposed initiatives like the proposed Senate legislation on used fuel. The House Republicans are committed first and foremost to carrying out the current law (continuing the Yucca Mountain licensing process).

It is reasonable to conclude that the Yucca Mountain Project could resume only if Senator Reid loses his position of power, and even then only after the end of the Obama Administration. Senator Reid's current term expires in 2016, which will also be the last year of the Obama Administration. If the Republican Party regains a majority in the Senate in the 2014 elections then Senator Reid would lose his position as Majority Leader; however, he would still be expected to wield significant power and would probably be in a position to stymie a resurrection of funding for Yucca Mountain.

If Senator Reid loses his re-election bid in 2016, or if he is re-elected but his party is not in the majority, there may be an opportunity to resume work on Yucca Mountain at that time. Senator

[3] The Nuclear Energy Institute, on behalf of the nuclear industry, has endorsed giving priority to removal of shutdown plant fuel. This has also been a focus of recent legislative efforts

[4] DOE has stated that it must have authorizing legislation in order to move forward on a consolidated storage facility. Others maintain that DOE already has the necessary authority to proceed with a pilot consolidated storage program and would require only the appropriation of funds by Congress.

Reid is 73 years old today and would be 77 at the beginning of his next term, should he be re-elected. Moreover, Senator Reid was aided in the Yucca Mountain shutdown by the actions of Gregory Jaczko, a former Reid aide who had become chairman of the Nuclear Regulatory Commission. Dr. Jaczko resigned from the Commission and is no longer in a position to stop work on the Yucca Mountain Project.

The politics of Yucca Mountain are further complicated by the Nevada Presidential Caucus. The date of the caucus has been moved up in the calendar, and has thus increased in importance. Yucca Mountain opponents have enjoyed success in making opposition to the project almost a litmus test for prevailing in the state, even on the Republican side.

Restarting the Yucca Mountain Project would be a challenging task. Between DOE personnel, DOE contractors, NRC personnel and NRC contractors there were hundreds of people working on the project. Reconstituting the workforce would be difficult and would require time. Documentation from the project was supposedly retained and preserved by DOE and the NRC, but the extent to which the information can be retrieved will not be known until and unless the project is restarted.

The Government Accountability Office (GAO) performed a study of various options for getting to a point of being able to move fuel off of reactor sites. They estimated 15 years from the point of restarting Yucca Mountain licensing efforts to opening the repository site to accept fuel (Reference 6, p. 23). It should be noted that the action would require two licensing actions (a construction authorization and a license to operate the facility), and it would almost certainly continue to be opposed strongly by the State of Nevada and other interests. Further litigation is likely, and 15 years may therefore be optimistic.

Using the nominal 15 year estimate and assuming that work begins in earnest in 2017 following a change in the political situation, the earliest date for operation of Yucca Mountain would be 2032. If it is assumed that shutdown plant fuel is taken first, Crystal River would be among the first 7000 metric tons of fuel taken (Reference 8, p. 5). It is expected that the government would remove used fuel from some of the older shutdown plants before CR3[5]. With a nominal fuel acceptance rate of 3000 metric tons of fuel per year, that makes 2034 the earliest date for removing all fuel from CR3 for shipment to Yucca Mountain[6]. Of course, the ability to restart the project and license and construct Yucca Mountain by any date, much less 2032, is uncertain.

Evaluation of Scenario 2 – Consolidated Storage of Commercial Used Nuclear Fuel

There are a number of operating ISFSIs in the United States; almost all are located at reactor sites or on DOE sites. General Electric operates one private away-from-reactor storage site at Morris, Illinois which uses pool storage[7]. Private Fuel Storage obtained a license for an ISFSI on the Goshute Indian Reservation in Utah, but the facility has not been constructed and there

[5] Plants with the least fuel and the most advanced decommissioning offer the quickest benefit from consolidated storage – eliminating ISFSI costs (security, etc.) at a facility with no operating nuclear plant.

[6] This evaluation does not take credit for exchanges of acceptance allocations among utilities, but such exchanges are expressly allowed by the DOE Standard Contracts and would certainly be considered in any scenario of actual DOE performance.

[7] The Morris facility stores only boiling water reactor fuel, is full and is not accepting additional fuel.

are no plans to do so imminently. The development of an away-from-reactor ISFSI in the United States would be a substantial undertaking (Reference 9). However, there is a fair level of interest in moving forward on a consolidated storage facility, at least for used fuel at shutdown plants (like CR3), as shown by the DOE response to the BRC report (Reference 5) and recent legislation (Reference 7).

DOE has been developing plans for a pilot consolidated storage facility for shutdown plant fuel. Their schedule calls for enabling legislation in late 2014, site selection in 2017, and completion of licensing in late 2021. Under this schedule, the facility would actually begin receipt operations in early 2022 (Reference 10). DOE noted "significant schedule risks" associated with siting, legislation, budget, licensing and development of suitable rail cars for transportation. In a recent report, the Electric Power Research Institute (EPRI) estimated that a large consolidated storage facility could be sited, licensed, and constructed in six years (Reference 11, p. 1-3). The EPRI estimate is consistent with DOE's schedule. In contrast, the GAO estimated that it would take about 20 years to site, license, and construct two centralized storage facilities (Reference 6, p. 23), citing "complexities in siting, licensing, and constructing such facilities."

