



Decommissioning the Vermont Yankee Nuclear Power Plant and Storing Its Radioactive Waste

By Fairewinds Associates, Inc
For the Joint Fiscal Committee
January 12, 2011



Canisters of radioactive waste awaiting burial at the Waste Control Specialist site.

Courtesy of WCS

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Introduction

Fairewinds Associates, Inc first notified the Vermont State Legislature of its concerns regarding the decommissioning fund for the Entergy Nuclear Vermont Yankee Nuclear Power Plant. Our initial decommissioning reports are:

- *Decommissioning The Vermont Yankee Nuclear Power Plant: An Analysis Of Vermont Yankee's Decommissioning Fund And Its Projected Decommissioning Costs, 11-2007*
- *Decommissioning Vermont Yankee Stage 2 Analysis of the Vermont Yankee Decommissioning Fund: The Decommissioning Fund Gap, 12-2007*

Other more recent Fairewinds Associates' reports are posted on the Joint Fiscal Office (JFO) website. <http://www.leg.state.vt.us/jfo/>

Recommendations

1. An updated and independent decommissioning analysis of the Vermont Yankee nuclear plant should be completed prior to any Legislative discussion of Vermont Yankee decommissioning costs.
2. The allocation of the Decommissioning Fund Stocks should be determined.
3. A new wholly independent contractor should be chosen to perform a new and updated decommissioning analysis.
4. Texas Compact Contract and By-Laws require significant review and adjustment in order to fully protect Vermont.

The aforementioned recommendations are based upon the following seven concerns:

Concern 1 Entergy's Vermont Yankee decommissioning analysis is technically and economically outdated.

While the Decommissioning Cost Analysis for the Vermont Yankee Nuclear Power Plant, TLG Services, Inc. January 2007 (Document E11-1559-002, Rev 0) is the decommissioning document of record for Entergy Nuclear Vermont Yankee (ENVY); it is technically and economically outdated. Created in 2006 and submitted to the Vermont Department of Public Service in January 2007, the TLG decommissioning analysis is more than 4-years-old and thus does not reflect current economic analysis or current technical changes.

- 1.1 First, escalation and inflation factors have changed and may no longer be accurate. Now that Vermont Yankee is only one-year away from the end of its license and ultimate decommissioning, it is imperative that accurate financial data be generated. The TLG report do not reflect the current US economic status and is based upon data and opinions created more than four-years ago under very different economic conditions.
- 1.2 Second, new technology has been developed which may dramatically decrease the cost of decommissioning, and those options have not been analyzed for their application to the decommissioning of Vermont Yankee. Located about 40-miles north of Chicago, the Zion Illinois nuclear power plant is applying a new methodology in nuclear decommissioning¹. [See Attachment 1, Matt Wald, NY Times Zion Decommissioning]
- 1.3 Third, The new decommissioning method being applied at Zion increases the amount of radioactive waste shipped and stored at a waste disposal site at the same time it improves utilization of craftspeople onsite and thus reduces the overall cost of decommissioning a nuclear plant even while more radioactive waste is shipped. Since the net effect of this new approach is that more radioactive waste is generated, this new methodology, if applied at Vermont Yankee, will require more land at the Texas Compact waste disposal site. [See Concern 7: Shipping Vermont's Nuclear Waste to Texas.]
- 1.4 Fourth, new computer software has optimized the methodology for packaging radioactive waste material for shipment thus significantly reducing costs by optimizing the shipping

¹ *After the Nuclear Plant Powers Down*, Matthew L. Wald, *New York Times*, November 22, 2010.
http://www.nytimes.com/2010/11/23/business/23nuke.html?_r=1&hp

size of the waste and associated shipping costs. [See Attachment 2, Decommissioning Software]

- 1.5 Fifth, the site is facing significant site contamination not assessed in ENVY's 2007 TLG report, and since the TLG report is also only based upon a standard generic industry-styled report, it does not accurately reflect any site anomalies. The January 2010 incident of underground pipes leaking radioactivity and contaminating the soil and on-site water table with Cesium-137, Strontium-90 and Cobalt-60, as well as tritium has yet to be factored into ENVY's site decommissioning costs.
- 1.6 Lastly, at the time the 2007 TLG Services Decommissioning Analysis was released, Fairewinds Associates, Inc expressed concerns regarding cash flow, site specificity, and conflict of interest, which are expanded upon in this report.

Concern 2 VY's numerous decommissioning estimates are extraordinarily divergent.

Fairewinds Associates, Inc recommends a new decommissioning cost analysis by an independent firm that is not a wholly owned subsidiary of Entergy like TLG Services is. Previous analysis by Fairewinds Associates, Inc that was presented to the House Natural Resources Committee during the 2010 legislative session has identified an extraordinary variation in decommissioning cost estimates among the various the Entergy TLG decommissioning reports created in 1991, 1996, 2001 and 2006.

Fairewinds Associates detailed this issue in two reports that are available on the Joint Fiscal Office Website.

- July 14, 2010 Report to the Joint Fiscal Committee entitled: Summation for 2009 to 2010 Legislative Year For the Joint Fiscal Committee Reliability Oversight, and
- A Comparison of TLG Services Projected Decommissioning Costs for Vermont Yankee April 2, 2010 Testimony.

The Table below briefly summarizes these two reports and shows the wide disparity in Entergy's estimates.

Summary of VY Decommissioning Projections from all four studies

Study Year	Dismantle \$ (,000)	Restore \$ (,000)	Total \$ (,000)	2012 \$ Dismantle (,000)	2012 \$ Restore (,000)	2012 \$ Total (,000)
1993	254,475	44,258	298,733	536,140	93,245	629,385
1999	480,806	37,500	518,306	740,179	57,730	797,909
2001	514,041	43,722	557,763	791,343	67,308	858,651
2006	468,844	40,053	508,897	593,237	50,679	643,916

Note - Costs escalated at 4% per year

Note that the above table escalates costs at 4% per year in order to accurately compare all four studies in 2012 dollars. Unlike the 1991, 1996, and 2001 studies, the 2006 TLG report combined both Independent Spent Fuel Storage Installation (ISFSI) and decommissioning costs. In writing this table, Fairewinds attempted to separate those two aspects, however the TLG report is written in such a way as to make cost separation very difficult.

