STATE OF VERMONT
PUBLIC UTILITY COMMISSION

Joint Petition of NorthStar Decommissioning Holdings, LLC, NorthStar Nuclear Decommissioning Company, LLC, NorthStar Group Services, Inc., LVI Parent Corporation, NorthStar Group Holdings, LLC, Entergy Nuclear Vermont Investment Company, LLC, and Entergy Nuclear Operations, Inc., and any other necessary affiliated entities to transfer ownership of Entergy Nuclear Vermont Yankee, LLC and for certain ancillary approvals, pursuant to 30 V.S.A. §§ 107, 231, and 232	)	Docket No. 8880

SUMMARY OF PREFILED TESTIMONY OF WARREN K. BREWER

Mr. Brewer's testimony presents the results of an analysis of the proposed transfer of the Vermont Yankee Nuclear Power Station (VY Station) from the Entergy Petitioners to the NorthStar Petitioners, and the plan for subsequent prompt decommissioning of the Vermont Yankee Nuclear Power Station. Mr. Brewer evaluates the change in decommissioning approach that would result from the proposed transfer to NorthStar, and identifies areas of risk of unanticipated and added costs. Mr. Brewer explains why those risks are important to evaluating whether the assets available to NorthStar under the proposed transfer are sufficient to complete decommissioning of the VY Station, including NRC license transfer, spent fuel management, and site restoration.

Mr. Brewer sponsors the following exhibits:

Exhibit DPS-WKB-1	Resume of Warren K. Brewer
Exhibit DPS-WKB/GAM-2	Review of Proposed Transfer of Vermont Yankee to NorthStar and Plan for Subsequent Prompt Decommissioning
Exhibit DPS-WKB-3	Discovery Response A.ANR:NS.2-65
Exhibit DPS-WKB-4	Discovery Attachment A.DPS:JP.1-22.3 [Confidential – Filed Under Seal]
Exhibit DPS-WKB-5	Discovery Attachment A.DPS:JP.1-38.1 [Confidential – Filed Under Seal]
Exhibit DPS-WKB-6	Letter from James Kim, U.S. Nuclear Regulatory Commission, to Site Vice President, Entergy Nuclear Operations, Inc., Re: Vermont Yankee

	Nuclear Power Station – Exemptions from the Requirements of 10 CFR Part 50, Sections 50.82(a)(8)(i)(A) and 50.75(h)(1)(iv) (June 17, 2015)
Exhibit DPS-WKB-7	Discovery Response A.DPS:NS.2-25
Exhibit DPS-WKB-8	M.S. Terrell, D. McGee, "Decommissioning Lessons Learned at Yankee Rowe," WM'01 Conference (Feb. 25-Mar. 1, 2001)
Exhibit DPS-WKB-9	Electric Power Research Institute, "Connecticut Yankee Decommissioning Experience Report: Detailed Experiences 1996-2006" (Nov. 2006)
Exhibit DPS-WKB-10	Electric Power Research Institute, "Yankee Rowe Decommissioning Experience Record," Vol. 1 (Dec. 1997)
Exhibit DPS-WKB-11	Electric Power Research Institute, "Yankee Rowe Decommissioning Experience Record," Vol. 2 (Dec. 1998)
Exhibit DPS-WKB-12	Discovery Response A.DPS:TS.1-9
Exhibit DPS-WKB-13	Letter from Edward D. Halpin, Pacific Gas & Electric, to U.S. Nuclear Regulatory Commission, Re: Docket No. 50-133, License No. DPR-7; Humboldt Bay Power Plant, Unit 3; Decommissioning Funding Report for Humboldt Bay Power Plant, Unit 3 (Apr. 1, 2013)
Exhibit DPS-WKB-14	Letter from Christopher J. Wamser, Entergy Nuclear Operations, Inc., to U.S. Nuclear Regulatory Commission, Re: Update to Irradiated Fuel Management Program Pursuant to 10 CFR 50.54(bb); Vermont Yankee Nuclear Power Station; Docket No. 50-271; License No. DPR-28 (Dec. 19, 2014)
Exhibit DPS-WKB-15	Discovery Response A.DPS:NS.2-24
Exhibit DPS-WKB-16	Discovery Response A.DPS:NS.1-92
Exhibit DPS-WKB-17	Discovery Response A.DPS:NS.2DM-18

Exhibit DPS-WKB-18	Discovery Response A.DPS:NS.2-26
Exhibit DPS-WKB-19	Discovery Response A.DPS:NS.2-9
Exhibit DPS-WKB-20	Electric Power Research Institute, "Maine Yankee Decommissioning Experience Report: Detailed Experiences 1997-2004" (May 2005)
Exhibit DPS-WKB-21	Letter from Mike Gorski, Massachusetts Department of Environmental Protection, to Joseph Lynch, Yankee Atomic Electric Company, Re: Beneficial Use Determination; Yankee Nuclear Power Station (July 29, 2005)
Exhibit DPS-WKB-22	Discovery Response A.DPS:NS.2-16
Exhibit DPS-WKB-23	Discovery Response A.DPS:NS.2DS-12
Exhibit DPS-WKB-24	Discovery Response A.DPS:NS.2DM-27 [Confidential – Filed Under Seal]
Exhibit DPS-WKB-25	Discovery Response A.DPS:NS.2DM-28 [Confidential – Filed Under Seal]
Exhibit DPS-WKB-26	Discovery Response A.DPS:NS.2DS-15

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PREFILED TESTIMONY OF WARREN K. BREWER

Q1. State your name and business address.

A1. Warren K. Brewer, 4451 Brookfield Corporate Drive, Suite 107, Chantilly, VA 20151.

Q2. On whose behalf are you testifying?

A2. I am testifying on behalf of the Vermont Department of Public Service.

Q3. What is your occupation?

A3. I am an executive consultant for Four Points Group, Incorporated. Four Points Group is an engineering consulting firm engaged in providing services to the nuclear industry. The services provided by Four Points Group include decommissioning cost estimating and planning and cost estimating and analysis with respect to spent fuel management and disposition. I have over 40 years of experience in the nuclear industry and have been involved in decommissioning cost estimating and planning since 1989.

Q4. Have you previously provided expert testimony?