Leaving aside for a minute the large disparity in the schedule estimates, it is evident that the first critical factor for a consolidated storage facility is to get authorization and funding from Congress to proceed with the project. Whether through stand-alone legislation or as part of a larger energy bill, such authorization requires the consent of both houses of Congress and the President (or an override of a presidential veto). Key members of the House of Representatives have indicated they oppose proceeding with consolidated storage because they feel it would lessen the pressure to revive the Yucca Mountain Project. That House position could change, depending on court action or other factors, so obtaining the necessary legislative authorization by 2014 cannot be ruled out but also cannot be considered a likely outcome in today's political environment.

In addition to the date when a pilot consolidated storage facility for shutdown plant fuel starts operation, the pickup amount, pickup rate and pickup order will also affect the time required to move all CR3 fuel offsite.

Pickup amount

To this point, DOE's planning for a pilot consolidated storage facility has focused on picking up fuel from nine shutdown sites with no other operating plants: Big Rock Point, Haddam Neck, Humboldt Bay, Lacrosse, Maine Yankee, Rancho Seco, Trojan, Yankee Rowe and Zion. Those plants have a total of 2813 metric tons of used fuel. DOE acknowledged recent and prospective additions to those plants: Crystal River, Kewaunee, San Onofre and Oyster Creek, with a total of 4263 metric tons of used fuel. The total inventory of stranded fuel[8] is therefore 7076 metric tons (approximately 575 dual purpose systems), once Oyster Creek shuts down and assuming no more additions to the list. In August 2013, Entergy announced it would permanently shut down the Vermont Yankee nuclear plant by the end of 2014, adding approximately 666 metric

[8] "Stranded fuel" is commonly defined as used fuel stored at a reactor site with no operating power plant. Accordingly, DOE is not including fuel at Millstone 1, because there are two operating units at the Millstone site.

tons[9] to the amount stored at shutdown plants, for a total of approximately 7742 metric tons.

Pickup rate

The rate at which DOE picks up fuel, combined with the start date, determines when all of the shutdown plant fuel will be consolidated at an away-from-reactor ISFSI. The typical DOE planning for transportation has assumed a ramp-up to 3000 metric tons of used fuel per year. To accomplish that goal, a substantial transportation infrastructure is required, including rail cars, transportation overpacks, impact limiters and logistical support. If DOE were to pick up at the 3000 metric ton per year rate with no ramp-up, that would complete the shutdown site mission (all 13 plants) in approximately 2.4 years.

Initial DOE planning is for a much lower pickup rate, with 7-9 years for removal of all fuel from the first nine plants (Reference 13, p. 26). The lower rate corresponds to a range of 300-400 metric tons per year. At those rates, the bigger mission (all 13 of the aforementioned shutdown plants with stranded fuel) would take 18-23 years.

The 3000 metric ton per year rate is viewed as highly optimistic for the pilot consolidated storage facility. By the same token, the utility of a pilot facility that takes 20 years to remove all stranded fuel is low, and would not likely survive an economic evaluation. Accordingly, it is assumed for present purposes that DOE would make a significant investment in transportation infrastructure in order pick up fuel at a high rate and thereby realize the economic benefits to the federal government of consolidating all stranded fuel[10]. This assumption is consistent with the DOE plan, which is to follow the pilot consolidated storage facility for shut down plant fuel with a larger storage facility or facilities that would consolidate a substantial portion of the existing used fuel inventory.

Pickup Order

The pickup order prescribed in the Standard Contract between DOE and utilities is oldest fuel first queue. Utilities are, however, permitted to exchange pickup obligations. The Standard Contract also permits DOE at its discretion to move fuel from shutdown plants to the front of the queue. Presumably DOE would exercise that discretion for the pilot consolidated storage facility.

With that being said, the Standard Contract does not prescribe how DOE would prioritize fuel pickup from the various shutdown plants. To maximize the savings on damage payments, DOE would presumably go site-by-site rather than picking up fuel from various sites concurrently. Possibly DOE would apply an approach that resulted in picking up fuel from the sites with the least number of storage systems first, thereby enabling the earliest possible cost savings. That approach (smallest number of dual purpose systems first) would put CR3 eighth out of the aforementioned 14 plants. Alternatively, DOE could go by order of final shutdown, which would put CR3 tenth.

9 Based on Reference 12, Enclosure 6, Vermont Yankee through 2014.

10 Those benefits include discontinuing the need for federal government damages payments to plants with stranded fuel. Damages typically cover costs associated with security, emergency planning, monitoring and maintenance for used fuel storage. The benefits also include addressing concerns on the part of some federal legislators with the storage of spent fuel at shutdown sites.

Under either set of assumptions, CR3 fuel would be removed during the latter portion of the shutdown plant campaign, but CR3 would not be the last of the 13 plants.

The pilot consolidated storage facility envisioned by DOE would be relatively simple. It would accept fuel from shutdown sites in licensed dual purpose (storage and transportation) systems. Presumably, in order to ship CR3 fuel to the facility, the fuel would already be in such a dual purpose system, or DOE would provide a dual purpose system into which Duke Energy would load fuel from the onsite spent fuel pool for offsite transportation by DOE. The Transnuclear NUHOMS-32PTH1 is licensed for storage and transportation, and Duke Energy has purchased 10 NUHOMS-32PTH1 canisters and 12 storage overpacks (horizontal storage modules) for use at Crystal River. More than 40 of the NUHOMS-32PTH1 systems would be needed to storage all CR3 used fuel.

