

**For the Joint Fiscal Committee**

**December 2010**

**Reliability Oversight**

**Entergy Nuclear Vermont Yankee (ENVY)**

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## **INTRODUCTION**

Fairewinds Associates, Inc began its contract with the Joint Fiscal Committee (JFC) and the Joint Fiscal Office (JFO) in July 2009 in order to review the progress made by Entergy Nuclear Vermont Yankee (ENVY) toward addressing the challenges identified by Act 189: An Act Relating To A Comprehensive Vertical Audit (CVA) And Reliability Assessment Of The Vermont Yankee Nuclear Facility, and to present ongoing information and analysis regarding reliability issues with Entergy's Vermont Yankee Nuclear Power Plant. This current report, Fall 2010, is the first requested report in the extension of services of Arnie Gundersen, Fairewinds Associates, Inc, Burlington, VT as consultant to the Legislative Joint Fiscal Committee.

### **Section 1. Recommendations for Joint Fiscal Committee and the Legislature**

Fairewinds Associates, Inc believes that the following items should be implemented, acted upon or fostered:

1. Continued monitoring of the Construction Office Building (COB) Well
2. Restart extraction wells
3. Add additional extraction wells
4. Better communication between the Department of Public Service (DPS) and the Department of Health (DOH)
5. Entergy should identify and monitor all gamma ports
6. Monthly updates for Legislative review from the DPS on the progress of "completed" action items.
7. In the event of a license extension, any MOU between the DPS and Entergy must include objective criteria and should be submitted for technical review by independent nuclear engineers to assure engineering reliability and technical accuracy prior to signing of any MOU.
8. Again, Fairewinds Associates notes that DPS and ENVY have not addressed the July 2010 recommendations created by the Public Oversight Panel. The Panel expressed concerns regarding ENVY's lack of a questioning attitude and inadequate allocation of resources.
9. Better communication between DPS and Fairewinds Associates

In addition to the above broad recommendations, detailed notifications and recommendations are delineated in the beginning of each subsection.

## **Section 2. Leaks At Vermont Yankee And Their Monitoring**

### **2.1. Tritium Contamination Moves Into Bedrock**

Given the fact that the tritium contamination has moved into bedrock, *Fairewinds Associates, Inc* recommends continual monitoring of the Construction Office Building (COB) well reported at least two times per month and continue for the life of the plant. An assessment of this well will enable the State of Vermont to monitor the progression of the tritium plume containing not only tritium but also other radioactive isotopes like Strontium 90 and Cesium 137 in order to mitigate damage to the aquifer and surrounding environment. Contamination of the aquifer is not part of NRC jurisdiction or required monitoring. This issue is left to the states to assess and monitor.

To Date: On October 8, 2010, the DOH announced that concentrations of tritium significantly above background were discovered in the former drinking well for the Construction Office Building (COB). When ENVY took the COB well out of service February 25, 2010, it said it was a precautionary matter to eliminate a “small possibility” of “cross contamination” from the groundwater into the well if the well remained in service. [See press release below.] However, the hydrological COB well test results announced October 8, 2010 suggest that the likelihood of cross contamination of the well water was more significant than ENVY engineers had estimated.

History: This on-site well is located between the Connecticut River and the former underground pipe leak that was discovered in January 2010. Unlike the on-site monitoring wells used to track the movement of radioactive effluent on site that are only 30 to 40 feet deep, the Construction Office Building (COB) well is 360 feet deep and actually penetrates through the bedrock into the aquifer. The COB well was one source of on-site drinking water until it was closed as a precaution on February 25, 2010, and at the time it was closed no tritium had been detected in that well. ENVY’s February Press release stated that if the well continued to operate, there was a “small possibility” that its operation would draw tritium into the aquifer and cause “cross

contamination”. Thus, even after the well has been turned off, cross contamination is apparently occurring.