A4. Yes. I have provided expert witness testimony before state regulatory bodies, in arbitration, before the U.S. Tax Court and in numerous proceedings before the U.S. Court of Federal Claims. My resume, Exhibit DPS-WKB-1, contains a listing of the matters in which I have provided expert testimony.

Q5. What is your educational and professional background?

A5. I have a B.S. in electrical engineering from Louisiana Tech University and an M.S. in nuclear engineering from the Massachusetts Institute of Technology. I completed a graduate level course of study in areas related to nuclear reactor and power plant design at the Bettis Reactor Engineering School.

After obtaining my Master's degree, I worked for slightly over 10 years at the Division of Naval Reactors, the joint Department of Defense and Department of Energy organization responsible for all aspects of design, construction, maintenance, and operation of nuclear reactors in U.S. Navy ships and training facilities. I left the Division of Naval Reactors in 1986 and accepted a position with Pickard, Lowe and Garrick, a nuclear industry engineering consulting company. In late 1986, two colleagues and I formed ABZ, Incorporated, and I worked for ABZ as owner, consultant, and ultimately president. In January 2017 I sold my ownership in ABZ, and I am now an executive consultant for Four Points Group.

Q6. What is the purpose of your testimony in this proceeding?

A6. The purpose of my testimony is to present my review of the proposed transaction, which involves the acquisition of Entergy Nuclear Vermont Yankee, LLC

(ENVY), which owns the VY Station, by NorthStar Decommissioning Holdings, LLC from Entergy Nuclear Vermont Investment Company, LLC (ENVIC), which presently holds 100% of the membership interest in ENVY; the assumption by NorthStar Nuclear Decommissioning Company, LLC and NorthStar Group Services, Inc. of certain decommissioning obligations; and the plan for the subsequent prompt decommissioning of the VY Station. If the proposed transaction occurs, ENVY would be renamed NorthStar Vermont Yankee, LLC (NorthStar VY). Throughout my testimony, I refer to Petitioners ENVIC and Entergy Nuclear Operations, Inc., along with ENVY (pre-transfer or in the absence of a transfer) as "Entergy." I refer to Petitioners NorthStar Group Holdings, LLC; LVI Parent Corporation; NorthStar Group Services, Inc.; NorthStar Nuclear Decommissioning Company, LLC; and NorthStar Decommissioning Holdings, LLC, and (post-transfer) NorthStar VY, as "NorthStar." My review included evaluation of how the approach to decommissioning the VY Station would change as a result of the proposed transfer. My review also evaluated the proposed NorthStar plan for decommissioning to identify areas of risk for unanticipated costs, including identifying aspects of the NorthStar plan that are without precedent and that could also result in added costs. My analysis included evaluation of the plans and costs for decontamination and dismantlement as well as storage and management of spent nuclear fuel and site restoration. As part of my review, I prepared, with Gregory A. Maret, the joint expert report submitted as Exhibit DPS-WKB/GAM-

2 to Mr. Maret's and my testimony. I am also sponsoring Exhibits DPS-WKB-3 through DPS-WKB-26, which are cited in my testimony or in the joint report.

Q7. Please describe the scope of your review of the proposed transfer and plan for subsequent decommissioning of the VY Station.

A7. My analysis included review of the Petitioners' Prefiled Testimony, particularly focusing on the testimony of Mr. Scott E. State; the supporting exhibits, and other documents provided by Petitioners in response to information requests; and publicly available documents relevant to evaluating risks associated with the potential costs for decommissioning of the VY Station, including industry information related to decommissioning of other plants.

Q8. What conclusions did you reach concerning the proposed transfer of the VY Station to NorthStar and the plan for subsequent prompt decommissioning?

A8. Based on information currently available, my conclusions are:

1. Provided that funding assurance can be established, a DECON option is preferable to a SAFSTOR approach.
2. If Entergy were to adopt certain of NorthStar's fundamental assumptions about the funding and performance of decommissioning, Entergy could begin decommissioning promptly and finish in about the same time as NorthStar is proposing.
3. There are risks of costs exceeding estimates due to unknown or changing conditions.

4. There are risks of unanticipated costs related to spent fuel storage and management.
5. There are risks of unanticipated costs related to site restoration.
6. Some of NorthStar's assumptions and elements of its proposed approach to decommissioning are unprecedented and thus, present risk of added costs.

Q9. What is the significance of risk of potential unanticipated or added costs related to decommissioning?

A9. Here and throughout my testimony, my use of the term decommissioning is meant to include all post-shutdown activities including those needed to terminate the NRC operating license, those needed to safely store and manage spent nuclear fuel until removed from the site, and those needed for site restoration. While these three categories of costs are governed by different regulations, all three need to be completed to fully decommission the site. It is important that the estimated resources necessary to complete the totality of this work are understood. The risks that can lead to added costs in the decommissioning process need to be identified to allow regulators to have confidence that adequate financial resources are available to support the completion of decommissioning. The risks described in my testimony should be considered in establishing what constitutes sufficient financial assurance for decommissioning of the VY Station.

Q10. What is the fundamental difference in the decommissioning approach being proposed by NorthStar compared to the decommissioning approach that Entergy plans to use in the absence of the transfer of the VY Station to NorthStar?

A10. Absent the transfer of the VY Station to NorthStar, Entergy currently plans to utilize a SAFSTOR approach for decommissioning of the VY Station. Specifically, the VY Station would be placed in a safe condition for storage, and the decontamination and dismantlement of the VY Station could be deferred until about 2068, with completion of decommissioning by 2075. The basis for choosing the SAFSTOR option was to allow growth of the nuclear decommissioning trust fund (NDT) to provide adequate funding for all aspects of decommissioning. NorthStar, on the other hand, plans to utilize a DECON approach, with dismantlement activities starting as soon as the license is transferred from Entergy. Work is already being performed consistent with the NorthStar plan and NorthStar anticipates beginning dismantlement as early as 2019. NorthStar plans to complete decommissioning activities other than spent fuel storage by 2026, with the last spent fuel not being removed from the site until an assumed date of 2052. After removal of spent fuel, the ISFSI would be decontaminated and dismantled.

Q11. Why do you conclude that the DECON option is preferable to the SAFSTOR option for decommissioning?

