UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of: Entergy Nuclear Operations, Inc., Vermont Yankee Nuclear Power Station September 4, 2014 License Amendment Request	Docket No. NRC-2015-0029 Docket No. 50-271

Declaration of William Irwin, Sc.D, CHP

I declare under penalty of perjury that the foregoing is true and correct:

(1) A true and correct copy of my CV is attached to this declaration.

(2) Since December 2005, I have been an employee of the Vermont Department of Health, where I am the Radiological and Toxicological Sciences Program Chief.

(3) In my role at the Vermont Department of Health, I have managed or helped manage environmental surveillance and emergency preparedness for the Vermont Yankee Nuclear Power Station.

(4) I was involved in helping draft portions of the State of Vermont's March 6, 2015 Comments ("State's Comments") on Entergy's proposed Post Shutdown Decommissioning Activities Report ("PSDAR").

(5) I attest to and affirm the factual underpinnings of those portions of the State's Comments that speak to radiological contamination discovered at the site that will likely increase the anticipated costs of radiological decommissioning.

(6) In addition, and without limitation on other statements I could attest to and affirm, I specifically attest to and affirm the factual underpinnings discussed in pages 9-19 of the State's Comments, including, among other things the following:

a. The characterization of the site (radiological and non-radiological) has not yet occurred. Rather, Entergy has elected to wait decades until nearly the end of the allowed SAFSTOR period before engaging in this characterization. The decision to delay characterization calls into question all of the cost estimates that Entergy has provided in its PSDAR and related filings. Without a full site characterization, there is no way to determine what it will ultimately cost to perform radiological decommissioning, spent fuel management, and site restoration.

b. The PSDAR also does not describe the depth and breadth of the planned radiological environmental monitoring program.

c. The PSDAR also inadequately describes radiological emergency preparedness during decommissioning. The basis of emergency planning ignores hostile action based scenarios that could destroy key structures storing radioactive materials or result in a zirconium fuel cladding fire while fuel remains in the spent fuel pool.

d. Throughout the SAFSTOR years, large quantities of radioactive materials in solid and liquid form will be left in storage onsite where leaks have occurred in the past, and may occur again. In

addition to radioactive material storage, inventory management and monitoring, and response to leaks into the environment, there is a serious concern about fire protection for the structures, systems, and components containing radioactive materials in storage. Capabilities to monitor for and respond to these kinds of radiological emergencies are not adequately addressed in the PSDAR.

e. One clear omission from the PSDAR and Decommissioning Cost Estimate is the recent discovery of strontium-90 in locations where that contaminant had not previously been discovered. *See* Vermont Department of Health Communications Office, *Strontium-90 Detected in Ground Water Monitoring Wells at Vermont Yankee* (Feb. 9, 2015), http://healthvermont.gov/news/2015/020915_vy_strontium90.aspx. The Department of Health also found cesium-137, strontium-90, and other long half-life radioactive materials in soil samples taken in 2010. *See* http://healthvermont.gov/enviro/rad/yankee/laboratory_testing.aspx. The Department of Health's publication of results regarding strontium-90 in groundwater wells occurred *after* Entergy submitted its PSDAR. At this point, we already know of at least one way in which the Decommissioning Cost Estimate is incorrect—

namely, the analysis underlying the estimated amount of soil removal that will be needed surrounding the advanced off-gas (AOG) building. On that issue, Entergy has stated the following:

> It should be noted that no additional remediation of the soil in the vicinity of the AOG building was included, based upon the earlier remediation (soil removal) performed by Entergy VY and the findings from the GZA groundwater investigation that *only tritium had migrated into the groundwater*. Tritium is a low-energy beta emitter with a half-life of approximately 12.3 years, decaying to non-radioactive helium. As such, any residual sub-grade tritium is not expected to require any further remediation at the time of decommissioning in order to meet site release criteria.

Decommissioning Cost Estimate, § 3, page 12 (emphasis added; footnote omitted). The Decommissioning Cost Estimate is clearly out-of-date and incorrect in its claim that "only tritium ha[s] migrated into the groundwater" in this area. *Id.* This new data on strontium-90 creates doubt regarding Entergy's claim in the PSDAR that previous excavation of the AOG leakage site eliminates the need to excavate deeper than three feet below grade. *See id.*; *see also id.* at § 3, page 13 (noting that foundations and building walls will only be removed "to a nominal depth of three feet below grade"). Many long-lived radionuclides are likely to be found in soils and groundwater far from the small excavation made to repair the leaks that likely allowed reactor condensate to enter into the site soils for many years. In addition, these same long-

lived radionuclides are likely to be found in the structures, systems, and components left during SAFSTOR and then later decontaminated and dismantled.

f. The presence of strontium-90 or other long-lived radionuclides could greatly increase the costs of decommissioning and site restoration.