Although the government has the unconditional legal obligation to accept and transport all fuel, there are three potential complications that, as a practical matter, could affect the ability of DOE to load CR3 fuel from the fuel pool into canisters and ship those canisters (in a suitable transportation overpack) directly to a consolidated storage facility. Those complications are burnup, system-specific transportation limits, and the need to stage fuel for offsite transportation. Again, even though DOE is legally obligated to solve each of these issues without delay or cost to CR3, we are here assessing practicalities and probabilities. Each issue is discussed below.

Burnup

Some of the CR3 fuel is high burnup (HBU), defined as having produced energy in excess of 45,000 megawatt-day per metric ton. The NRC's current position is that it will allow transport of HBU fuel only on a case-by-case basis[11] (Reference 14). The technical issues underpinning the NRC's concerns are being investigated analytically and experimentally as part of the program to further develop the technical basis for long-term used fuel dry storage. Most fuel being discharged from U.S. reactors today is HBU, and there are significant quantities of it present at recently shutdown plants like Kewaunee and San Onofre. It is reasonable to expect, but by no means certain, that transportation of HBU fuel will be resolved sufficiently to permit the offsite transportation of the limited quantity of CR3 HBU fuel during the 2020s or later. Transnuclear has in fact submitted a request to the NRC to amend the MP-197 transportation overpack certificate of compliance to allow the transportation of high burnup fuel.

All other things being equal, HBU fuel is hotter (thermally and radiologically) than fuel with lower burnup. Accordingly, typical dry storage loading strategy is to place a few HBU assemblies in the interior of a canister and load old, relatively cold fuel on the

[11] NRC statement in Interim Staff Guidance – 11 (Reference 14): "The staff is currently reevaluating the technical basis for the transportation of spent fuel including assemblies with average assembly burnups exceeding 45 GWd/MTU. The staff is reviewing data and technical reports to further understand the mechanical and fracture toughness properties of spent fuel cladding in relation to the transportation of high burnup fuel under 10 CFR 71.55. Therefore, until further guidance is developed, the transportation of high burnup commercial spent fuel will be handled on a case-by-case basis using the criteria given in 10 CFR 71.55, 10 CFR 71.43(f), and 10 CFR 71.51."

exterior, thereby reducing dose and overall heat load. To put the issue into perspective for CR3, there are 1319[12] fuel assemblies in the fuel pool, of which 428 are HBU.

The nine plants in DOE's initial planning basis for consolidated storage were shut down in the 1990s or earlier. Only one (Maine Yankee) discharged any HBU fuel. The 90 Maine Yankee HBU assemblies were placed in damaged fuel cans, which should ease NRC concerns over the integrity of the HBU fuel during transportation.

System-specific transportation limits

The NRC applies different requirements to storage and transportation, so fuel that meets storage requirements typically requires additional radioactive decay time to meet the requirements for transportation. The primary impact is on the allowable heat load (decay heat from the fuel)[13]. Typical required decay times are 5-10 years for storage and 15 years for transportation. An evaluation of the CR3 fuel indicates all of the fuel should be transportable in NUHOMS-32PTH1 systems by approximately 2024, assuming the requested amendment to the MP-197 certificate of compliance is granted.

Staging fuel for offsite transportation

Most shutdown reactors have already placed their fuel in dry storage or have plans to do so in the near future, so their dual purpose systems should be ready for offsite transport whenever convenient for the shipper (DOE)[14]. At CR3, one motivation for continuing pool storage instead of going to dry storage is to avoid the cost associated with constructing an ISFSI. For a site like CR3 with fuel in the pool, when DOE arrives to pick up fuel, there will not be a large number of canisters loaded and awaiting transport. If the CR3 fuel is to be loaded into canisters directly from the fuel pool and then transported offsite, the transportation and loading must be well coordinated.

Summary

Provided there are no additional schedule delays due to the complications discussed above, it would appear that the earliest date by which all CR3 fuel would be removed from the spent fuel pool and shipped to a DOE pilot consolidated storage facility is 2024 (start in 2022, pick up all stranded fuel within 2.4 years with CR3 toward the end of that time frame). It should be reiterated that this appears to be a very optimistic scenario; more likely it would take years longer.

[12] Of the 1319 fuel assemblies, 1243 are used fuel assemblies that operated in the reactor core and 76 are fresh, unused fuel assemblies that were intended for future operation at CR3. It is possible that the 76 fresh fuel assemblies will be shipped offsite for use in another reactor or for recovery of uranium, rather than being stored onsite long-term pending removal by DOE.

[13] For the NUHOMS-32PTH1, the maximum allowable heat load for storage is 40.8 kilowatts, while for transportation the maximum allowable heat load is 26 kW.

[14] DOE has indicated that rail shipment is the preferred mode for offsite transport, although heavy-haul truck shipment to a rail line and barges are also possibilities.

If the Yucca Mountain Project is restarted, it may be possible to ship all fuel from CR3 to Yucca Mountain by 2034. It is reiterated that DOE has terminated all work on Yucca Mountain and the probability of restarting the project is not considered high at this time.