A11. SAFSTOR presents the risk that regulatory requirements may change and thereby increase decommissioning costs. SAFSTOR also exposes decommissioning to risk that sufficient qualified personnel will not be available at the time dismantlement is to be performed or that the qualified labor pool will be in such demand that costs will be higher than anticipated. There is more uncertainty in

availability of radioactive waste disposal sites decades in the future. Delay in decommissioning also increases the risk that there will be higher-than-anticipated costs, particularly with respect to radioactive waste processing or disposal. Finally, with SAFSTOR, there is risk that the expected financial performance of the decommissioning trust fund will not be met. Of course, with respect to this last risk, the SAFSTOR period does provide a longer period for trust fund growth—provided the fund earnings outpace escalation of decommissioning costs combined with the costs for maintaining the plant in SAFSTOR.

Q12. What is your assessment of the ability of NorthStar to perform the decommissioning of the VY Station sooner than planned by Entergy?

A12. My assessment is that Entergy would be equally capable of proceeding with an approach similar to NorthStar's, if it were to adopt the same assumptions NorthStar makes.

Q13. What is the basis for this assessment?

A13. NorthStar identifies various reasons it can perform the decommissioning earlier than Entergy. NorthStar suggests that its capabilities and approach result in cost savings such that, unlike Entergy, there is no need to defer the start of decommissioning for decades to allow growth of the NDT to adequately fund the work. However, in my assessment, NorthStar's ability to perform the decommissioning earlier is due to differences in the assumptions underlying the Entergy and NorthStar approaches. The difference in assumptions allows NorthStar to demonstrate adequate funding for an earlier decommissioning of the

VY Station. The Entergy estimate is roughly the same as the NorthStar estimate once adjusted to be based on the same assumptions as the NorthStar estimate. The most significant difference in assumptions is the method of funding spent fuel management costs.

Q14. Explain the difference in the Entergy and NorthStar assumptions relative to funding spent fuel management.

A14. Entergy assumes that spent fuel management activities are funded from the NDT. The Entergy plan does not feature credit for anticipated recovery of spent fuel management costs from the Department of Energy (DOE). The Entergy approach requires a substantial SAFSTOR period to allow the NDT to grow sufficiently to pay for spent fuel maintenance, license termination, and site restoration, as well as fund the continued maintenance of the VY Station site during the SAFSTOR period.

By contrast, NorthStar assumes that the vast majority of spent fuel related costs are recovered from the DOE with very little delay between incurring the expense and recovering those costs. As a result of this assumption, the only funds needed from the NDT for spent fuel management are those to cover the spent fuel costs for the period between incurring the expense and recovering it from DOE. This NorthStar assumption eliminates the need for a SAFSTOR period and avoids the considerable costs for plant maintenance during the SAFSTOR period. This one altered assumption reduces the assets required from the NDT by hundreds of millions of dollars.

Q15. Are there any other significant differences in assumptions between NorthStar and Entergy that suggest that NorthStar could perform the decommissioning earlier?

A15. Yes. The Entergy decommissioning estimate includes about 17.3 percent contingency. The NorthStar estimate only includes 10 percent for contingency and profit. (NorthStar combines those concepts.) This changed assumption reduces the NorthStar estimate by about $37 million.

Additionally, as discussed later in my testimony, the 10 percent contingency/profit included in the NorthStar estimate can be claimed as each task of the decommissioning is completed, and under the NorthStar approach, any unused contingency included need not be made available to pay for other activities. NorthStar has indicated that it may make some amount of the profit it captures after completion of a given task available to fund cost overruns of other activities until the decommissioning is complete, but it has made no firm commitment to do so.

Q16. What is the significance of these cost calculations?

A16. If Entergy were to utilize the same assumption being used by NorthStar concerning funding of spent fuel management costs, and also reduce the contingency in the estimate to 10 percent consistent with the NorthStar estimate, the total decommissioning costs estimated by Entergy and NorthStar would differ by only about 1.6 percent. This difference is less than the NorthStar estimated NDT fund balance at the completion of decommissioning. This is not to say there is no difference in the Entergy and NorthStar estimates aside from the

assumptions discussed. Rather, the point is that any differences aside from these three assumptions are small and, if Entergy were willing to adopt the same assumptions being made by NorthStar, Entergy would be equally capable of commencing decommissioning earlier, as NorthStar proposes to do.

Q17. What other analysis of the proposed transfer and plan for decommissioning the VY Station did you undertake?

A17. I have analyzed the areas of risk that may result in the cost to decommission the VY Station being greater than estimated by NorthStar. I also analyzed the extent to which there is a lack of precedent for certain assumptions and approaches in the NorthStar plan.

Q18. What are the general risks that may result in decommissioning costs exceeding estimates?

A18. There are four general types of risks:

1. Performance risk, or the risk associated with completing the defined scope of activities within the estimated schedule and cost;
2. Scope risk, or the risk that the defined scope does not consider all activities required, that new activities are identified during decommissioning, or that conditions change during the decommissioning and require additional work;
3. Regulatory risk, or the risk that the rules governing performance of the work can change; and
4. Financial risk, or the risk that one or more of the financial assumptions used for the funding analysis was incorrect.

Generally contingency is included in estimates only to account for performance risk. Scope risk is sometimes dealt with by added contingency or inclusion of allowances. Moreover, the planned work generally incorporates strategies to minimize or mitigate changes of scope. Regulatory risk and financial risk are generally addressed in financial analyses based on, but separate from the cost estimate.

Q19. Why is it necessary to consider all of the general types of risks?

A19. It is important that there are funding sources available to handle the higher costs that can result from any of the types of risks.

Q20. Describe the specific categories of risks you have identified that can result in higher than anticipated costs.

A20. The risks can be grouped into three categories. The first category is risk associated with less than complete knowledge or changing knowledge of the conditions of the site and the scope of work needed to complete the license termination and site restoration. The second are risks associated with spent fuel management and recoveries of spent fuel related costs from DOE. The last category of risks consists of items associated with site restoration activities beyond the risks associated with knowledge of site conditions. Except as specifically noted in my testimony, the risks I have identified would generally apply to both the Entergy and NorthStar approaches. However, the ability or commitment of Entergy or NorthStar to fund the added cost resulting from these risks may be different.