On February 23, 2010 an ENVY press release regarding the contamination of the Construction Office Building (COB) well stated:

“As mentioned yesterday, as a prudent precaution, the decision has been made to take the Construction Office Building (COB) drinking water well out of service. The well will, however, be maintained as a deep monitoring well and will be included as one of the deep wells that will be part of geo-physics testing. Design changes and temporary modifications have been approved, with concurrence from the Agency of Natural Resources, so that drinking water to the COB can be supplied by another well onsite. Preliminary work for the switchover is in progress, with completion in a few days. The Construction Office Building (COB) drinking well, which supplied drinking water to the VY site only, is set in bedrock deep below the flow of the surface groundwater containing tritium above it. The COB well is over 350’ below the surface into bedrock while the groundwater monitoring wells are on the order of 25’ to 35’ deep and are above the bedrock. ***While daily testing of the well has consistently shown all sampling results to be below detectable limits, the deep well is within the field of shallow groundwater wells that have tested positively for tritium. In addition, there is a small possibility that continued use of the well could result in its cross contamination.***” (Emphasis added)

## 2.2. Tritium Concentration Levels In Water

The tritium discovered in the Construction Office Building (COB) well October 2010 had a concentration of more than 1,000 pCi/l, which is almost half the European standard of 2,000 pCi/l of tritium in drinking water. For that reason, *Fairewinds Associates, Inc recommends that the monitoring of the COB well continue for the lifetime and clean up the Vermont Yankee nuclear power plant.* While the current EPA limit for tritium in drinking water is 20,000 pCi/l, some states, like California, are currently discussing much lower limits in light of new data showing that tritium remains in the body for much longer than scientists originally believed. The current EPA and NRC regulations regarding tritium levels in drinking water were created more than 30-years ago prior to newer testing methods and subsequent scientific data.

An email from Dr. William Irwin on October 27, 2010 indicates that ENVY does not plan further inspections of this well in the near future. Specifically, Dr. Irwin stated:

“As we published in our update of 10/15/10, Entergy indicated that they have removed the packer testing and sample pumping equipment from the COB well

so no additional information will be coming from that source for some time. We have asked them to consider restarting the testing of the COB well to at least give us data about the overall sample contamination level. The Entergy VY Chemistry Manager stated they are considering this.”

In Fairewinds Associates, Inc’s opinion the State has the authority to order continued monitoring. The state of New Jersey has ordered continuing monitoring of the tritium leak at the Oyster Creek nuclear power plant, an Exelon owned BWR of similar age to Vermont Yankee. The tritium leak at Oyster Creek already contaminated the surrounding aquifer before it was uncovered and the site is now undergoing a mammoth tritium extraction project.

Fairewinds Associates would like the Legislative Joint Fiscal Committee to know that the upward trend in tritium in wells on the site is most disturbing. While well GZ-3, the very first shallow on-site test well found to contain tritium, had a concentration of only 700 pCi/l when the investigation first began in January 2010, the concentration has risen dramatically since that time. Thus, Fairewinds believes that eliminating the testing of tritium in the deep Construction Office Building (COB) well seems to be counterproductive to monitoring and mitigating any potential deleterious trends, as history of other on-site wells shows the concentration may be escalating, not decreasing. The positive finding of tritium in the COB well at 220 feet indicates that tritium has entered the bedrock and is seven times deeper than anticipated and than previously measured in the shallow wells, and does not mean that tritium has entered the groundwater at a depth of 350 feet. This new and unanticipated discovery of tritium in a deep well indicates that the tritium is moving downward toward the aquifer where its possible removal and dissipation will be much slower, expensive, and involved process.

On November 29, 2010, tritium was discovered in well GZ-22D at a depth of 60-feet immediately above bedrock. Concentrations of 500,000 pCi/l were identified near the abandoned COB well. These high concentrations occurred 150-feet away from the original leak. That this concentration is at bedrock near the COB well raises even further concerns about tritium entering the aquifer.

### 2.3. Extraction Wells For Removal of Tritium And Other Radioactive Isotopes

An *Extraction Well* is a “well employed to extract fluids (either water, gas, free product, or a combination of these) from the subsurface. Extraction is usually accomplished either by a pump located within the well or suction created by a vacuum pump at the ground surface”<sup>1</sup>.