A third scenario, no consolidated storage but eventual offsite shipment of fuel to a geologic repository different from Yucca Mountain, was not evaluated in detail herein. However, it is noted that DOE set a goal of 2048 for operation of such a repository (Reference 5). Accordingly, a third potential date for evaluation might be 2050, shortly after the projected opening date of the other repository.

Recommendations

When evaluating options for used fuel management at Crystal River 3, it is recommended that several offsite shipment dates (e.g., 2024, 2034, and 2050) be considered at a minimum. The earliest possible date is considered to be 2024 (pilot consolidated storage facility scenario). The 2034 date applies to both a protracted consolidated storage scenario[15] and a nominal Yucca Mountain scenario. The latest date, 2050, is based on the DOE aspiration of having another repository in service by 2048.

The aforementioned dates are not carved in stone. There is a high degree of uncertainty associated with any date in the area of used fuel management right now. Additional dates should certainly be evaluated if necessary to improve the understanding of how pickup date affects the economic evaluation of wet storage vs. dry storage.

Given the inherent uncertainty of the economic analysis due to the unknown date for complete removal of fuel, it is suggested that non-economic considerations be weighted strongly. Examples of such considerations include the following.

- It is conceivable that a need would arise to reopen a dry storage system – for example, to remediate a container, address a technical concern, or conform with DOE transportation requirements (see following bullet). It would be costly and challenging to open a dry storage system by putting it back in the spent fuel pool, but it has been done. Absent a pool, options are much more costly and more challenging – they include (i) constructing onsite, licensing and using a dry transfer system (none currently exists) or (ii) placing a canister into a transportation overpack and sending it to another site with an operating pool, in which the system could be opened. If all CR3 fuel is placed in dry storage, the expectation is that the pool will be removed from service. Unless the CR3 pool is maintained available after dry storage loading, a decision to put fuel into dry storage should be viewed as irrevocable, and one that constrains the ability to address future issues. It should be noted that CR3 would not be alone in this regard if it were to put its spent fuel in dry storage. Other shutdown plants (e.g., Maine Yankee, Trojan) are now in a configuration with all used fuel in dry storage and no spent fuel pool, and others (e.g., Zion, Kewaunee) plan to do likewise.
- The DOE Standard Contract for used fuel management was written based on the assumption that fuel would be removed from the pool and shipped offsite. The contract does not require DOE to accept fuel in dual-purpose systems such as the NUHOMS-

[15] In a protracted consolidated storage scenario, the government implements consolidated storage of spent fuel from shutdown plants but implementation is delayed from the 2021 schedule cited by DOE.

32PTH1. DOE could theoretically attempt to compel Duke Energy to unload fuel from dual-purpose systems and put it into a different, DOE-supplied system for removal from the CR3 site. As noted above, opening a system without an onsite pool would be an undesirable and costly evolution. Keeping the fuel in the spent fuel pool keeps all options open for offsite shipment. As noted above, other plants have already placed all spent fuel in dry storage and removed their spent fuel pools, so CR3 would not be the only plant to be challenged in the event DOE refuses to pick up fuel stored in dual purpose systems.

- It is possible that some of the uncertainty associated with the political component of the used fuel management issue will be resolved within the next few years. This might argue for leaving the fuel in the spent fuel pool for the time being and deferring a final decision until some of the uncertainty is resolved.

References

1. Letter, Jon A. Franke (Duke Energy Corporation) to the U. S. Nuclear Regulatory Commission, Cessation of Power Production at Crystal River Unit 3, February 20, 2013.
2. United States of America Public Law 97-425, "Nuclear Waste Policy Act of 1982," January 7, 1983.
3. U. S. District Court of Appeals for the District of Columbia Circuit, No. 11-1271, Order on Petition for Writ of Mandamus, August 13, 2013.
4. "Report to the Secretary of Energy by the Blue Ribbon Commission on America's Nuclear Future," January 26, 2012.
5. "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," Department of Energy, January 2013.
6. GAO-12-797, "Spent Nuclear Fuel - Accumulating Quantities at Commercial Reactors Present Storage and Other Challenges," August 2012.
7. S.1240, "The Nuclear Waste Administration Act of 2013," Senators Wyden, Alexander, Feinstein and Murkowski, June 27, 2013.
8. "Alternative Storage Facility Design Concepts," Presentation by Joe Carter (Savannah River National Laboratory) at the June 26-27, 2013 Nuclear Infrastructure Council / Institute for Nuclear Materials Management Technical Workshop on DOE's Proposed Pilot Interim Storage Project.
9. "Centralized Interim Storage – Past, Present, and Future," Steven P. Nesbit, November-December 2012 Radwaste Solutions Buyers Guide.
10. "Project Planning Considerations & Technical Exchange," Presentation by John Wagner (Oak Ridge National Laboratory) at the June 26-27, 2013 Nuclear Infrastructure Council / Institute for Nuclear Materials Management Technical Workshop on DOE's Proposed Pilot Interim Storage Project.
11. "Cost Estimate for an Away-from-Reactor Generic Interim Storage Facility (GISF) for Spent Nuclear Fuel," 1018722, Electric Power Research Institute, Palo Alto, California, 2009.
12. Letter, Brian Gutherman (Gutherman Technical Services) to Marcus Nichol (Nuclear Energy Institute), June 2012 Used Fuel Data, July 27, 2012.
13. "Evaluation of Removing Used Nuclear Fuel From Shutdown Sites," Presentation by Steven Maheras (Pacific Northwest National Laboratory) at the June 26-27, 2013 Nuclear Infrastructure Council / Institute for Nuclear Materials Management Technical Workshop on DOE's Proposed Pilot Interim Storage Project.