Q21. Why does incomplete knowledge of site conditions create risk of unanticipated costs?

A21. The condition of the site is an essential input in evaluating the work that will be required to complete decommissioning. Thus, knowledge of the site conditions is a fundamental factor in determining the decommissioning costs. Prior to initiating a decommissioning project, work referred to as site characterization is performed to establish the site conditions. Characterization typically involves a combination of historical records reviews, surveys, and sampling or other forms of direct observations and measurements.

Regardless of the extent of the characterization work performed, site conditions are never known with absolute precision. This is in part because some conditions, including levels of contamination in structures, equipment, or soils, cannot be determined until some dismantlement work has been performed. Nonetheless, the more thorough, detailed, and up-to-date the site characterization is, the less risk there will be in establishing the scope of work and cost of decommissioning.

Reports on experience from other decommissioning projects have identified the importance of complete site characterization in minimizing the risk of unanticipated costs. For example, in the case of the decommissioning of Connecticut Yankee, results of characterization work that became available after Bechtel had been hired as the decommissioning contractor led to a dispute about the scope of work. Ultimately, based on Bechtel's view that the new

characterization work represented an unanticipated scope of work, Bechtel did not perform the decommissioning.

Q22. What is the difference in the concern about inadequate site characterization for a SAFSTOR approach as planned by Entergy and a DECON approach as proposed by NorthStar?

A22. Under a SAFSTOR approach some contaminants can decay or change during the lengthy SAFSTOR period such that the risk of unknown areas of contamination is greatly reduced or eliminated. For example, the radioactive isotope tritium has a half-life of about 12.5 years and thus, a SAFSTOR period of 50 years would result in the tritium concentration decreasing to about six percent of the initial value. DECON does not allow for similar decay. Radioactive contaminants with substantially longer half-lives would also decay, but not sufficiently to eliminate concerns with finding unknown areas of contamination. Non-nuclear contaminants have no similar decay process but may decrease during a long SAFSTOR period by dilution, diffusion, or other process. A DECON approach does not allow for the concentration of contaminants to decrease.

Q23. How does the concern about unknown site characteristics resulting in unanticipated work specifically relate to the planned decommissioning of the VY Station?

A23. NorthStar's proposed decommissioning relies on characterization work performed by Entergy in the form of historical records assessments and routine historical radiation surveys conducted as part of plant operation. There was a site

assessment performed in 2001 that included some contemporaneous sampling and measurements, but site conditions may have changed in the intervening 16 years. The presence of tritium and strontium contamination in groundwater has been identified, which can result in redistribution of contamination. Additionally, there has been an ongoing issue with contaminated water leaks into the turbine building. This can lead to contamination of additional concrete and soil and require additional efforts to collect and dispose of contaminated water.

NorthStar has identified routine radiation survey maps maintained during operation as part of the information relied on to understand the scope of decommissioning work. While such survey maps are useful information and may show the locations of areas of contamination, they do not provide data to allow assessment of the depth of contamination and the amount of material that will have to be removed.

Q24. What other information suggests the possibility that unanticipated site conditions may be discovered during decommissioning of the VY Station?

A24. NorthStar's response to another discovery request suggests that its knowledge of the site conditions is incomplete. In Exhibit DPS-WKB-3, A.ANR:NS.2-65, four separate areas and instances of contamination of various types at the VY Station are discussed. In each of the four cases, the response points out that the conditions were identified prior to Entergy ownership of the VY Station and that the Petitioners lack any direct knowledge of the conditions. In discussing one of the situations, the Petitioners acknowledge that additional work may be required.

The VY Station began operation in 1972 with Entergy taking over in 2002. Thus, there were over 30 years of plant construction and operation prior to Entergy ownership and operation. The Petitioners would lack direct knowledge of any other situations occurring during this more than 30-year period. As between Entergy and NorthStar, Entergy would have greater opportunity to know about events that may have impacted site conditions since 2002.

Q25. Please summarize your findings regarding the risk of unanticipated costs due to unexpected site conditions.

A25. Unanticipated conditions can result in cost impacts ranging in magnitude from relatively small to extremely large. During the decommissioning of the Humboldt Bay nuclear plant in California, unanticipated contamination was discovered that resulted in almost $200 million of added work. Unanticipated contamination discovered after the start of the decommissionings at Connecticut Yankee and Yankee Rowe resulted in significant added scope and schedule impacts. Regardless of the extent of work to understand site conditions conducted prior to the initiation of decommissioning work, there will always be uncertainty in what will be encountered once the decommissioning is underway. The possibility of discovery of unexpected conditions and resulting unanticipated costs should be accounted for in assessing the financial assets needed for decommissioning.

Q26. What are the risks of unanticipated costs from changing plant conditions?

A26. During decommissioning, events can occur that result in unanticipated conditions and unanticipated costs. Mishandling of radioactive or non-radioactive hazardous

materials can create new areas of contamination requiring added work for remediation and hence unanticipated added costs.

An extreme example would be some sort of fuel-handling event while loading or transferring spent fuel to the ISFSI. The NRC requires plant licensees to consider fuel handling events and to analyze the consequences of such events to demonstrate that occurrence of such event would not result in risk to the health and safety of the public. Although such an event may be evaluated as presenting little or no risk to the public, such an event could spread contamination requiring additional cleanup work. Even without spreading contamination, such an event would result in unanticipated costs necessary to analyze the cause of the event, to develop actions to prevent another occurrence, and to implement those actions. The schedule delay resulting from these activities would also result in additional costs associated with maintaining the plant organization and infrastructure for a longer time. These additional costs could impact the decommissioning cost estimate in ways that affect all aspects of decommissioning.

Q27. Are there other sources of unanticipated costs based on uncertainty about site conditions?

A27. Yes. Aside from the type of unknown or changing conditions already discussed, there are other types of unanticipated conditions that may be encountered during decommissioning. Such changing conditions can be in the form of changes in regulatory requirements, difficulties with equipment, schedule delays, or identifications of physical features of plant structures that make removal more

difficult. The report on the Connecticut Yankee decommissioning experience notes that "many times the need for additional funding is identified during the implementation of a power plant decommissioning." The Humboldt Bay decommissioning project encountered numerous issues resulting in an unanticipated increase in decommissioning costs of about $449 million between 2009 and 2011—an increase of about 84 percent in the expected decommissioning cost.