*Notification: These ongoing leaks are critical Aging Management Reliability Issues. In its 2009-2010 Summary to the JFC, issued in August 2010, Fairewinds Associates, Inc recommended that at least one extraction well be operated continuously until Vermont Yankee is dismantled in order to assure that cesium, strontium and any other radioactive isotopes that remain trapped in the soil do not make further progressive movement toward the Connecticut River. In addition to continued operation of the tritiated water extraction well(s), Fairewinds Associates, Inc also recommends that the Legislature instruct the Department of Health to cease publicizing ENVY information on its State Website, but rather to instruct Entergy to issue the information in the form of a Press Release so it is clear that such information is an ENVY opinion is not misrepresented as an official position of the State. Furthermore, in order to prevent the migration of cesium and strontium to the water table, aquifer, and Connecticut River, Fairewinds Associates continues to recommend that the extraction well nearest the area of the initial leak continue to operate until the Vermont Yankee nuclear power plant is decommissioned, dismantled, and the site is returned to Greenfield status.*

Immediately prior to Thanksgiving, on November 23, 2010, the Vermont Department of Health (DOH) announced on its website that on November 18, 2010 ENVY shut down its tritium extraction wells. The DOH site stated:

“On November 18, Entergy Vermont Yankee officials told the Health Department that the 300,000 gallon objective for groundwater remediation had been met, and groundwater extraction has been terminated.”  
<http://healthvermont.gov/enviro/rad/yankee/tritium.aspx>

Fairewinds Associates observed that since this Entergy notification was posted on an official State website, various newspapers across the State interpreted the notice to mean that turning off the extraction wells was approved by the DOH. The headlines from the November 24

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<sup>1</sup> <http://www.contaminatedsite.com/glossary/glossary%20-%20e.htm>, Contaminated And Hazardous Waste Site Management Glossary, Gowen Environmental.

Burlington Free Press read, "Vermont Health Dept. says tritium cleaned at nuke plant". The New England Cable Network said, "VT Health Dept. says tritium cleaned at nuke plant", and the Brattleboro Reformer headline read, "Tritium cleanup finished at VY". Concernedly, when did Entergy notify the DOH or the DPS that it was ceasing operation of these critical extraction wells? Was DOH or DPS notified of this critical operational change prior to the November 18, 2010 cessation date, on that date or not until immediately prior to the Thanksgiving holiday so that the scientific facts would get lost during the holiday rush and news coverage. Fairewinds Associates, Inc wants to remind the Legislature that Entergy has exhibited a pattern of sending out press releases regarding critical safety and reliability issues on Friday afternoons at 5 pm in hopes of avoiding public and media scrutiny.

In fact, months earlier, ENVY made the decision to shut off the extraction wells based upon how much water had been removed, rather than how much tritium remained in the soil. Prior to the discovery of tritium in bedrock, ENVY decided that when it extracted 300,000 gallons of tritiated water from the soil the extraction wells would be shut down regardless of how much tritium still migrated across the site. In spite of the new tritium contamination in the bedrock, ENVY did not revise its earlier decision to stop the tritium extraction effort. Neither ENVY nor the state mandated any criteria regarding the cessation of this critical extraction well.

According to the October 12 edition of Vermont Digger, "Larry Smith, spokesman for Vermont Yankee, said Entergy will "re-evaluate" whether it should halt the extraction once the corporation has reached its target extraction total of 300,000 gallons. So far, the company has pumped 267,000 gallons of contaminated water from the site"

ENVY has planned to end service of the tritiated water extraction wells at the beginning of December 2010, at which time it anticipated having removed approximately 300,000 gallons of tritiated water from the shallow surface wells. December 2010 also appears to have been chosen as a date to close the tritiated water extraction wells in order to avoid any winter freezing issues in the extraction of the well pipes. *In Fairewinds Associates' opinion a nominal investment by ENVY would successfully mitigate such tritiated water extraction well pipe freezing issues during Vermont's winter weather.* In Fairewinds 2009-2010 Summary to the JFC, *Fairewinds*