14. “Cladding Considerations for the Transportation and Storage of Spent Fuel,” U. S. Nuclear Regulatory Commission Spent Fuel Project Office, Interim Staff Guidance 11, Rev. 3, November 17, 2003.

Appendix A

Pickup Date and Pickup Rate for Use in the CR3 Decommissioning Plan

The Nuclear Regulatory Commission requires permanently shutdown units to submit a Post-Shutdown Decommissioning Activities Report (PSDAR), also referred to as the Decommissioning Plan. CR3 plans to submit the PSDAR in December 2013. The PSDAR includes a description of planned decommissioning activities, a schedule of significant activities, a site specific cost estimate and an environmental impact assessment. In order to perform the cost estimate, it is necessary to know how long used fuel will be stored on site, and in what mode. This appendix documents an estimate of the date when DOE begins to remove used fuel from CR3 and the rate at which DOE picks up the fuel.

Used Fuel Pickup Start Date

As discussed in the body of this report, there is a great deal of uncertainty associated with the beginning of fuel removal from CR3. Three dates were proposed for consideration, as summarized below. These industry dates correspond to when the government would begin removing fuel from reactor sites, not to when CR3 fuel removal would commence.

Industry Pickup Start Date	Description
2022	Begin to remove fuel to a consolidated storage facility (shutdown site fuel first).
2032	Begin to remove fuel to a repository at Yucca Mountain (shutdown site fuel first).
2048	Begin to remove fuel to a repository other than Yucca Mountain (shutdown site fuel first).

Each scenario for fuel removal may or may not come to fruition. Assuming one or more are successful, the start date of each scenario is also uncertain. Picking any one date for beginning offsite shipment of used fuel is by definition speculative. For the purpose of the CR3 PSDAR an industry pickup start date of 2032 is chosen. The rationale for the selection is provided below.

> Each of the three dates noted above are associated with a specific scenario for spent fuel removal. The selected date, 2032, is judged to be feasible in two of the three scenarios (i.e., consolidated storage and Yucca Mountain).
>
> For consolidated storage, DOE established a target start date of 2021[16] for beginning fuel pickup from shutdown plants, as discussed in the body of the paper. While that date is viewed as optimistic, it is technically feasible. Moreover, given the current interest in consolidated storage, it appears reasonable to assume that if consolidated storage happens at all, it would likely begin by 2032 (nearly two decades from now, and more than a decade after the DOE goal of 2021). The overall probability of success for this scenario is judged to be on the order of 40%.

[16] While the DOE strategy document (Reference 5) calls for beginning consolidated storage in 2021, subsequent national laboratory studies refer to 2022 as the date when the consolidated storage facility will begin to receive fuel.

> For Yucca Mountain, 2032 is considered an achievable industry pickup start date if the work is restarted in 2017 and carried out with appropriate urgency. Again, the timing and factors to contributing to the uncertainty in this scenario are discussed in the body of the paper. Given the adamant opposition of Senator Reid and the Obama Administration to the Yucca Mountain Project, combined with the history of slow progress with Yucca Mountain, the overall probability of success for this scenario by 2032 is judged to be on the order of 10%.
>
> Taken both potential success paths together, the overall probability of beginning industry pickup by 2032 is judged to be approximately 50%. In other words, given current conditions, 2032 is considered a reasonable median date by which the federal government will begin used fuel removal from reactor sites. In a best case scenario, the date could be significantly earlier; in a worst case scenario, much later.

It is recognized that this date differs from dates that have been used in the past for other Duke Energy nuclear plants as well as some dates that are used in industry. While earlier dates than 2032 are possible, they are not considered probable and would therefore likely underestimate the total decommissioning cost at a shutdown plant like CR3[17]. Similarly, later dates are possible as well, but in light of the current attention on used fuel management and the interest in removing fuel from shutdown sites, those later dates are judged at this time to be unduly pessimistic.

The PSDAR will be periodically updated. When it is, this evaluation should be revised, as necessary, to reflect the then-current used fuel management situation.

Pickup Rate

As with the pickup start date, there is a great deal of uncertainty associated with any estimate of pickup rate of used fuel from the industry. With that being said, the pickup rates provided in Reference A1 are commonly used and appear to be a reasonable basis for either a consolidated storage facility or a repository. The rates start relatively low (400 metric tons uranium (MTU) per year) and increase within five years to a steady state value of 3000 MTU/yr, significantly in excess of current annual used fuel production rate. The pickup rates are shown in the table below, and are recommended for use in the PSDAR.