Not only are the previous four TLG studies divergent, other experts have provided wildly differing opinions in testimony before the Vermont Public Service Board during a 2-week hearing process in 2009.

According to the May 19, 2009 Associated Press article, TLG's Entergy expert William Cloutier said that decommissioning costs for Vermont Yankee might exceed \$900,000,000.

MONTPELIER, Vt. (AP) - An expert on nuclear decommissioning says current estimates of the costs of dismantling the Vermont Yankee nuclear plant could be too low.

William A. Cloutier Jr., a consultant to Vermont Yankee owner Entergy Nuclear, tells the Public Service Board that several factors could make the costs higher than the \$800 million to \$900 million now estimated.

The testimony of Cloutier, who works for an Entergy affiliate, comes on the heels of the Vermont Legislature's passage of a bill that would require Entergy to shore up the Vermont Yankee decommissioning fund.

Yet only two-months after Entergy employee Cloutier stated that costs might in fact almost reach \$1 Billion, the Department of Public Service engineer Uldis Vanags testified to the Public Service Board that the decommissioning costs for VY would be less than \$560,000,000. Mr. Vanags, a health physicist who participated in the decommissioning of Maine Yankee, testified before the Vermont Public Service Board that the decommissioning costs at VY would be less than those at Maine Yankee (\$560,000,000) because VY is:

“fairly unique in that except for that one line from the chemistry drain line, that underground line carrying radionuclides that contaminated some soils underneath the building, oddly they don't have any other lines carrying radioactive effluents or materials underground, which was not the case at Maine Yankee.” *Docket 7440, Public Service Board Hearing Transcript, June 2, 2009, Page 191-192*

The DPS and Entergy testimonies to the Vermont Public Service Board estimate that decommissioning costs could be as low as \$550,000,000 and could also almost reach \$1 Billion. Such an extraordinarily large range of cost estimates is not conducive to accurate public policy decisions. Mr. Vanags, who has a background in health physics, failed to take into account the significant engineering differences between a Boiling Water Reactor (BWR) like Vermont Yankee (VY) and a Pressurized Water Reactor (PWR) like Maine Yankee. Nuclear Regulatory Commission (NRC) calculations indicate that BWR reactors like VY usually cost at least 40% more to decommission than a PWR because the radioactive steam runs throughout the entire plant engineering system therefore making the plant more radioactive than a PWR and requiring more clean up at the end of plant life. Moreover, as you will note, Mr. Vanag's testimony was based upon the untruthful assertion by Entergy that VY had no underground piping carrying radiation (radionuclides).

The 40-year-old Oyster Creek nuclear power plant in New Jersey is a Boiling Water Reactor (BWR) like Vermont Yankee that is also leaking tritium. Owned by Exelon, Oyster Creek announced December 9, 2010 that it will shutdown in 2019 following 50-years of operation. Unlike VY, Oyster Creek has a decommissioning fund has already accumulated \$750,000,000, according to the New York Times and the Asbury Park Press. In spite of \$750 Million put aside, the news reports claim that the plant may still not have enough money to dismantle the plant without putting it in SAFSTOR for as long as 60-years. According to the latest figures at the end of November 2010, the VY Decommissioning fund contained \$465,000,000, which is almost

\$300,000,000 less than has already been accrued at Oyster Creek. The estimated costs for decommissioning and dismantling Oyster Creek is similar to the 2001 TLG estimate for VY, and shows a wide disparity when compared with the 2006 TLG estimate.

Concern 3 Major incorrect assumption factored into Entergy Nuclear Vermont Yankee's decommissioning costs by TLG Services.

In addition to being based upon an analysis created more than four years ago, ENVY's TLG analysis contained an incorrect assumption that dramatically increased decommissioning cost estimates on paper. Although former vice-president of ENVY Jay Thayer publicly renounced this key financial error in a hearing before the Vermont Senate Finance Committee, the financial inaccuracies in the report itself have never been corrected, and have never been identified or audited by any Vermont agency or commission.

Specifically, ENVY and TLG Services attempted to draw down the Vermont Yankee decommissioning fund by applying the cost of the Interim Spent Fuel Storage Installation (ISFSI) to Vermont Yankee's Decommissioning Fund. Nuclear Regulatory Commission Statute prohibits applying the cost of spent fuel to the plant's decommissioning fund, yet Entergy and TLG Services attempted to subtract these Department of Energy costs from Vermont Yankee's decommissioning fund. In April of 2009, 27-months after the TLG report was submitted, Entergy retracted its effort to strip the fund of these unauthorized costs. All spent (used) fuel storage costs are borne by the Department of Energy since it has failed to produce the federal waste repository upon which nuclear power plant operation and licensure is based.

Background on TLG and VY Decommissioning Scenarios: Prior to the 2006 decommissioning costs analysis by TLG Services, the cost for storing spent fuel (ISFSI) was never included in any estimates. TLG Engineering created its 1991, 1996, and 2001 reports when it was an independent Engineering Services firm prior to its acquisition by Entergy. It was only in the 2006 decommissioning cost analysis, prepared after TLG became a wholly-owned Entergy subsidiary, that it attempted to tap into the VY decommissioning fund for Entergy's fuel storage costs.

In Fairewinds Associates review of other nuclear power plant NRC licensee records there was no evidence of any other attempts by nuclear corporations to raid decommissioning funds in order to subsidize the spent fuel storage (ISFSI) costs. Fairewinds was also unable to find evidence of TLG recommending such methodology at any other nuclear power plant. The 2007 TLG report appears to be the first and only attempt by a nuclear power plant licensee to tap the decommissioning fund to subsidize its interim spent fuel storage.

It has been established law for many years that the costs associated with interim spent fuel storage (ISFSI) should be charged to the Department of Energy and not deducted from any nuclear power plant's Decommissioning Fund. In testimony provided to the Vermont Public Service Board in 2001, Department of Public Service State Nuclear Engineer William Sherman noted that interim spent fuel storage costs were being collected by utilities litigating against the Department of Energy. Mr. Sherman noted that *it was likely that the decommissioning fund could support* the cost to decommission Vermont Yankee, but his analysis specifically excluded the cost of interim spent fuel storage. Interim spent fuel storage was a separate item in Mr. Sherman's testimony in 2001, and it was the position of DPS that these costs would be recovered from the Department of Energy (DOE) and not deducted from VY's Decommissioning Fund. According to Mr. Sherman's 2001 prefiled testimony²:

Q. You mentioned earlier that you used a lower decommissioning estimate than VYNPC. Please describe the decommissioning estimate you used.