[redacted]

Q28. Why are schedule delays important if work is being done under fixed price contracts?

A28. The NorthStar estimated costs are based on a timeline of performance. NorthStar relies on the use of fixed price contracts and performance bonds to suggest that schedule delays or scope increases for individual tasks will not result in unanticipated costs. However, when the schedule of a fixed price contract is extended, the direct payment for the contract scope may not increase, but the schedule delay could extend the period for providing other support services such as project management, health physics, utilities, maintenance, and warehouse services, and hence add to overall costs. These added costs that are not part of the fixed-price scope but necessary to complete that scope are considered cascading costs. For example, the lengthened schedule can result in payment for project management over a longer period. Similarly, support services such as health physics support may be required over a longer period, resulting in increased costs. There has been no explanation of how the NorthStar approach will eliminate the possibility of such additional cascading costs, and NorthStar has provided no explanation as to how such additional costs would be funded.

Q29. What are the potential risks of unanticipated costs associated with spent fuel management?

A29. As an initial matter, NorthStar assumes that funds from the NDT can be used to pay for spent fuel management costs. NorthStar has stated that money recovered from the DOE will be put back in the NDT to limit the amount outstanding from the NDT at any given time to no more than $20 million. Based on my experience

in the industry, it is not clear to me that even this limited use of NDT funds for spent fuel management would be allowed.

Entergy obtained an exemption from the NRC to allow use of funds from the NDT for fuel management costs as well as license termination costs. Exhibit DPS-WKB-6, Letter from James Kim, U.S. Nuclear Regulatory Commission, to Site Vice President, Entergy Nuclear Operations, Inc., Re: Vermont Yankee Nuclear Power Station – Exemptions from the Requirements of 10 CFR Part 50, Sections 50.82(a)(8)(i)(A) and 50.75(h)(1)(iv) (June 17, 2015). Entergy is apparently using funds from the NDT to pay for spent fuel storage operating costs. The NRC exemption granted to Entergy was predicated on Entergy's proposed SAFSTOR decommissioning approach. The facts on which the NRC approved the exemption will not be applicable with the NorthStar proposed DECON decommissioning approach. NorthStar has not addressed the applicability of the NRC exemption to NorthStar after the transfer of the VY Station. This risk of adverse NRC action is unique to NorthStar.

Q30. What are the types of risks for unanticipated costs related to spent fuel management?

A30. There are several different types of risks for unanticipated costs related to spent fuel management, including:

- Possible cost for repackaging of spent fuel for acceptance by DOE
- Possible cost for repackaging of spent fuel due to extended storage
- Costs for transfer of spent fuel to DOE

- Offset against recoveries from DOE
- Lower than anticipated or delayed recovery from DOE
- Continued spent fuel storage beyond the assumed date of 2052

Q31. What is the risk that there may be unanticipated costs to repackage spent fuel for acceptance by DOE?

A31. In spent fuel litigation in the Court of Federal Claims, plaintiffs, including Entergy VY, have pointed out that the DOE has taken the position that absent a change to the Standard Contract, loaded spent fuel canisters such as those being used at the VY Station cannot be accepted by DOE. This is despite the fact that the NRC has licensed those canisters for both storage and transport. As a result, those plaintiffs argue that in the future when the DOE starts accepting spent fuel, the loaded canisters will have to be opened and the individual spent fuel assemblies repackaged into DOE transportation casks. At least some of the costs for repackaging will be costs identified in the Standard Contract as being the responsibility of the plant licensee. The need to repackage spent fuel could result in substantial costs.

Q32. Why could repackaging spent fuel result in substantial costs?

A32. NorthStar assumes that the license termination work at the VY Station will be complete by 2026. NorthStar also assumes that DOE will begin accepting spent fuel from the VY Station in 2026. Since decommissioning the spent fuel pool will not be the last activity in the license termination, the NorthStar plan would result in fuel being transferred to DOE after the spent fuel pool is no longer

available. Without the spent fuel pool, there would be no place for the VY site to perform spent fuel repackaging.

One option to provide for repackaging would be to build a new facility. Some work has been performed regarding potential dry transfer facilities.[1] A dry transfer facility would be a heavily shielded facility with remotely operated equipment and an inert atmosphere to allow spent fuel canisters to be opened, the fuel assemblies removed, and then placed in a different cask for transport. No such facility has ever been built and there are formidable challenges in doing so. Cost estimates for such a facility, if proven to be technically acceptable, range as high as $300 million. Of course, once repackaging is complete, the newly constructed dry transfer facility also would have to be decommissioned, resulting in more costs.

Q33. How do you respond to NorthStar's position that repackaging spent fuel may not be required (see Exhibit DPS-WKB-7, A.DPS.NS.2-25)?

A33. While there is uncertainty in predicting any future requirement, plaintiffs, including Entergy, have argued and courts have agreed that, at present, the appropriate assumption is that repackaging will be needed.[2] As a result, until such time that there is certainty as to whether such repackaging will or won't be needed, the conservative approach is to plan to accommodate such repackaging.

[1] U.S. Government Accountability Office, "Nuclear Waste Management: Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives," at 55 (Nov. 2009).
[2] *System Fuels, Inc. v. United States*, 818 F.3d 1302, 1307 (Fed. Cir. 2016).

Q34. What is your opinion of the NorthStar position that, even if repackaging is required, all of costs will be recoverable from DOE?

A34. I do not agree with that position. At a minimum the cost of the activities needed to actually place the spent fuel into the DOE cask may be determined to be activities required of the plant owner in accordance with the standard contract. Those costs would likely be different than the transfer costs in NorthStar's model. Beyond that, until repackaging is performed and a claim for related costs submitted and adjudicated, it is my opinion that it is unreasonable to assume all claimed costs would be recovered. Additionally, even if all costs are awarded, some funding mechanism would be needed to fund the considerable costs until recoveries from DOE could be realized. There would be costs associated with such a funding mechanism as well as for preparation and litigation of the DOE claims.

Q35. Is there any alternative to constructing a dry fuel transfer facility?