g. Long half-life radioactive materials are expected to be found in soils at Vermont Yankee. These include 5,730-year half-life carbon-14, 100-year half-life nickel-63, 29-year half-life strontium-90, 30-year half-life cesium-137, 13.5-year half-life europium-152, and 12.3-year half-life hydrogen-3. *See* Abelquist, Eric W., *Decommissioning Health Physics, A Handbook for MARSSIM Users* (2d Ed. 2014). These radioactive materials and hard-to-detect radionuclides were found in the decommissioning of both Maine Yankee and Connecticut Yankee in addition to transuranics, radioisotopes of plutonium, curium, neptunium, and americium. *See* Letter from Thomas L. Williamson, Maine Yankee Director of Nuclear Safety and Regulatory Affairs to NRC (Jan. 16, 2002) (ADAMS ML020440651). Further, as the State pointed out to Entergy in the State's December 2014 comments, carbon-14 has been a major issue in the decommissioning of other sites such as Yankee Rowe and is expected to be a concern in the decommissioning of future sites such

as San Onofre. Despite the State's explicit request, Entergy has not yet provided any evaluations, analyses, or other bases for assuming that carbon-14 will not be of concern in decommissioning Vermont Yankee.

h. Conversations with Health Department staff in Maine and with Environmental Conservation Department staff in Connecticut indicate that decommissioning is likely to reveal unanticipated radioactive sources to be remediated. These included pockets of highly contaminated groundwater dammed up by existing structures at Maine Yankee and a 25-foot-deep 225-foot-long excavation of soil around the reactor water storage tank at Connecticut Yankee. These kinds of potential situations are not adequately accounted for in the PSDAR. The PSDAR provides no assurance that the challenges of remediating these radioactive materials are factored into the planning and funding for the decommissioning of Vermont Yankee.

i. Even if strontium-90 had not recently been discovered, the PSDAR would be deficient given other evidence that soil contamination exists—and that remediation is thus likely to be needed—more than three feet below grade. The October 2014 Site Assessment Study documents the 1991 leak in the chemistry lab drain line, the AOG reactor condensate leaks confirmed in 2009, the piping leaks

between the radioactive waste building and the AOG building discovered in 2010, and other spills and leaks of radioactive materials. The area between the Connecticut River, the intake structure, the discharge structure, and the reactor, turbine, and radioactive waste buildings may contain large volumes of contaminated soil requiring excavation to meet the derived concentration guideline levels for appropriate remediation in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual. Significant leakage of reactor condensate and radioactive materials spills have occurred: in the AOG piping tunnel; in piping between the AOG building and the radioactive waste building; in and around the radioactive waste building; in the condensate storage tank courtyard; and between the Connecticut River and the reactor, radioactive waste, and AOG buildings. If Entergy fails to remediate beyond three feet below grade, contamination could reach the groundwater and river water down-gradient of these areas. The PSDAR provides no information to determine whether the human and financial resources required for all necessary soil removal and other remediation will be available at the time the remediation must occur.

j. Entergy's Decommissioning Cost Estimate only addresses so-called contingencies that are "almost certain to occur." Decommissioning

Cost Estimate at xii. Actual contingencies—such as the discovery of strontium-90 and other radionuclides in places not previously thought to be contaminated—have historically led to enormous escalations in decommissioning costs. For instance, at Connecticut Yankee, the discovery of strontium-90—the very same radiological contaminant that was recently discovered in the groundwater at Vermont Yankee—led to an enormous decommissioning cost escalation during the radiological decontamination and dismantlement phase that Entergy intends to postpone until the end of its SAFSTOR period. Yet Entergy categorizes all of these types of potential expenses as "financial risks" and explicitly notes that it "does not add any additional costs to the estimate for financial risk." Decommissioning Cost Estimate § 3, page 6.

(7) In addition, and without limitation on other statements I could attest to and affirm, I specifically attest to and affirm the following factual underpinnings discussed in pages 45-46, 49, 51-53, and 57 of the State's Comments:

a. Regardless of a plant's size, other site-specific factors can—and do—affect the potential environmental and other impacts of decommissioning. For instance, Vermont Yankee has an operating elementary school located just 1500 feet from the reactor building. The close proximity of an operating elementary school cannot be ignored. At a minimum, this factor calls for imposing common-

sense mitigation measures that ensure that schoolchildren are not present during certain decommissioning activities, such as the transfer of spent nuclear fuel or the demolition of buildings containing radioactive or non-radiological hazardous materials like asbestos and lead.[1] It is well known that young children are more vulnerable to adverse health reactions to airborne contaminants such as lead. *See, e.g.*, Vermont Dept. of Health, *Lead Poisoning and Prevention*, http://healthvermont.gov/enviro/lead/ ("Young children are at highest risk because their developing bodies absorb lead more easily. Lead dust exposure can have life-long health effects such as lowering a child's IQ."). Thus, in contrast to Entergy's "bounding" claim, a decommissioning activity such as the demolition of a building that contains lead (and the lead dust created from that) might have minimal or no environmental impacts at a larger plant in an isolated area, but significant consequences at Vermont Yankee if even a small amount of lead dust travels the short distance between the plant and the nearby elementary school. Entergy's PSDAR therefore fails to show that these environmental impacts are bounded by previous analyses.