A. I used a decommissioning estimate of \$412 million, expressed in 1999 dollars. I believe that, if VYNPC continued to operate the plant until the end of its operating license, it could accomplish decommissioning for \$412 million. To arrive at this amount, I adjusted the VYNPC estimate of \$499 million in the following areas: spent fuel management, site restoration, and low-level radioactive waste burial.

Q. Please describe your adjustment for spent fuel management.

A. VYNPC included costs in its estimate for operations and maintenance of a dry cask facility for spent nuclear fuel until 2031. VYNPC also includes costs for the purchase of dry cask and overpacks. VYNPC assumes the federal government will begin to remove spent fuel from the site in 2010 and complete removing fuel in 2031. The first fuel was scheduled to leave Vermont Yankee in 1999. The federal government has failed to perform a contractual obligation with Vermont

² *Prefiled Testimony of William Sherman on Behalf of the Vermont Department of Public Service*, March 9, 2001, Docket Nos. 6120 and 6460, Page 14 of 18, line 12 (and following)
<http://publicservice.vermont.gov/dockets/6460/6460ShermanRED.PDF>

Yankee to begin removing spent fuel from nuclear sites in 1998, and is liable for damages. Ratepayers have paid for spent fuel disposal through a one-mill charge established by this contract for each kilowatt-hour of Vermont Yankee power produced. Ratepayers should not be liable for paying again for spent fuel disposal, and my expectation is that VYNPC will succeed in receiving fair damages. Therefore, I adjust VYNPC's estimate to assume the federal government began removing fuel in 1999, and I remove from VYNPC's estimate the amounts for casks and overpacks which are required because spent fuel disposal is not available.

Q. What is your opinion regarding whether the FERC would accept the adjustments you have proposed?

A. There is a high likelihood the FERC will accept the adjustments identified above.... The adjustment for spent fuel management - the use of the spent fuel trust for expenses expected to be recovered in damages from DOE - is the same adjustment that I participated in negotiating for ratepayers' benefit in the FERC decommissioning cases for the Maine Yankee and Connecticut Yankee plants, and which the FERC accepted.

Vermont's DPS and Mr. Sherman were not the only organization to recognize that the Decommissioning fund could not be used by Entergy to fund the storage of spent nuclear fuel. In *Update of the Tax and Regulatory Considerations for Nuclear Decommissioning Trusts*³ a legal presentation the nuclear law firm Winston & Strawn made to the industry, it stressed the fact using any decommissioning fund for interim spent fuel storage was specifically excluded. In its presentation Winston & Strawn acknowledged,

“NRC Decommissioning Excludes: ... Spent Fuel Management (10CFR 50.44(bb)) Independent Spent Fuel Storage Installation (ISFSI): separate license/separate decommissioning funding.”

Despite the evidence that interim spent fuel storage (ISFSI) should not be funded via any decommissioning fund monies, TLG Services and ENVY deliberately chose to wrongfully add more than \$200,000,000 in costs into its 2007 Decommissioning Report filed with the Vermont Department of Public Service in January 2007.

Fairewinds Associates, Inc first alerted the State Legislature and the Auditors office of the faulty calculations in the 2007 TLG study in November and December 2007 in its two initial decommissioning reports written for the State Legislature. Yet this Entergy TLG Services

³ Repka, David, William Horin, and Gregory Pavin, *Update of the Tax and Regulatory Considerations for Nuclear Decommissioning Trusts*, Winston Strawn. June 18-21, 2007.

decommissioning estimate continues to be the only one available and its inaccurate financial calculations are being misapplied in analyzing both the state of the fund and the timeframe for decommissioning VY. When the cost of interim spent fuel storage (ISFSI) is included in estimates for VY's decommissioning, hundreds of millions of dollars of additional expense are incurred by Vermonters via an attempted deduction from the decommissioning fund. The net effect of this deduction of the interim spent fuel storage (ISFSI) fees by Entergy from the VY decommissioning fund is the *proposal* that decommissioning and dismantling VY will have to wait at least 60-years until adequate funds are available.

However, between January 2007 and March 2009, neither the Department of Public Service nor Entergy attempted to revise this erroneous assumption leaving the public and legislature believing that VY had inadequate decommissioning funds to decommission Vermont Yankee unless it waited for 60-years for the fund to grow. Entergy finally reversed its attempt to wrongfully apply VY decommissioning funds to interim spent fuel storage (ISFSI), and stated so in its April 14, 2009 testimony by then executive vice president Jay Thayer to Senator Ann Cummings' Senate Finance Committee (Transcript Attached, Attachment 3).

Today the courts have decided there's plenty of precedent. The Department of Energy has started paying some companies damage claims for their cost of storing fuel. So the point I want to make here is during the remaining operation of Vermont Yankee for however long that may be we are -- I fully intend to recover the cost of fuel storage from the Department of Energy because they failed to perform. After the plant shuts down, whenever that may be, we also fully intend to collect those costs from the Department of Energy. So those costs will not be taken from -- will not be removed from the decommissioning fund. Okay. That's a point that's been in some question over the last few weeks.