*Associates, Inc recommended that at least one extraction well be operated continuously until the plant is dismantled to assure that cesium, strontium and other isotopes remain trapped in the soil and not make further progressive movement toward the Connecticut River or to bedrock and the aquifer. Moreover, Fairewinds' recommendation was made in August 2010, months prior to the October 2010 discovery of tritiated water contamination in the Construction Office Building (COB) drinking water well.*

The October 2010 discovery of tritiated water at a level seven times deeper than previously indicated confirms Fairewinds' August 2010 recommendation that ENVY must keep at least one extraction well running until the plant is dismantled. In fact, due to the recent discovery of 1,000 pCi/l of tritiated in the former Construction Office Building (COB) drinking water well, it now appears necessary to keep as many extraction wells running as possible until the plant is dismantled. Whatever tritiated water may be removed from the surface wells is isotopic contaminated water that will not enter bedrock and threaten the underlying aquifer.

#### **2.4. Additional Monitoring Wells Placed On Site Following Tritium Leak**

In addition to its eastward migration toward the river, it appears that the plume of tritiated water and other radioactive isotopes have migrated further north and is moving downward into bedrock and toward the aquifer. *Fairewinds Associates, Inc recommends that a formal testing schedule monitoring the on-site plume, Connecticut River fish, and on-site vegetation be conducted for tritium, strontium and cesium.*

Well GZ-13, which was located considerably to the north of the plume in April, is included within the plume as of September 2010. This evidence shows that the tritium plume widening at the same time as it is being drawn deeper toward the aquifer as evidenced by the detection of tritium 200 feet into the bedrock. While, the Vermont Yankee Nuclear Power Plant site contains numerous other shallow wells that have been drilled to monitor the spread of the tritiated water from the leak from the Advanced Off Gas (AOG) system that was uncovered in January 2010 the testing frequency is not adequate to assess plume migration and possible environmental damage.

The Vermont Department of Health (DOH) website<sup>2</sup> is an excellent source for data regarding the tritium concentration in these sampling wells. The data indicates that tritium concentrations have decreased near the leak while increasing further away from the leak. For instance, well GZ-3, the first monitoring well in which the tritium leak was detected in January 2010 had a reading of 700pCi/l in January. Now GZ-3 has readings more than 100,000 pCi/l according to monitoring data collected at the end of October 2010. Well GZ-10, the monitoring well nearest the leak had readings of 2,000,000 pCi/l in February 2010, while the October 2010 data shows that GZ-10 has readings near zero. This change in well concentrations shows that the radioactive plume of tritium and other isotopes continues to move east toward the Connecticut River.

### **2.5. New Safety Related Leak in the High Pressure Coolant Injection (HPCI) System**

The recently uncovered leak in ENVY's High Pressure Coolant Injection system (HPCI) is another Vermont Yankee aging management reliability issue. Fairewinds Associates' other significant concern regarding this leak is that the DPS did not notify the DOH of the radiation leak for three weeks. While it is most likely that all the radiation that leaked from the remained contained within the reactor building, *Fairewinds Associates maintains that statewide protocols should exist by which the DOH, which is tasked with the radiation monitoring of Vermont Yankee, is always made aware of any and all leaks at ENVY. Such protocols should be put in place from this point forward given ENVY's aging management reliability issues.*

On September 24, 2010 an auxiliary operator noticed steam coming from a pipe in ENVY's HPCI. According to records, The Department of Public Service State Nuclear Engineer was notified of the HPCI leak on September 27, 2010. Almost one month later, on October 19, 2010, independent sources notified Fairewinds Associates of the HPCI leak. At that time, Fairewinds Associates' Chief Engineer Arnie Gundersen requested that the DPS engineer look into the reported problem and was assured that DPS would investigate. On October 20, the DPS engineer confirmed to Fairewinds Associates that a leak in the HPCI system had indeed occurred. DPS had already been aware of the HPCI system leak for three weeks, but did not notify the Department of Health regarding the existence of the leak until October 20, 2010. Both

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<sup>2</sup> <http://www.healthvermont.gov/enviro/rad/yankee/documents/VYTritiumData.pdf>

DOH and Fairewinds Associates, the JFC consultant, had been unaware of the leak for almost a full month, although NRC had been notified early on as had DPS.