Year	Pickup Rate (MTU/yr)
1	400
2	600
3	1200
4	2000
5	3000
thereafter	3000

[17] For a shutdown plant decommissioning cost estimate it may be appropriate to select a more probable DOE fuel removal date than an earlier, published DOE fuel removal date that is applied to an operating plant's decommissioning study. The operating plant decommission studies are used to establish appropriate rate recovery to ensure an adequate balance in the decommissioning fund at the end of power operations. Decommissioning studies for operating plants are updated periodically. If a published date for spent fuel removal turns out to be overly optimistic, the operating plant has time available to modify the date and adjust funding, as needed.

Pickup Order

Pickups from a specific plant are often assumed to be consistent with the annual allocations to that plant, in accordance with the "first permanently discharged, first removed" methodology of the DOE Standard Contract. However, recognizing that CR3 is a shutdown plant, and consistent with the body of this report, two additional assumptions are made.

1. DOE picks up used fuel from shutdown plants prior to beginning to pick up used fuel from operating plants[18].
2. DOE picks up used fuel from shutdown plants based on the permanent shutdown date of the plant, such that fuel will be removed first from the plants that were shut down the longest.

The nine sites that ceased power operation prior to CR3 have a total used fuel inventory of 2813 MTU. Applying the industry pickup rate from above, that corresponds to 3.3 years to work through the spent fuel at those nine sites before getting to the CR3 fuel. That corresponds to an actual CR3 pickup start date of 2035 (or year 4 from the above table).

With these assumptions, there would be 613 MTU of pickups left in 2035 when CR3 pickups begin. That is greater than the existing CR3 inventory of 1319 fuel assemblies, so a simple calculation would indicate that all CR3 used fuel would be removed in 2035. In reality, achieving a 2000 MTU/yr pickup rate from a single site alone would be difficult. Transporting 1319 fuel assemblies away from the same site in less than nine months would be particularly challenging task if all the fuel were still in the spent fuel pool. Accordingly, it is reasonable to assume that a 2035 start date would correspond to removal of all CR3 fuel by 2036.

Summary

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site. DOE's spent fuel management program had assumed that spent fuel allocations would be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor. Recent developments indicate DOE will likely exercise the discretion available under its contracts and remove spent fuel first from shutdown sites with no operating reactors (such as Crystal River). In doing so, it would appear reasonable that DOE will remove fuel first from the plants that have been shut down the longest. Duke Energy's current spent fuel management plan for the CR3 spent fuel is based in general upon: 1) a 2032 start date for DOE initiating transfer of commercial spent fuel to a federal facility (either a consolidated interim storage facility or the proposed repository at Yucca Mountain), 2) a corresponding 2035 date for beginning to remove spent fuel from the Crystal River Site, and 3) a 2036 completion date for removal of all CR3 spent fuel. The assumption that DOE begins removing spent fuel from commercial reactor sites in 2032 is not based on any specific DOE plan but on a subjective assessment of possible DOE performance by Duke Energy as of September 2013. The assessment considers the possibility that DOE may open a pilot consolidated storage plant for spent fuel from shutdown plants as well as the possibility that DOE may resume work on the Yucca Mountain Project and open Yucca Mountain to fuel from commercial nuclear power plants with first priority for shutdown plants.

[18] This is (i) allowed by the Standard Contract and (ii) consistent with Reference 5.

References

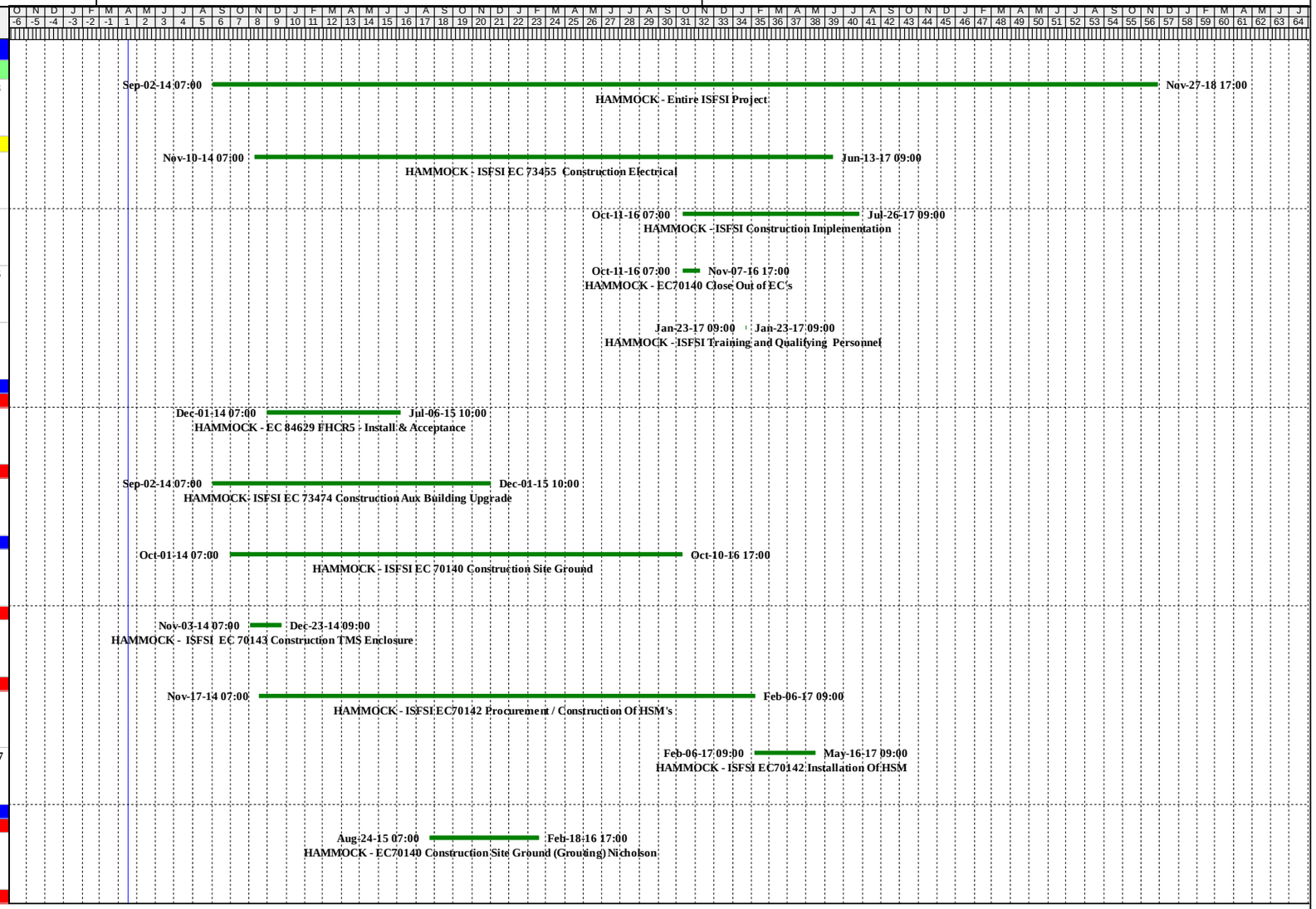
A1. DOE/RW-0567, Acceptance Priority Ranking & Annual Capacity Report, U. S. Department of Energy Office of Civilian Radioactive Waste Management, July 2004.