Page 5, lines 2-15 of the April 14, 2009 Transcript, Thayer to Senate Finance Committee, 1 PM

...the cost of spent fuel storage, after the plant shuts down the cost to -- one of the things that you do is you put all the fuel that's in the pool into these dry storage containers and to get the plant -- get the fuel out of the plant. That's one of the first activities in the decommissioning. That takes the first five to seven years to do that because you've got to wait five years before you do -- before you can put the fuel -- the newest fuel into those containers. That costs anywhere between 200 and 250 million dollars. Now the question previously has been is that -- are we going to have to collect that much more in the decommissioning fund, and what we've decided to do as this court case that I described to you a minute ago, the cases that we filed with the Public Service Board we have made a decision that we're not going to collect that in the decommissioning fund. We're going to take

that as a -- we're going to collect that from the Department of Energy because of this court case that I described to you before and the precedent for the Department of Energy paying those as damages in a breach of contract to Entergy Nuclear Vermont Yankee. So rather than collect an additional 200 million dollars we're going to say well as we incur those costs we'll bill the Department of Energy and receive those funds back so that that's not another strain on the decommissioning fund. I think some of the previous cases and some of the cases that were done by your consultants indicated that all that money had to be in there. That's why we got up to 900 million, a billion dollars for decommissioning and spent fuel storage and greenfielding because those costs were assumed to be a liability of Entergy Nuclear Vermont Yankee when in fact the courts have decided those costs are a liability of the Department of Energy. *Page 19, lines 8-25 and Page 20, lines 1-17 April 14, 2009 Transcript, Thayer to Senate Finance Committee, 1 PM*

We did not envision, I want to be plain here, we did not envision at any time during those discussions that we would use the full 60-years allowed by law in the SAFSTOR period. We still don't. We still don't. If the plant were to close in 2012, the plant would remain in SAFSTOR for a period of time. Most likely, most likely in the 15 to 20-year time frame. Now we did some work with earnings on the fund, fund under realistic scenarios, fund growth under bad scenarios, and they all come out in a time frame to 15 to 20-year period. *Page 15, lines 14-24 of April 14, 2009 Transcript, Thayer to Senate Finance Committee, 1 PM*

For more than two years, between 2007 and 2009, Entergy applied economic criteria to the Vermont Yankee decommissioning fund in a manner not allowed by federal statute. Had this assumption by Entergy been allowed to stand, it would have delayed VY's decommissioning by six decades. Fairewinds Associates, Inc has found no evidence that the Vermont Department of Public Service objected to this arrangement. Now, fully four years later, even though stripping interim spent fuel storage costs (ISFSI) from VY's decommissioning fund is no longer under consideration, the 2007 TLG study which has those wrongfully calculated financials, is still being used as the baseline for determining the cost and time duration of decommissioning and dismantling Vermont Yankee.

Concern 4 Apparent Conflict of Interest Among Entergy, ENVY and TLG Services

In 2001, Entergy acquired TLG Engineering. In 2002, Entergy acquired Vermont Yankee. The 2007 TLG VY decommissioning report is the first report in which both VY and TLG were wholly owned Entergy subsidiaries. The resultant Entergy ownership of both the Vermont Yankee nuclear power plant and the formerly independent TLG is an apparent conflict of interest

that could potentially lead to a financial analysis that is not in the best interest of the State of Vermont.

The evidence reviewed by Fairewinds Associates, Inc shows that two changes made in the 2007 TLG report differ from the 2001 TLG report and are not substantiated in the broader nationwide industry work of TLG Services. Moreover, the inclusion by Entergy's TLG Services of these new changes in its 2007 VY Decommissioning Study is not in the best interest of the State of Vermont.

1. First, the unexplained precipitous decline in 2006 decommissioning estimate compared to the 2001 TLG report, with interim spent fuel storage (ISFSI) fees wrongfully deducted, is an a clear example of the latest report's lack of verifiable objectivity. The 2001 report estimated decommissioning costs at approximately \$850,000,000, which then suddenly dropped to \$650,000,000 in 2007.
2. Second, the inclusion of interim spent fuel storage (ISFSI) funding without any indication that it was a dramatic change from the previous TLG estimates simply are not substantiated in other TLG Services decommissioning estimates nationwide. The 2007 TLG analysis wrongfully included approximately \$250,000,000 in charges to the Decommissioning fund for interim spent fuel storage (ISFSI), which is a violation of federal statute. The Department of Energy (DOE) is responsible for the cost of spent fuel storage, not each nuclear power plant's decommissioning fund.

TLG Services inclusion of these two significant changes without a detailed discussion of why they were made, their impact on cost, and without any reference documents could be indicative that the 2007 TLG Report was written to benefit Entergy and does not adequately reflect the financial interests of the State of Vermont.

Concern 5 Missing Decommissioning Cash Flow Analysis in TLG Report

The estimated cash flow analysis TLG Services presented to the PSB in 2009 regarding Vermont Yankee is completely inaccurate. Therefore, the State has no analysis of the decommissioning

and dismantling costs for Vermont Yankee based upon an accurate economic fund balance projection.

None of the TLG studies compare the yearly expenditures to decommission Vermont Yankee against the amount of money available each year in the decommissioning fund. Fairewinds Associates believes that the first such Cash Flow Analysis was developed in its November 2007 report to the Legislature.⁴

The November 2007 cash flow analysis created by Fairewinds Associates clearly showed that with interim spent fuel storage (ISFSI) factored into the VY Decommissioning costs, it appears to be impossible to decommission Vermont Yankee in less than 60 years. During the 2009 Public Service Board hearings, TLG created and submitted its own Cash Flow Analysis on behalf of Entergy (Exhibit EN- TLG-3, admitted May 18, 2009, docket 7440). The testimony by TLG Services showed that decommissioning the plant (including dismantling) and funding the interim spent fuel storage (ISFSI) cannot, in most of the scenarios they presented, be completed in less than 60-years. *Fairewinds Associates notes that Entergy renounced the interim spent fuel storage (ISFSI) costs in the April 14, 2009 testimony to the Senate Finance Committee, yet TLG Services included these costs in their May 18, 2009 testimony to the Vermont Public Service Board.*

Since TLG used its 2007 report as its base case, all of the cash flow analyses it presented to the PSB wrongfully assumed funding of spent fuel storage (ISFSI). While Entergy ultimately rejected this assumption in 2009, that change is not reflected in any Decommissioning documents of record.

Concern 6 Decommissioning Fund Investments

After three years of review, the Vermont State Auditor's Office finally issued an audit report regarding the Vermont Yankee Decommissioning Fund. This report was of particular interest to our firm since Fairewinds Associates, Inc first notified the Vermont State Legislature and the

⁴ *Decommissioning The Vermont Yankee Nuclear Power Plant: An Analysis Of Vermont Yankee's Decommissioning Fund And Its Projected Decommissioning Costs, 11-2007*

State Auditor's office of concerns regarding the fund. While the Auditor's report appears to be accurate in the areas the Auditor chose to evaluate, it is deficient in evaluating two critical areas.