After Fairewinds Associates and DOH were notified of the HPCI leak, NRC Region 1 spokesperson Neil Sheehan issued the following statement:

“The leak was discovered on Sept. 24 when an operator, during normal rounds, observed a puff of steam coming off a line. It is a pinhole leak on a 1-inch drain line for the High-Pressure Coolant Injection (HPCI) system. That system would be used if the reactor had to shut down suddenly. Since high pressure levels would remain inside the reactor vessel, the HPCI system can be used to inject water inside despite those conditions.

The system and the drain line are located inside the reactor building. As such, any leakage is captured by a sump and sent to a radioactive liquids treatment system.

The company apparently needed to time to develop a repair plan. It also would have prioritized the work based on the safety significance. It was -- and is -- low in this case.

Entergy attempted to repair the leak on Oct. 6 and could not get good steam isolation on the system without going into the steam tunnel. Therefore, the company decided to halt the effort and rescheduled it for Oct. 15. On Oct. 15, they found it was not a weld that was leaking but that a through-wall hole (pinhole leak) had developed and a different repair plan would have to be put together.

Our Resident Inspectors at Vermont Yankee have stayed on top of the issue and will continue to monitor the company's repair efforts.”

According to Entergy and the NRC, while the leak was releasing radioactive steam and water into the reactor building, none of that radiation is reaching the environment because it is both collected and treated inside the reactor building. Fairewinds believes that the significance of the HPCI leak is that it is located in a Safety Related System (SRS) used to cool the plant in an emergency. High Pressure Safety Related piping is subject to more stringent design, construction, and inspection requirements, therefore it is critical that piping defects in Safety Related Systems should be identified prior to leaking. According to the NRC:

“The high pressure coolant injection (HPCI) system is an independent emergency core cooling system requiring no auxiliary ac power, plant air systems, or external cooling water systems to perform its purpose of providing make up water to the reactor vessel for core cooling under small and intermediate size loss of coolant accidents. The high pressure coolant injection system can supply make up water to the reactor vessel from above rated reactor pressure to a reactor

pressure below that at which the low pressure emergency core cooling systems can inject.”<sup>3</sup> See Attachment 1, NRC Schematic BWR HPCI.

Before a possible cause of the leak was even analyzed, the State’s DPS engineer stated that the leak in the pipe was due to “erosion”<sup>4</sup>. It is the opinion of Fairewinds Associates, Inc that it would be technically impossible for “erosion” to cause this leak since the leak is in a one-inch drain line containing stagnant water, and therefore the pipes would not be subject to the effects of erosion because the water is stagnant, not moving, and not eroding. Once again, it is Fairewinds Associates’ belief that this is another Vermont Yankee reliability issue due to aging management. The industry record substantiates such an opinion where leaks of this type are generally age related and corrosion induced. A similar one-inch pipe with stagnant water in the Reactor Water Clean-up system leaked in 2009. Moreover, because stagnant water cannot cause erosion, Fairewinds believes that corrosion<sup>5</sup> due to stagnation is the most likely cause of the hole in the HPCI. While, the Public Oversight Panel also identified problems in the Flow Accelerated Corrosion program due to improper use of Line Correction Factors, it is unlikely that flow accelerated corrosion would be the cause of this leak since there is no flow in this stagnant pipe.

In its first report issued to the Legislature in March 2009, the Public Oversight Panel identified that the Vermont Yankee Nuclear Power Plant has experienced Microbiologically Induced Corrosion (MIC) in its Service Water System, and this issue has also been discussed in previous Fairewinds Associates’ reports. However, the Service Water System uses unpurified Connecticut River water while the HPCI system uses purified water, so MIC is an unlikely cause of this newly discovered leak.