OWNER'S SCHEDULE

ISFSI LEVEL 2 SCHEDULE

Apr-21-14 16:45

Activity ID	Activity Name	Original Duration	Start	Finish
TRAN OWNER'S SCHEDULE		10700	Sep-02-14	Nov-27-18
TRAN-3 ISFSI		10700	Sep-02-14	Nov-27-18
DFISFSIHAM-H	HAMMOCK - Entire ISFSI Project	37138	Sep-02-14 07:00	Nov-27-18 17:00
TRAN-3-1 ISFSI Project		10700	Sep-02-14	Nov-27-18
DFM6.3.2.7-H	HAMMOCK - ISFSI EC 73455 Construction Electrical	5230	Nov-10-14 07:00	Jun-13-17 09:00
DFW6.3.2-H	HAMMOCK - ISFSI Construction Implementation	1592	Oct-11-16 07:00	Jul-26-17 09:00
DFM70140-H	HAMMOCK - EC70140 Close Out of EC's	160	Oct-11-16 07:00	Nov-07-16 17:00
DFWT0000-H	HAMMOCK - ISFSI Training and Qualifying Personnel	0	Jan-23-17 09:00	Jan-23-17 09:00
TRAN-3-1-2 Aux Bldg Work		2521	Sep-02-14	Dec-01-15
TRAN-3-1-2-2 FHCR-5		1193	Dec-01-14	Jul-06-15
DFWM19400-H	HAMMOCK - EC 84629 FHCR5 - Install & Acceptance	1193	Dec-01-14 07:00	Jul-06-15 10:00
TRAN-3-1-2-1 Aux Bldg		2521	Sep-02-14	Dec-01-15
DFI6.3.2.13H	HAMMOCK- ISFSI EC 73474 Construction Aux Building Upgrade	2521	Sep-02-14 07:00	Dec-01-15 10:00
TRAN-3-1-1 ISFSI General		5300	Oct-01-14	May-16-17
DFM6.3-H	HAMMOCK - ISFSI EC 70140 Construction Site Ground	4098	Oct-01-14 07:00	Oct-10-16 17:00
TRAN-3-1-1-1 TMC Installation		280	Nov-03-14	Dec-23-14
DFM70143-H	HAMMOCK - ISFSI EC 70143 Construction TMS Enclosure	280	Nov-03-14 07:00	Dec-23-14 09:00
TRAN-3-1-1-2 HSM Installation		5040	Nov-17-14	May-16-17
DFW6.3.4.25SH	HAMMOCK - ISFSI EC70142 Procurement / Construction Of HSM's	4470	Nov-17-14 07:00	Feb-06-17 09:00
DFW6.3.-00H	HAMMOCK - ISFSI EC70142 Installation Of HSM	570	Feb-06-17 09:00	May-16-17 09:00
TRAN-3-1-3 Pad & Apron Work		2932	Aug-24-15	Feb-06-17
TRAN-3-1-3-3 ISFSI Berm		1000	Aug-24-15	Feb-18-16
DF1639546-6H	HAMMOCK - EC70140 Construction Site Ground (Grouting) Nicholson	1000	Aug-24-15 07:00	Feb-18-16 17:00
TRAN-3-1-3-1 Pad & Apron		632	Oct-11-16	Feb-06-17