A Trust Banker in Vermont contacted Fairewinds Associates, Inc and expressed considerable concern regarding the sudden drop in the fund's value during the 2007 to 2008 banking crisis and an insufficient evaluation of the fund's individual equities by any Vermont State Agency or by the Auditor's office.

“The assets appear to be housed in a safe location and, in all probability, the managers are capable. That said, there is no disclosure of the individual equities. I do find this odd. At the minimum I think the State should have in their files a list of the individual holdings at regular intervals. Without this, it is very difficult to benchmark performance or to get a sense of risk.”

Unfortunately the Auditor's Office did not evaluate the individual holdings to determine if their asset allocation caused the volatility experienced in 2007 and 2008. More importantly, the State needs to determine if this same volatility is currently present as Vermont Yankee is prepared for decommissioning.

Concern 7 Shipping Vermont's nuclear waste to Texas for regular waste disposal, decommissioning, and final dismantlement.

Vermont and Texas are currently members of a Congressionally approved two-state Interstate Compact that allows (and requires) Vermont Yankee to ship all of its radioactive waste (other than irradiated fuel) to Texas, once the Texas site is fully operational. The federally mandated interstate compacts were formed with the goal in mind of having several specific large-sized nuclear waste disposal sites rather than numerous nuclear waste dumps sited in almost every state in the US and by extension, maybe at each individual nuclear power plant site. Congress established the federal waste compacts in order to avoid the federal Constitutional Interstate Commerce Clause that prevents interference in interstate commerce of goods and services including nuclear waste. Thus the individual nuclear waste compacts strictly limit nuclear waste shipments to the states that are members of each specific compact. As initially configured, the Texas/Vermont Radioactive Compact Commission included only nuclear waste generated in Vermont and Texas. However, the gubernatorial appointed commission voted on January 4,

2011 to open up to out-of-compact radioactive waste generators by a vote of 5-2. The two Vermont commissioners, who were appointed by Governor Jim Douglas, voted in support of this move that opens the WCS Texas Waste Disposal Site to 36 more states.

Vermonters should be concerned about the Texas Compact for several key reasons:

1. The Texas Compact has no staff and no operating funds. A volunteer staffer who recently moved to Colorado processes most of the information. As of 12-2010, the commissioners, who draw no salary, are only paid travel expenses.
2. The Compact has no legal staff to advise it regarding the ramifications of decisions that are currently being made as well as to assure that current decisions meet Vermont Statute.
3. Fairewinds believes the Texas-Vermont Compact should develop a paid staff to oversee the activities of its contractor, Waste Control Specialists.
 - 3.1. Mr. Gundersen, chief engineer for Fairewinds Associates, Inc, was a founding member of the Connecticut Low-Level Radioactive Waste Advisory Committee (LLRWAC) for the Connecticut-New Jersey Compact for 10-years beginning in 1982.
 - 3.2. While the Connecticut LLRWAC Advisory Committee consisted of 10 volunteer members, there five paid staffers who administered the day-to-day business of the Compact.
 - 3.3. The Staff members were paid via a fee system that was charged to the nuclear power plants and other generators that shipped waste within the Compact. Because more than 99% of the radioactive waste created, as it is measured in curies, is generated by the nuclear reactors, the Connecticut-New Jersey Radioactive Waste Compact decided that the nuclear power plants and any other high curie generators should be the firms charged for the Compact's administrative costs. Therefore, hospitals and other licensees that actually produced about 10% of the volume of waste, but had a very low curie content of measurable radioactivity were exempt from paying any management fees.
 - 3.4. Fairewinds Associates, Inc recommends that in order to protect Vermont's hospitals and other medical facilities from being burdened by burgeoning radioactive waste disposal costs, that the Texas-Vermont Compact create a similar pricing structure in which the operating costs are borne by the nuclear power plants that have the most radioactivity of

which to dispose. Hospitals and other medical facilities dispose of radioactive waste that has very little radioactivity as measured in curies in comparison to that from operating and/or dismantled nuclear power plants.

Waste Control Specialists (WCS) the company that anticipates receiving final approval to run the Texas/Vermont nuclear waste dump, has staff and funding and thus creates most of the public information. After receiving a disposal license with more than 90-unresolved-conditions, WSC approached the Compact Commission to change its bylaws to set up a system that would accept radioactive waste from additional nuclear waste generators in addition to nuclear waste from Texas and Vermont. *Although barrels of radioactive waste have begun being shipped to Texas, the site itself will not officially open until the end of 2011.* The Texas Compact Commission voted affirmatively on January 4, 2011 to facilitate the import radioactive nuclear waste generated outside of the compact to the Texas facility. At present there are eight Compact Commissioners, six from Texas and two from Vermont appointed by each state's governor. In the January 4, 2011 vote, three Texas Commissioners and both Vermont representatives voted to support allowing additional States to dispose their nuclear waste in Texas. Voting was 5 to 2 in favor of having other States gain access to the WCS nuclear dump space, with Vermont voting with the majority, and two Texas Commissioners remaining opposed to allowing other States to use the facility.

By voting to publish the proposed import rule in December 2010 in the Federal Register and approve the import rule in January 2011, the Vermont Commissioners have taken a major, potentially irreversible step that Fairewinds Associates believes risks Vermont's disposal capacity. In the years to come there is no guarantee that Vermont's two commissioners will have any sympathetic Texas commissioners to help limit incoming out-of compact waste, therefore limiting Vermont's access to adequate nuclear waste storage. While the provisions in the rule allegedly preserve capacity for Vermont Yankee and Vermont's other nuclear waste generators, like hospitals, these numbers are very speculative because they are based upon 5-year *estimated* figures provided by the waste dump host WCS. Indeed, Vermont may ultimately find itself dependent upon WCS achieving expanded storage capacity, which is by no means assured. In fact, WCS is still awaiting approval of a 4,000-page amendment to its original license as one of

many outstanding conditions that must be met prior to its creation of permanent on site waste storage.