In order to fully repair the leak, ENVY had to make the system “inoperable” while repairs were made, and since the HPCI is a safety system, this means that other systems must be ready in the

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<sup>3</sup> *Reactor Concepts Manual, Boiling Water Reactor Systems*, USNRC Technical Training Center 3-13 Rev 0200, <http://www.google.com/url?sa=t&source=web&cd=8&ved=0CD0QFjAH&url=http%3A%2F%2Fwww.nrc.gov%2Freading-rm%2Fbasic-ref%2Fteachers%2F03.pdf&rct=j&q=%20%20high%20pressure%20coolant%20injection%20system&ei=3LLJTOXmEYOC8gav1LH0Cg&usg=AFQjCNEW-LKzczHbUs9S8iz2NBxH9sbSnw&sig2=BB8r94JPS4o6MBSbMKlsg>

<sup>4</sup> Erosion - gradual wearing away of the Earth by wind or water; disintegration; deterioration <http://dictionary.babylon.com/erosion/>

<sup>5</sup> Corrosion - wear, deterioration; rust, oxidation <http://dictionary.babylon.com/corrosion/>

event of an accident. The NRC allows this particular safety system to be made “inoperable” for a short amount of time in order to make emergency repairs. If, after the seven-day allotted time span for the repair, the repair has not been completed, then ENVY would have to shut down the plant until the repair is completed. In fact when the plant was shut down in order to repair the feedwater system leak (see below), ENVY also fixed the HPCI leak.

## **2.6. Another Feedwater System Leak**

*Notification: The recent (November 2010) leak in Vermont Yankee’s feedwater systems is indicative of a systemic issue within Entergy’s aging fleet of nuclear power plants. “Limited resource allocation for non-safety systems might, therefore, be systemic within Entergy,”* according to the July 2010 final report of the Vermont Yankee Public Oversight Panel.

*Fairewinds Associates, Inc recommends that Entergy identify and monitor all gamma ports and plugs given this systemic aging management reliability issue at old plants like ENVY and Entergy Nuclear Indian Point. Gamma ports are holes that were used during construction to inspect pipe welds and were subsequently plugged. After construction, the holes are plugged by welding over them, and then they are abandoned.*

On November 7, 2010 an operator noticed water leaking from a large, 24-inch Feedwater pipe. Vermont Yankee decided to shut the plant down to repair this leak. According to a Vermont Yankee press release:

“The Vermont Yankee Nuclear Power Plant in Vernon is commencing a plant shutdown at approximately 7:00 p.m. Sunday night. On Sunday plant operators identified leakage of approximately 60 drops per minute from a system pipe. Subsequent investigation by technicians and engineers identified the leak to be in the feedwater system piping. Because the leak is in a 24 inch piping section which cannot be repaired with the plant in operation, a conservative decision was made to take the plant out of service to perform a repair.”

Fairewinds Associates notes that this is the second leak in the feedwater system since 2009. The location of this latest feedwater leak was in an old “gamma port” in the feedwater pipe. In January 2009, a different old “gamma port” in feedwater pipe leaked in a similar fashion. As a result of our questions, DPS contractor NSA informed Fairewinds Associates that these are the first two-gamma port plugs at Vermont Yankee determined to be leaking.

In 2009 and again in 2010, the radioactive leakage from these “gamma plugs” was captured within the buildings and properly treated as radioactive waste. Unlike the tritium leak, these two feedwater leaks did not release unmonitored radiation into the environment.

While the feedwater system contains high pressure, high temperature radioactive water, the NRC does not consider it to be “safety related.” However, in July 2010, the Public Oversight Panel expressed its concerns about whether ENVY is allocating enough resources to these reliability systems that are not safety related. On page 9 of the *Supplemental Report of the Public Oversight Panel Regarding the Comprehensive Reliability Assessment of the Vermont Yankee Nuclear Power Plant, July 20, 2010*, the Public Oversight Panel stated:

“NSA has determined one common cause of these longstanding AOG problems to be a lack of adequate resources being applied to solve each issue definitively. The Panel agrees with NSA that ENVY has not applied enough resources to assure that the AOG system continues to function reliably in the future.