A35. Yes. Because the canisters in which the VY Station spent fuel is packaged are generally licensed for both transport and storage (subject to confirming that the specific fuel elements are included within the licensed content for transport or modifying the license to include them), the sealed canisters could be transported to another location for repackaging. This other location could be another nuclear power plant with an active spent fuel pool or some other commercial facility constructed for the purpose of performing the service of repackaging. This

approach would involve substantial technical, regulatory and political issues; in the end, it could be as expensive as constructing a dry transfer facility.

Q36. Explain the possible costs for repackaging of spent fuel for extended storage.

A36. The NRC is working to understand whether there are age-related effects on spent fuel storage canisters. Although the NRC is still performing research and has identified possible aging effects, it has concluded that spent fuel can be stored in dry storage for extended periods. The NRC is evaluating the length of such storage, and has included in its evaluations an assumption that the fuel would be repackaged every 100 years. Until the NRC states definitively that this assumption is not valid or DOE begins acceptance of spent fuel within a time frame that makes the assumption irrelevant, the possibility that fuel could be stored at the VY Station for 100 years and need to be repackaged should be included in post-shutdown planning.

Q37. How would potential costs for repackaging due to extended storage compare to the potential costs for repackaging to deliver fuel to DOE?

A37. They are very similar. The key difference is that the spent fuel would be repackaged into new storage containers rather than into transportation casks.

Q38. What are the potential costs associated with transfer of spent fuel to DOE?

A38. [redacted] There are two categories of costs related to transfer of sealed spent fuel canisters to DOE; infrastructure costs and recurring costs.

Q39. What are the infrastructure costs associated with transfer of spent fuel to DOE?

A39. By the assumed time that DOE will begin taking spent fuel from the VY Station, there will be no site infrastructure left to accomplish the transfer of the sealed canisters to transportation casks, pursuant to NorthStar's plan. A facility for the transfer will have to be constructed including one or more cranes with lifting capacities of around 125 tons. [redacted]

Q40. What is the likely cost of a cask transfer facility?

A40. A cask transfer facility will have to address concerns that the NRC has identified related to the seismic stability of vertical casks systems such as the Holtec system used at the VY Station. The specific concern relates to an activity called the stack-up operation. The stack-up operation is part of the process of loading a sealed spent fuel canister into a storage or transportation cask or transferring a loaded canister from a storage cask to a transportation cask.

A cask transfer facility at the VY Station would have to address this seismic stability concern. A cask transfer facility to address the seismic stability concerns at Entergy's Arkansas Nuclear One site has been estimated to cost in excess of $20 million. A DOE commissioned study of spent fuel options estimated the cost of such a facility at about $23 million.

Q41. What are the recurring costs associated with the transfer of spent fuel to DOE?

A41. [redacted] These fixed costs include ongoing costs for personnel training and mobilization and for mobilizing equipment. These types of costs [redacted] would be incurred on a calendar basis for each spent fuel transfer campaign over a period of 27 years, under NorthStar's proposal.

Q42. What other fixed costs would there be related to fuel transfer?

A42. To accomplish the transfer to DOE, one or more cranes would have to be purchased or leased. It is possible that such cranes could be part of the cask transfer facility but there would still be costs for maintenance of this equipment and maintaining the certification of the equipment over a period of 27 years. Alternatively, if the crane or cranes were leased, there would be recurring costs for mobilization and leased time. The mobilization costs for large cranes can be

very substantial. [redacted]

[redacted]

Q43. What is the risk of potential offsets against recoveries from DOE?

A43. In the DOE spent fuel litigation, the government has argued that there should be an offset for costs that licensees would have incurred to load spent fuel for shipment by DOE. Ultimately, the Court of Appeals for the Federal Circuit ruled that the cost of loading fuel for transfer to DOE has not been avoided, but instead deferred.[3] The Court stated that these deferred loading costs would have to be paid by the licensee at the time DOE does perform. The value of these deferred responsibilities will be established in the future. However, until such time as DOE begins acceptance of spent nuclear fuel and that value is established, the potential exists that the value of these deferred responsibilities could exceed the fuel transfer costs estimated by NorthStar by millions of dollars. NorthStar has not addressed this potential added cost.

Q44. What are the potential costs related to lower than anticipated or delayed recovery from DOE?

A44. There are potential costs related to the assumed magnitude of recoveries from the DOE as well as potential costs related to the timing of such recoveries and costs for obtaining the recoveries.

Q45. What is the concern about the magnitude of recoveries from DOE?

[3] *Carolina Power & Light Co. v. United States*, 673 F.3d 1271 (Fed. Cir. 2009).

A45. First, NorthStar assumes the recovery of 90% of spent fuel management costs from DOE. [redacted] There is the potential that recoveries may be less than assumed by NorthStar. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

Q52. What are the risks of added costs from continued spent fuel storage beyond 2052?

A52. If DOE does not begin spent fuel acceptance on a time frame that supports removal of all spent fuel by 2052 as assumed in the NorthStar model, or if the rate of acceptance is slower than assumed, then additional spent fuel storage costs will be incurred. A precise calculation of how that would affect total costs depends on the assumption about what fraction of incurred costs is recoverable from DOE, the timing of those recoveries, and the cost incurred in pursuit of the recoveries. Potential spent fuel storage beyond 2052 and associated added costs should be

considered in the financial planning. NorthStar has not addressed such added costs.

Q53. What are risks of unanticipated costs related to site restoration activities?

A53. Beyond the risks associated with unexpected site conditions as discussed earlier in my testimony, there are risks related to:

- The magnitude of resources available to fund site restoration activities;
- Site restoration standards; and
- Concurrent license termination work and site restoration work.

Q54. What is the risk related to the magnitude of the resources available to fund site restoration activities?

A54. The Entergy PSDAR for the VY Station identifies costs of about $57 million for site restoration. Entergy's evaluation of the adequacy of the NDT to fund license termination work and spent fuel management concludes that there will be at least $57 million available from the NDT for site restoration activities. In addition, Entergy agreed to establish a separate site restoration trust (SRT) fund that Entergy funded in the amount of $25 million to provide more resources to fund site restoration activities. With at least $57 million available from the NDT for site restoration and an additional $25 million in the SRT, there would be at least $82 million available for site restoration activities at the VY Station under the Entergy model.