[1] Despite specific requests for such information by the Department of Health and the Agency of Natural Resources in the December 2014 comments that the State provided to Entergy, the PSDAR is silent on the presence and eventual disposition of asbestos-containing materials and lead-based paint, and Entergy has failed to provide this requested information to either the Department of Health or the Agency of Natural Resources.

b. There is known and unknown contamination at Vermont Yankee from previously identified tritium leaks and the more recently identified presence of strontium-90. Entergy has not analyzed the environmental and other effects of any delay during the SAFSTOR period in addressing such leaks, including the well-known fact that migration will increase the area that is contaminated.

c. Entergy's PSDAR announces for the first time that an estimated 1.3 million gallons of highly radioactive water will be stored in the torus within the reactor building during decades of SAFSTOR. Given that it was not until the PSDAR that Entergy revealed plans to deal with this radioactive water in this manner, this issue raises environmental issues that are obviously not "bounded" by any previous environmental analysis. Nor has Entergy pointed to any previous analysis addressing potential environmental impacts associated with storing radioactive water in this manner. Entergy has not yet identified what instrumentation will be used to monitor torus water levels in the PSDAR or what kind of inspection regimen for possible leakage will be used until this water is properly disposed of as radioactive waste. Further, Entergy has not explained when disposal of this water will occur and how.

d. The PSDAR is also inadequate in terms of its environmental analysis related to the need for extensive groundwater monitoring.

To protect public health, safety, and the environment, Entergy must extensively monitor groundwater until decommissioning is complete and its license has been terminated. After tritium contamination was measured in groundwater at many nuclear power plants, the Nuclear Energy Institute developed the Groundwater Protection Initiative (NEI Technical Report 07-07). Throughout the different phases of decommissioning, Entergy should, at a minimum, maintain its current monitoring levels as required by NEI 07-07 at the Vermont Yankee facility until NRC license termination. This is necessary since radioactive materials will remain in storage for decades before decontamination and dismantling. It is particularly important in light of the Department of Health's recent identification of strontium-90 in groundwater.

e. The recent discovery of strontium-90 in groundwater raises additional concerns regarding soil contamination that may enter the groundwater and move in a way that threatens public health, safety, and the environment. This includes contamination from previously mentioned long half-life radioactive materials, as well as shorter half-life materials in the soils at Vermont Yankee. For instance, cobalt-60, cesium-134, zinc-65, and manganese-54 have been all been documented in soils and as sources in previously investigated leaks at Vermont Yankee. *See* Site Assessment Study;

Department of Health, *Laboratory analyses for soil samples collected March 17, 2010 at locations along the Vermont Yankee Advanced Off-Gas Pipe Tunnel leak pathway*, *available at* http://healthvermont.gov/enviro/rad/yankee/documents/VY_Data_soil_samples_march2010.pdf.

f. Despite the clear need for robust environmental monitoring until license termination, the PSDAR is mostly silent on this subject. For protection of the environment and public health, monthly sampling from all 32 groundwater monitoring wells and all three drinking water wells currently sampled at Vermont Yankee should continue through license termination, and split samples from those wells should be provided to the Vermont Department of Health for independent confirmatory analysis. In addition, Entergy should continue to perform radiological environmental monitoring of the pathways to the public, direct gamma radiation, soils, sediments, fish and other flora and fauna as conducted during operation of the facility until the large volume of radioactive materials stored onsite are removed by decontamination, dismantling, and licensed disposal. Along with those samples currently split with the Department of Health, including onsite groundwater and drinking water, sediments and fish from the Connecticut River, and direct gamma radiation measurements by dosimeter, the State of

Vermont must be provided split samples from the final status surveys that are intended to document that soil and structure remediation will allow release of the site for unrestricted use at NRC license termination. The PSDAR fails to include any such requirement and is thus deficient in this regard.

g. The PSDAR also inadequately describes what fire protection systems will be in place at Vermont Yankee. Throughout every stage of decommissioning, large quantities of radioactive material will exist within the remaining structures, systems, and components until they are decontaminated and dismantled. In the event of a fire, these materials may result in radioactive contamination of, and radiation doses to, firefighters and other first responders. Consumption by fire of radioactive materials may also result in offsite contamination. No evidence is provided in the PSDAR that local fire department personnel are fully prepared for onsite firefighting with limited support offered by reduced staff at Vermont Yankee. There is also no evidence in the PSDAR as to how offsite responders can manage offsite contamination that results from fires that consume radioactive materials stored onsite.

(8) In light of these and other concerns, there is a significant risk that the Vermont Yankee Nuclear Decommissioning Trust Fund will have a shortfall and will not be able to cover all of the costs of radiologically decontaminating the site if

the Nuclear Regulatory Commission does not closely monitor withdrawals from that fund.

Executed on April 20, 2015 in Montpelier, Vermont

/s/ *William Irwin*
William Irwin, Sc.D., CHP
Vermont Department of Health
Radiological and Toxicological
Sciences Program Chief
108 Cherry Street
Burlington, VT 05401