Litigation on the existing site still continues as this report is being written. The Sierra Club appealed in State Court the denial by the Texas Commission on Environmental Quality (TCEQ) for a contested case hearing. Fairewinds Associates therefore notes the potential uncertainty of expanding the current site when the original license for which WCS applied is not yet functional. Fairewinds Associates believes that the Compact commission should be assured of viable disposal capacity for Texas and Vermont prior to setting up procedures to bring in out-of-compact waste. Furthermore, the Compact rules say no foreign waste may be imported to the Texas site, but some radioactive waste processors in Tennessee have begun to take title to European wastes they are processing. Processors in Tennessee are planning to import waste from Italy and Germany and from all over Europe via a German nuclear broker, and it appears that Texas is now the likely final resting place for this waste. Fairewinds Associates' concern remains one of adequate space for Vermont's nuclear waste generators due to the permitted radiation value of the waste being imported.

Texas Commissioner Robert Gregory expressed his concern over the organization of the Texas waste compact as quoted in Vermont Digger (12/1/10).

“Gregory, one of the dissenting members, said the commission doesn't have the staff capacity or financial resources to evaluate applications. (The annual budget of \$125,000 covers travel and meeting expenses.) In addition, the subjective nature of the proposed permitting process, he said, could leave the commission vulnerable to lawsuits.

He doesn't know how the commission will defend itself from legal challenges if the commission says no to one entity and yes to another.

“Entergy, according to a Texas official, would have much to gain if the new landfill rules go through. The Louisiana-based corporation needs a place to put the waste from its fleet of 10 plants around the country. “Opening the Texas facility would allow them to take it from those other plants,” Gregory said Waste control specialists, Entergy, Santa Claus — anyone can sue us for not allowing radioactive waste to come in,” Gregory said. “What are we going to say if we can't defend ourselves?”

...Gregory, a Texas commission member who opposed the adoption of the new rules, said he doesn't understand why the rule has to be adopted by early January. He suspects the timing has something to do with a changing of the political guard in the Vermont governor's office.

"What on Earth is the rush?" Gregory said. "It's rushing to beat a date for when the new governor comes to town. If the commissioners change, then the vote would be 4-4; now it's 6-2."

Fairewinds believes that opening the Texas site to the rest of the nation's and possibly international nuclear waste may not be in the best interests of Vermont for the following reasons:

1. The TCEQ License limits Low Level Radioactive Waste (LLRW) disposal at WCS to 2,310,000 cubic feet of radioactive waste. Vermont is allocated 20% (~462,000 cubic feet) of the total amount Texas disposes over the operational period of the disposal site. Decommissioning Vermont Yankee may create more than this amount of waste. If a decommissioning approach is used at Vermont Yankee that similar to the one currently being applied to decommission the Zion Illinois nuclear plant in Illinois, the net effect is that decommissioning costs may drop significantly while the radioactive waste volume (amount of space needed) would become notably larger. Until Vermont Yankee is fully dismantled, it is unknown if Vermont may have any reserve space to give away to other States.
2. The Texas Commission on Environmental Quality (TCEQ) License limits Low Level Radioactive Waste (LLRW) storage at Waste Control Specialists (WCS) nuclear dump to 3,900,000 curies.
 - 2.1. Prior to July 2008, the Barnwell, SC LLRW storage site accepted waste from all over the U.S., but now it only accepts waste from the Atlantic Compact States of Connecticut, New Jersey, and South Carolina.
 - 2.2. The only other site open to accepting waste from throughout the U.S. is the Energy Solutions site, located in Clive, UT, but Energy Solutions is only licensed by the State of Utah for Class A waste.
 - 2.3. Thus, WCS is now the only offsite facility available for storage of Class B and C waste, and that radioactivity limit could be exceeded in just a few years by the Class B and C waste that is being generated by Vermont and Texas facilities without added the waste from all the other States with no place to put their radioactive waste.

2.4. “Radioactive Waste: In general, radioactive waste classes are based on the waste's origin, not on the physical and chemical properties of the waste that could determine its safe management. Other categories of radioactive waste not listed here include mixed waste and NARM wastes (Naturally-Occurring and Accelerator-Produced Radioactive Materials). One common factor for all categories of nuclear waste is the presence of at least some amount of long-lived radionuclides.⁵

2.4.1. “Low-Level Waste (LLW) Defined by what it is not. It is radioactive waste not classified as high-level, spent fuel, transuranic or byproduct material such as uranium mill tailings. LLW has four subcategories: Classes A, B, C, and Greater-Than Class-C (GTCC) described below.

2.4.1.1. On average, Class A is the least hazardous while GTCC is the most hazardous.

2.4.1.2. Class A On average the least radioactive of the four LLW classes. Primarily contaminated with "short-lived" radionuclides. (average concentration: 0.1 curies/cubic foot)

2.4.1.3. Class B May be contaminated with a greater amount of "short-lived" radionuclides than Class A. (average concentration: 2 curies/cubic foot)

2.4.1.4. Class C May be contaminated with greater amounts of long-lived and short-lived radionuclides than Class A or B. (average concentration: 7 curies/cubic foot)

2.4.1.5. GTCC Most radioactive of the low-level classes. (average concentration: 300 to 2,500 curies/cubic foot) (The 300 figure is based on the 1985 inventory. The higher figure represents anticipated inventory in 2020, including some decommissioning wastes.)”

3. Dr. Arjun Makhijani, nuclear engineer and president of the Institute for Energy and Environmental Research (IEER), evaluated the amounts of Class B and C Low Level Radioactive Waste (LLRW) sent for disposal from nuclear generators located in states that have no disposal path. He applied past data as posted on the Department Of Energy’s (DOE)

⁵ *Classifications of Radioactive Waste*, Institute for Energy and Environmental Research (IEER), <http://www.ieer.org/clsroom/r-waste.html>

Manifest Information Management System (MIMS) website that allows computation of data for specific sites, volumes and radioactivity as well as specific compacts.