In contrast, the NorthStar estimate only identifies a total of $25 million for site restoration costs, with the only funds specifically available for site restoration

being the funds in the SRT. This is less than one-half of the Entergy estimate for site restoration costs and less than one-third the total funds available for site restoration under the Entergy model.

The NorthStar analysis predicts a balance of $17 million at the end of decommissioning. If this surplus were available for site restoration activities, NorthStar would have a total of $42 million available for site restoration. This is only about one-half of the funds available under the Entergy plan.

If one assumes site restoration costs consistent with the Entergy estimate, the NorthStar analysis would then show a deficit of about $15 million rather than a surplus of about $17 million. NorthStar has not addressed the significant decrease in the amount of funds available for site restoration as compared to the Entergy estimate or how NorthStar will deal with potentially higher costs for site restoration activities.

Q55. Doesn't NorthStar have a $125 million support agreement that could be used to fund higher site restoration costs?

A55. NorthStar has indicated that the $125 million support agreement cannot be used to pay for activities that are solely related to site restoration. Exhibit DPS-WKB-22, A.DPS:NS.2-16.

Q56. What are the risks associated with site restoration standards?

A56. The specific site restoration standards that would apply can significantly affect the cost of site restoration work. For example, based on work in estimating site restoration costs for other sites, requiring all subsurface material to be removed—

rather than only the material down to a few feet below grade—could increase the costs by as much as $100 million. To the extent NorthStar would accept deviations from its assumptions about site restoration standards and the associated costs, it has not accounted for the risk of more costly site restoration standards in its funding plan.

Q57. Explain what you mean when you refer to concurrent license termination and site restoration work?

A57. NorthStar has proposed that license termination and site restoration will be performed concurrently; rather than sequentially as Entergy would undertake those activities. As described by NorthStar, the Entergy approach would involve first removing radioactivity from concrete structures and then, after license termination work is complete, demolishing and removing the remaining building structure. NorthStar, on the other hand, would generally demolish the structure and remove it from the site as part of license termination.

Q58. What are the risks associated with the NorthStar approach of concurrent license termination and site restoration work?

A58. There are three main risks. The first risk is increased opportunity for the spread of contamination and the concomitant cost increases that would accompany it. The second is added cost from mixing clean and contaminated waste streams. The third is a management risk of improperly segregating financial resources.

Q59. Describe the risk of increased spread of contamination to the costs of decommissioning activities.

A59. The demolition of buildings and structures before they have been decontaminated creates potential for the spread of contamination and generation of unanticipated work. Spreading of contamination can result in the need for additional remediation activities with added associated costs. Alternatively, mitigating measures could be implemented to prevent the spread of contamination—but such measures involve added costs. NorthStar has not explained how this concern would be addressed in its proposed approach to concurrent license termination and site restoration.

Q60. What is the risk associated with mixing waste streams?

A60. If the license termination (decontamination) work is performed first, there is a resulting stream of contaminated waste to be disposed of as radioactive waste. The subsequent structure dismantlement creates a separate and discrete stream of non-radioactive waste. However, if the structure is demolished without first decontaminating it, there is one waste stream, all of which must be disposed of as radioactive waste. A larger volume of material treated as radioactive waste and/or added work to develop and implement programs to separate the total waste into a radioactive waste stream and a non-radioactive waste stream will result in greater costs. NorthStar has not identified how this concern would be addressed in its proposed concurrent license termination and site restoration approach.

[redacted]

[redacted]

Q62. Explain the management risk associated with improperly segregating financial resources.

A62. With the normal sequential approach there is a distinct temporal differentiation between costs for license termination and costs for site restoration. With the NorthStar approach, there would be no real temporal or physical distinction between the two cost streams. A process or procedure that has not been described would have to be devised to allocate costs between the two activities. No matter the procedure, neither the procedure nor the implementation of it will be perfect. Thus, there is the risk that funds intended for site restoration will be used for license termination. NorthStar has not provided any detail on how the allocation of costs will be accomplished.

Q63. Is there any other reason to be concerned about the segregation of financial resources?

A63. Yes. NorthStar has not addressed the applicability of the NRC exemption granted to Entergy to NorthStar after the transfer of the VY Station. Further, the exemption granted to Entergy did not include the possible use of NDT funds for site restoration activities. NorthStar has not addressed the ability to use NDT funds for site restoration work if the cost of site restoration exceeds the funds in the SRT.

Q64. Explain your finding that some of NorthStar's assumptions and elements of its proposed approach to decommissioning lack precedent and thus, present risk of added costs.

A64. There are certain assumptions or approaches included in the NorthStar plan for decommissioning the VY Station that depart from the normal industry practice to date. Specifically, these are:

- Allowing subsurface equipment to remain in place
- Use of contaminated rubble for backfill
- Contingency or potential profit
- Level of contingency
- Use of contingency

Q65. What is the significance of allowing subsurface equipment to remain in place?

A65. The practice in previous decommissioning projects and in the decommissioning plans I have reviewed is to remove all equipment and dispose of it as clean or radioactive waste as applicable. There have been exceptions to this, particularly with respect to embedded piping, but generally all the equipment is removed. After removal of the equipment, radioactive contamination is removed from the remaining structure as needed to allow demolition of the reactor building. The foundations and building structures are removed to some depth below grade. Below the specified depth, the foundations and building structures have been decontaminated to the extent needed to meet NRC license termination criteria and the resulting foundations and structure remain in place. Subsequently, the subsurface void is backfilled.

The NorthStar proposed approach would remove building foundations and structure to four feet below grade and allow equipment below that depth to remain in place provided that the equipment meets the license termination criteria. This approach, which allows equipment and not just foundations and building structures to remain in place, creates a concern with the mechanical process of filling the subsurface void.

Q66. What is your concern with the proposed process of filling subsurface voids?

A66. In the common approach where all equipment is removed, the remaining subsurface building structure is a series of large void spaces. By appropriate demolition of floors or other structures, this can be reduced to essentially one large void space for each building. Backfilling a large open void can be accomplished reasonably easily ensuring little or no remaining voids that could lead to future sinking of the ground surface or creation of holes.