In its 2009 report, the Panel noted that inadequacy of available resources for non-safety related systems probably contributed to the cooling tower collapse in 2007 and leakage in 2008. The Panel is concerned that, one year later, inadequate application of resources continues to plague some non-safety systems, this time the AOG system. In its 2009 report, the Panel said,

Management issues – ENVY management needs to do a more effective job of leading VY in improvement changes and in effectively applying procedures and processes. ENVY management attention and leadership for the changes recommended by the Report are extremely important as the ENVY workforce changes with retirement and replacements of long term employees. ENVY management needs to assure adequate resources are allocated to the reliability of nonsafety-related systems. (Oversight Panel Report for the Vermont Yankee Reliability Assessment, March 2009, page iii)

Other outside observers have also identified resource allocation problems within Entergy. Writing about the Indian Point nuclear plants in New York, Entergy’s own team of experts said,

The physical condition of the plant in non-safety areas is visibly deficient. While station personnel pay close attention to the care, maintenance and operation of plant safety systems, the care and maintenance of some other plant systems and structures do not meet the standards of high-performing plants.... While these have no direct bearing on safe operation of the plant, it is the Panel’s view that the maintenance and preservation of non-critical plant systems, equipment and structures is important, because it communicates to employees and the public alike the owner’s and operators’ commitment and professionalism. (Indian Point Independent Safety Evaluation Report July 31, 2008, page 11)

In its supplemental report, the Public Oversight Panel also stated that:

**“Limited resource allocation for non-safety systems might, therefore, be systemic within Entergy.**

**The issue of inadequate application of resources takes on heightened importance given Entergy’s status as an aging plant. Over the remainder of Entergy’s operating life, the possibility of shutdown within a few years can never be ruled out and will become a near certainty at some point.”<sup>6</sup>**

[Emphasis added]

## **2.7. Act 189 And Review Of ENVY’s Feedwater System Reliability**

*Notification: Fairewinds Associates, Inc notifies the Legislature that the NSA Report<sup>7</sup> missed identifying inspection problems that appear to be endemic throughout the feedwater system and the resulting reliability failure that has resulted in two leaks in 22-months.*

Fairewinds Associates has not uncovered any record of periodic inspection of any piping segment plugs that were abandoned in place after being used in construction. *Fairewinds Associates, Inc recommends that periodic inspection of such piping systems be undertaken in order to assure ENVY’s reliability due to its aging management reliability issues.*

The Vermont legislature specifically chose ENVY's feedwater system as one of the reliability systems to be evaluated by the DPS contractor NSA. It appears that the NSA report to the legislature missed this reliability issue that has resulted in two leaks during the past 22-months.

Since January of 2009, ENVY's reliability has been adversely affected by two leaks in the VY’s feedwater system. Both leaks appear to be linked to "gamma ports" used during construction. In a review of the December 2008 NSA report to the Legislature, Fairewinds Associates was not able to find any discussion or reliability assessment of leaky gamma ports in the feedwater system nor in any of Vermont Yankee’s large bore pipe system. While the Feedwater portion of the report contains a section regarding inspection, it does not investigate possible leaks in the feedwater system that may be undetected until openly leaking and the adverse impact of such undetectable leakage upon plant reliability.

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<sup>6</sup> *Supplemental Report of the Public Oversight Panel Regarding the Comprehensive Reliability Assessment of the Vermont Yankee Nuclear Power Plant, July 20, 2010, Page 10*

<sup>7</sup> NSA – Nuclear Safety Associates – The Contractor hired by DPS to conduct the Act 189 Audit.

## **2.8. NRC Root Cause Analysis Of Vermont Yankee's Tritium Leak**

*Notification: Fairewinds Associates, Inc wants to inform the Legislature that both the NRC and ENVY's root cause analyses of the tritium leaks are inadequate. The Public Oversight Panel Supplemental Report had a more thorough analysis in which it determined that the lack of a questioning attitude and inadequate resources were in fact the root cause of the tritium leaks.*

*Notification: Fairewinds Associates, Inc notes that if aging problems caused the tritium leaks and aging problems caused the gamma plug leaks, then the effectiveness of ENVY's aging management program is not adequate to assure Vermont Yankee's ongoing reliability.*

The cause of the ENVY's January 2010 tritium leak was reviewed and analyzed by the NRC, and a report delineating the analysis and the NRC issued its review of the causes on October 13, 2010.