- 3.1. According to Dr. Makhijani, the total amount of Class B and C waste disposed of at Barnwell by these states over an eight-year period ending on June 30, 2008 was almost 4.6 million curies, or approximately 580,000 curies per year.
- 3.2. Moreover, Dr. Makhijani estimates that approximately 95-percent of this radioactivity came from utilities that would like to ship to Texas. At this rate, even if there were no other new nuclear generators, the storage capacity of the Texas site would run out in just under four years if the 36 additional States ship to it.
- 3.3. Fairewinds Associates, Inc is concerned that other States would ship their most radioactive material to Texas, rather than their least radioactive. This implies that the site's radioactive limit might be exceeded before its cubic foot limitations are exceeded.

Fairewinds Associates asked for months: Why rush to allow other States to use land that Vermont may need to dismantle Vermont Yankee? If Vermont Yankee did not use its allotted space after the plant is decommissioned, then it would be appropriate to allow other States access to the Texas facility. Or if WCS is licensed for much more additional land and a compact agreement was forged assuring that Vermont would have more than adequate waste disposal space, it might be possible to sign such an agreement as long as it also indemnifies Vermont from nuclear waste litigation forged by other states or parties against WCS. However, it remains Fairewinds' opinion that until a decommissioning approach is chosen and an accurate assessment of waste is calculated that includes soil contamination from the recent AOG leak, it was extremely unwise to allow other States to use land that may be required to decommission and dismantle Vermont Yankee.

After the Nuclear Plant Powers Down

By **MATTHEW L. WALD**
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<http://www.nytimes.com/2010/11/23/business/23nuke.html? r=1&hp>

ZION, Ill. — Twelve years ago, Commonwealth Edison found itself in a bind.

The Zion Station, its twin-unit nuclear reactor here, was no longer profitable. But the company could not afford to tear it down: the cost of dismantling the vast steel and concrete building, with multiple areas of radioactive contamination, would exceed \$1 billion, double what it had cost to build the reactors in the 1970s. Nor could Commonwealth Edison walk away from the plant, because of the contamination.

The result was that Zion Station sat in limbo for more than a decade, and Commonwealth Edison, now part of Exelon, paid about \$10 million a year to baby-sit the defunct reactor.

Now, though, the company is trying out a radical new approach to decommissioning the plant that promises to make the process faster, simpler and 25 percent less expensive — instead of hiring a contractor, it has turned the job and the reactors over to a nuclear demolition company that owns a nuclear dump site. The cost will be covered by the \$900 million that Exelon accumulated in a decommissioning fund.

If the approach is successful, it could have implications for 10 other nuclear plants around the country that are waiting to be decommissioned, and for the 104 reactors that are still in operation but will eventually be torn down. It will also save money for electricity customers, who often end up paying for the cleanup of nuclear plants through their utility bills.

The decommissioning operation at Zion, which began on Sept. 1, will skip one of the slowest, dirtiest and most costly parts of tearing down a nuclear plant: separating radioactive materials, which must go to a licensed dump, from nonradioactive materials, which can go to an ordinary industrial landfill.

The new idea is not to bother sorting the two. Instead, anything that could include radioactive contamination will be treated as radioactive waste.

Exelon could never have done this on its own, because the fee for disposing of radioactive waste was too high. But the company has given the reactor to EnergySolutions, a conglomerate that includes companies that have long done nuclear cleanups, and which also owns a nuclear dump.

“This is a first-of-a-kind arrangement,” said Adam H. Levin, director of spent fuel and decommissioning at Exelon.

He added that others could do the job for less than Exelon and acknowledged, “utilities in general are not very good at tearing plants down.”

Government regulations require that nuclear reactor sites be thoroughly decontaminated, so that they can be released for re-use — often a lengthy process. The plan is to return Zion’s site, in the midst of parkland on the Lake Michigan shore north of Chicago, to re-use by 2020 — 12 years earlier than expected under Exelon’s original plan, which was to begin in 2013 and finish in 2032.

Any money left over from the \$900 million in the plant’s decommissioning fund goes back to electricity customers in the Chicago area.

On Sept. 1, Exelon transferred ownership, along with the license issued by the Nuclear Regulatory Commission, to EnergySolutions, which is based in Salt Lake City.

The company owns a one-square-mile area of desert about 70 miles west of there, in Clive, Utah, where most of the Zion plant is supposed to be shipped. The dump in Clive already has parts of several other defunct nuclear plants — including Maine Yankee in Wiscasset, Me., and Yankee Rowe in Rowe, Mass.

In those two cases, the reactor owners tried to sort the radioactive materials from the nonradioactive, in order to dispose of ordinary concrete and steel at recycling centers or industrial landfills. It turned out to be a costly mistake, many in the industry now say.

Workers used a device like a pneumatic drill to “scabble” the concrete, knocking off the surface layer.

“It got to be very, very complicated and nasty work,” said Andrew C. Kadak, a nuclear consultant who at the time was president of the company that operated Yankee Rowe. Often, he said, a survey would find that the concrete was not clean, or worse: that a tiny bit of radioactive material was mistakenly shipped to a “clean” landfill.

“It’s easier to suppose everything is radioactive,” Mr. Kadak said.

Sometimes a contractor hired to decommission plants would also find radioactive material in unexpected places or at unexpectedly high levels, other experts said.

Crowds of workers would stand idle while the contractor sought the plant owner’s authorization to deviate from the procedures specified in the contract — a costly proposition at a site with 500 workers paid collectively “\$30,000 to \$50,000 an hour,” said John A. Christian, president of the Commercial Services subsidiary of EnergySolutions.

At Rowe, managers finally gave up and shipped vast amounts of concrete, much of it clean, to the repository in Clive.

The new plan for Zion, by far the largest nuclear power plant to be decommissioned and the first twin-unit reactor to be torn down, eliminates the relationship between contractor and owner. EnergySolutions has hardly any internal cost for burial, beyond shipping.

Mark Walker, a spokesman for EnergySolutions, said that the dump could accommodate all 104 of the nation's operating nuclear plants, "with space left over."

It could also absorb plants that are shut and awaiting decommissioning, like Indian Point 1 in Buchanan, N.Y.; Millstone 1 in Waterford, Conn.; and Three Mile Island 2, near Harrisburg, Pa., the site of the 1979 accident.

Not everyone is delighted with the idea of Exelon turning the job over to EnergySolutions.

Tom Rielly, the executive principal of Vista 360, a community group in nearby Libertyville, Ill., said that with a monopoly provider of dump space also functioning as the contractor, it would be difficult to determine what was being charged for disposal and whether electricity customers were getting a good deal.