If equipment such as pipes, tanks, or ductwork are left in subsurface spaces, the geometry of the void to be filled is much more complicated requiring more effort to fill and increasing the potential that there are substantive voids remaining. In fact, equipment with internal voids could corrode over time and result in new voids, leading to greater risk of surface instability over time. NorthStar has stated that such items would be filled with concrete or other material to ensure stability. However, NorthStar has not identified the cost of actions to determine what can be left, to select what needs to be filled with

concrete or other material, and to actually fill such equipment—compared to the cost of simply removing all of the equipment.

Q67. Do you have any other concerns about NorthStar's proposed approach that would allow subsurface equipment to be left in place?

A67. Yes. NorthStar has not addressed the extent of equipment expected to be left in place, how particular equipment to be left in place will be differentiated from equipment to be removed, how this selection process will be controlled, or how the process of backfilling the space will ensure that the resulting site is stable given the presence of remaining equipment.

Q68. What is the NorthStar approach to the use of rubble for backfill?

A68. NorthStar proposes to allow concrete meeting the "applicable radiological and non-radiological standards for radiological decommissioning and site restoration" to be crushed (rubblized) and used at the VY site as fill material. NorthStar states that its proposal is consistent with the approaches used at Yankee Rowe and Connecticut Yankee.

Q69. Do you agree that the approach being proposed by NorthStar is consistent with the approaches used at Yankee Rowe and Connecticut Yankee?

A69. No. As noted by NorthStar in response to a discovery request, Connecticut Yankee was authorized to reuse concrete debris as fill but ultimately did not implement such reuse. For radiological decommissioning (license termination), there is a process used to determine required radiological cleanup limits. This process, subject to NRC approval, establishes allowed limits for the amount of

various radioactive isotopes that can remain in material left on site. These limits are referred to as Derived Concentration Guideline Levels (DCGL). NorthStar would allow rubblization and use of any concrete material as fill as long as reuse of that material does not result in exceeding the DCGLs. Yankee Rowe proposed reuse of concrete, which was ultimately allowed but with different limitations than the NorthStar proposal. The Commonwealth of Massachusetts ultimately directed that the reused concrete be limited to material with "no distinguishable plant related radioactivity above background." Thus, the NorthStar proposed approach is not consistent with what was approved or done at Yankee Rowe.

Q70. What is unique about NorthStar's approach to contingency or potential profit?

A70. NorthStar includes in each task a "contingency or potential profit margin" in an amount equal to 10 percent of the estimated cost of the task. This approach is different from other decommissioning plans and cost estimates. Generally, any profit for contractor work is embedded within the base estimated cost and a separate contingency is added. There is generally no profit included for work that is self-performed. NorthStar has not addressed why it is departing from the normal approach to contingency and profit.

Q71. What is unique about the level of contingency included in the NorthStar decommissioning cost estimate?

A71. The level of contingency (or potential profit) is 10 percent. Although NorthStar discusses this value as contingency or potential profit, it is clear that the full 10 percent could be used as contingency if needed to complete that specific task (but

not others). Thus, in a general sense, this means that the NorthStar estimate has 10 percent contingency. This is much less than the contingency in the Entergy estimate for the VY Station and less than the level of contingency I have seen in preparing and reviewing decommissioning cost estimates for other facilities.

Q72. What level of contingency would be consistent with your experience?

A72. Decommissioning cost estimates often apply contingency on a line item basis with different levels of contingency for different types of work. In a few cases I have seen a single line added to the estimate that represents the total contingency for the project. Regardless of the way contingency is estimated, the total contingency is normally between 15 and 20 percent, with some estimates as high as 25 percent.

Q73. If the level of contingency were made consistent with your experience, what would be the change in total project cost?

A73. The estimated NorthStar costs from 2019 through 2052 are about $520 million excluding spent fuel management costs. Increasing the level of contingency to 15 percent would add about $24 million to the total cost. The Entergy cost estimate included in the Entergy PSDAR submitted to the NRC included 17.3 percent contingency. Increasing the percent contingency in the NorthStar estimate to 17.3 percent would increase the total cost estimate by almost $35 million. At 25 percent, the high end of the range of contingency in decommissioning estimates, about $71 million would be added to the NorthStar estimate.

Q74. What is unusual about NorthStar's proposed use of contingency?

A74. NorthStar has established a pay-item disbursement schedule. Each pay-item includes 10 percent for contingency or profit. When a task on the pay-item disbursement schedule is complete, NorthStar will collect the full amount allocated to that task, including the additional 10 percent. The amount withdrawn is irrespective of whether completing the task actually cost more or less than the estimated amount reflected in the pay-item schedule.

In other projects, while contingency may be allocated in the estimate on a line item basis, the total contingency in the estimate is treated as a resource that can be used to fund any task as needed. Thus, if a task is completed at a cost equal to or less than the base estimate, no contingency will be used and any contingency identified in the estimate for that item remains available for other tasks.

Q75. Is there a reason that the contingency is usually treated as a resource that can fund any task as needed?

A75. Normally, contingency is included in decommissioning estimates to account for things that are expected to occur such as labor delays, weather issues or equipment failures that increase costs. While the type of events covered by contingency can be largely defined, the precise timing or detail of the events cannot be predicted. Hence it is not possible to definitively know which tasks ahead of time will require contingency or the amount needed for each task.

Q76. What is your concern about the NorthStar approach to the use of contingency?

A76. NorthStar has indicated that the contingency or profit taken may be available to fund other activities, but it is not committing to maintain these funds for such use. Not having "unused" contingency available for other tasks could place added demands on the $125 million support agreement and other financial assurance mechanisms. NorthStar has not explained how its approach addresses the concerns that contingency is generally intended to alleviate.

Q77. Do you have any other concerns about the NorthStar approach to use of contingency?

A77. Yes. In the NorthStar approach, if a task is completed on budget or under budget, NorthStar will take an amount from the trust fund that is greater than the cost of the work. That is, NorthStar will take from the NDT the estimated cost in the disbursement schedule plus the full 10 percent contingency/profit premium associated with that task. It is unclear that withdrawing an amount greater than the actual cost of decommissioning work would be acceptable to the NRC. The proposed NorthStar approach is not discussed in the revised PSDAR or License Transfer Application submitted to the NRC. The NRC might view such an approach as reducing the assets in the NDT available to complete decommissioning.

Q78. Does this conclude your testimony?

A78. Yes, at this time.