Remaining Level of Effort

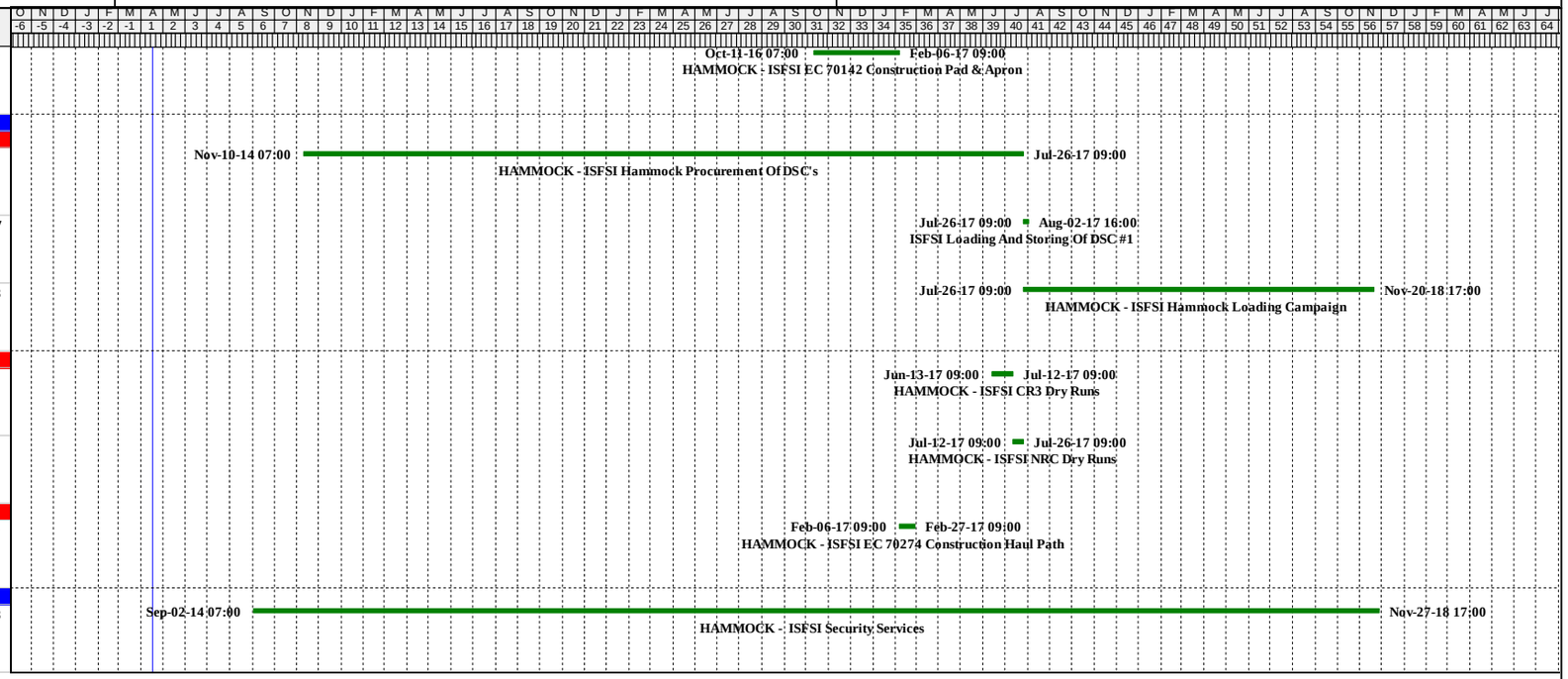
Milestone

OWNER'S SCHEDULE

ISFSI LEVEL 2 SCHEDULE

Apr-21-14 16:45

Activity ID	Activity Name	Original Duration	Start	Finish
DFW6.3.4.25H	HAMMOCK - ISFSI EC 70142 Construction Pad & Apron	632	Oct-11-16 07:00	Feb-06-17 09:00
TRAN-3-1-4 Fuel Movement & Storage		10160	Nov-10-14	Nov-20-18
TRAN-3-1-4-1 Loading Campaign		10160	Nov-10-14	Nov-20-18
DFM6.3.2.19H	HAMMOCK - ISFSI Hammock Procurement Of DSC's	5470	Nov-10-14 07:00	Jul-26-17 09:00
DFW54200	ISFSI Loading And Storing Of DSC #1	103	Jul-26-17 09:00	Aug-02-17 16:00
DFW54200-H	HAMMOCK - ISFSI Hammock Loading Campaign	6608	Jul-26-17 09:00	Nov-20-18 17:00
TRAN-3-1-4-2 Dry Run Process		240	Jun-13-17	Jul-26-17
DFM00003-H	HAMMOCK - ISFSI CR3 Dry Runs	160	Jun-13-17 09:00	Jul-12-17 09:00
DFM00002-H	HAMMOCK - ISFSI NRC Dry Runs	80	Jul-12-17 09:00	Jul-26-17 09:00
TRAN-3-1-4-3 Haul Path		120	Feb-06-17	Feb-27-17
DFW70274-H	HAMMOCK - ISFSI EC 70274 Construction Haul Path	120	Feb-06-17 09:00	Feb-27-17 09:00
TRAN-3-1-5 Security		8578	Sep-02-14	Nov-27-18
DFW2.5-H	HAMMOCK - ISFSI Security Services	8578	Sep-02-14 07:00	Nov-27-18 17:00



Remaining Level of Effort

Milestone