But approval from utility regulators in Illinois was not required for the deal, and the Nuclear Regulatory Commission gave its assent, so the work is going forward.

EnergySolutions cannot dispose of all the waste.

Clive is licensed only for the least contaminated material. And the spent nuclear fuel is in the same situation as used reactor fuel all over the country: the Energy Department is under contract to take it, but has no place to dispose of it.

Until a permanent repository is built at the proposed Yucca Mountain facility in Nevada or another location, the waste will stay at the Zion site in steel and concrete casks built to last for decades.

Frank Flammini, a control room operator, has worked at the Zion Station since before it shut down.

The room, filled with 1970s-style dials, used to have at least six people around the clock, but on a recent afternoon he sat alone in the control room with his coffee cup, next to the one modern piece of equipment, a flat-panel display showing the temperature, water level and humidity of the room housing the spent fuel.

Mr. Flammini, 54, said he was called on now and then to make sure equipment was "tagged out" so that workers could safely dismantle it. But hours go by with little to do.

The parking lot of Zion is so quiet these days that the raccoons and skunks have been joined by shy species like coyote.

Mr. Flammini said he knew his job here was not permanent.

"It'll get very busy for about four years, and then it'll go away entirely," he said.

NUCLEAR DECOMMISSIONING: Sweet package

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<http://www.istockanalyst.com/article/viewiStockNews/articleid/4668379>

(Source: Engineer)Software based on technology developed for the packaging sector is now being used in nuclear decommissioning. Dave Wilson reports

Developing algorithms that can optimise the means by which sweets, laundry detergents and pharmaceuticals can be packaged might not initially seem very relevant to companies involved in the decommissioning of nuclear power plants.

But based on his past research, in which he created algorithms for exactly such purposes, Richard Williams, professor of mineral and process engineering at Leeds University, has now helped to develop a software package based on similar principles that can help contractors plan the safe decommissioning of nuclear facilities.

The original software Williams developed uses algorithms to simulate how particles of any shape or size behave when they are placed into a container. He developed the software after realising that most existing software packages used to solve such packing problems could only handle simple and regular-shaped objects - a scenario that did not reflect real-life problems accurately enough.

When this earlier packaging software was trialled in the food and pharmaceuticals industry, a number of manufacturers expressed an interest in purchasing it, and so Williams and his team commercialised the product through the formation of the Leeds University spin-out company Structure Vision.

But Williams also realised that there was a bigger potential application for the algorithms that he had developed. Because he had previously worked with engineers at BNFL, he was especially familiar with the problem of decommissioning nuclear power plants and realised that the software could play an important role there too.

Now the algorithms have been incorporated into a new software package that has recently been launched by Structure Vision. Called NuPlant, it enables planners to work out the optimum way to break up and package contaminated equipment, reducing the number of long-term storage containers needed for the task.

Williams said that, in use, the three-dimensional structural diagrams that detail the specific process equipment in the nuclear plant that is due to be cut apart during the decommissioning process must first be imported into the software.

Such data can be extracted from existing two-dimensional documentation, which can then be transformed into three-dimensional plant structural diagrams.

Alternatively, where records of the equipment in older plant may be missing or inadequate, a three-dimensional map can be created from a laser survey of the plant, a process that captures exterior surface models of the process equipment that can then be used as the basis from which a three-dimensional map of the process pipelines and process reactors can be reconstructed.

Williams said that the software has been validated with a number of third parties, including Energy Solutions, Nuvia and LLWR, and in most of the trials that have been undertaken, the companies have either been able to provide a three-dimensional design data set or two-dimensional drawings of the plant that can then be converted to three-dimensional images.

Once the data has been captured by the system, the software can analyse the most effective way that the plant can be dismantled and then make suggestions as to the most efficient way that the waste can then be packaged. That is important because independent commercial contractors have

estimated that just packing such waste resourcefully could lead to literally millions of pounds being saved, according to Williams.

In dismantling any item from a nuclear power plant, the software allows a user to scrutinise a number of different methods by which the equipment in the plant can be cut apart prior to storage. The software can propose the number of cuts to be made to dismantle the equipment, in what order they should be made, as well as how the material would best fit into containers and how any additional content in the containers could be optimally positioned.

Contractors can then apply their own costing models to examine the outlay incurred in decommissioning specific equipment in the plant in the particular fashion suggested by the dismantling protocol options presented by the software.

'One of the big cost issues involved in decommissioning a nuclear facility relates to the number of personnel required to perform such operations and the time it takes them to do so. If the process takes longer, or requires more human presence than expected, then a heavy cost penalty may be incurred,' said Williams.

'But by using our software, in conjunction with their own costing models, it is possible for a contractor to work out the most effective, cost-efficient route for dismantling the plant.'

It is also possible for users of the software to assign specific properties to the material that is being cut apart and packaged - an important consideration given the lifetime of much nuclear waste. Typically, in the case of a nuclear plant, this consists of a description of the type of the material, the type of waste it is, and the level of radiation it emits.

Report generation is another important feature of the software, and Williams said that the specific technical parameters that the software generates were defined by Structured Vision after consultation with its validation partners who provided invaluable input through an advisory group as to the nature of the information that they required.

Typically, the reports contain an inventory of the contents of a storage container, listing the number of components that are in it, the weight distribution, the radiation distribution, and details about the properties of the cement mix that it is filled with to provide shielding from radioactivity. Williams said that prior to the development of the NuPlant software, such a detailed inventory was previously unavailable to contractors working on decommissioning and that such reporting is critical for regulatory reasons.

In the future, Williams sees an important use for Structure Vision's software in new nuclear build too, where it will enable designers to envisage how nuclear plants that are currently being designed will be able to be decommissioned most cost-effectively and safely when they have reached the end of their useful life. As such, the company is actively seeking to work with individuals involved in such programmes to ensure that its software can play an important role early on in the design cycle.

The key facts to take away from this article

- * NuPlant software uses algorithms to solve packing problems
- * It simulates how particles behave when placed into a container
- * It also analyses the most effective way that a plant can be dismantled
- * The software could also one day play a key role in new nuclear build

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