Background: The tritium leak that was first detected during the winter of 2010 was not a single failure of any one component, but rather a larger breakdown of many components. Beginning in 2007, two separate Advanced Off Gas (AOG) system pipes leaked steam and water into a closed concrete vault during an extended time period. That concrete vault, which was designed and constructed during the early 1970's, had a special drain line with which to collect any leakage. However, that drain line was most likely clogged with dirt since its construction during the 1970's and in fact it may never have worked as designed. Since the drain was plugged, the concrete vault filled with radioactive water containing tritium, cesium, strontium, and cobalt that then leaked out near a wooden two by four that had also been left since the early 1970's.

In its October 13, 2010 Inspection Report evaluating the "Root Cause" of the AOG (Advanced Off Gas System) tritium leak detected in January 2010, the NRC determined that the root cause was due to construction techniques applied during the 1970's. NRC said,

"The failure to satisfy early construction and housekeeping standards during the 1970s, as well as the lack of corporate emphasis and commitment to the timely implementation of a buried piping inspection and remediation program, are what ultimately resulted in the tritium contamination in 2009/10."

Fairewinds Associates notes that the entire power plant was originally constructed at the same time as the AOG (Advanced Off Gas System) vault that leaked and therefore was built to the same 1970 construction standards and 1970 housekeeping standards as the AOG vault. In Fairewinds opinion, it is disingenuous to suggest that the problems associated with the vault might not be found elsewhere in this nuclear plant. Indeed, as has been previously discussed in this report, during November 2010 a gamma plug failed in the feedwater system. Another gamma plug in the feedwater system also failed in January 2009. The failures of these plugs were related to poor weld seals, these aging plugs were also installed in the feedwater piping during the early 1970's.

### **Section 3. Progress On Act 189 Reliability List**

#### **3.1. What Is The Definition Of Complete?**

*Notification:* While some goals have actually been achieved, on larger efforts “complete” only means that the DPS contractor, NSA, believes that ENVY has created a process by which to achieve the goal at some point in the future. Fairewinds Associates, Inc recommends mandatory, monthly updates by DPS on each of the 90-items delineated by the Public Oversight Panel in response to Act 189.

Monitoring of these “closed” items means that the State’s Nuclear Engineer is not only responsible to assure ENVY continues to meet its performance metrics, but that there will no longer be review meetings by which to assure that ENVY is indeed meeting standards the legislature set in place in order to assure ENVY’s reliability. For those items that the State Engineer has responsibility for monitoring, NSA or other experts will only be involved from this point forward if the State Engineer believes it is necessary.

Before the Legislature reconvenes in January 2011, the DPS, its consultant NSA, and Vermont Yankee's staff set a goal of “closing” all 81-items identified in the original NSA report as well as completing review of the additional 9 items from the supplemental AOG (Advanced Off Gas System tritium leak) inspection. Monitoring of these “closed” items means that the State’s Engineer is the only person reviewing the 91-items outlined as critical reliability issues by the Vermont Yankee Public Oversight Panel. The DPS will no longer hold review meetings by

which to assure that ENVY is indeed meeting standards the legislature set in place in order to assure ENVY's reliability. *For those items that the State Engineer has responsibility for monitoring, NSA or other experts will only be involved from this point forward if the State Engineer believes it is necessary. Given the critical engineering nature of these issues, Fairewinds Associates, Inc recommends ongoing oversight of this process by an independent party in conjunction with the DPS.*

While the DPS goal of "closing" ENVY's list of repair items has been achieved, Fairewinds Associates would like the Legislature to be informed that the term "closing" as applied to the list of 90-items does not mean that any actual task has been accomplished or fully completed, and in Fairewinds Associates' opinion, such action does not fulfill the mandate of Act 189 or assure Vermonter that ENVY's aging management reliability issues have been rectified.

### **3.2. Procedure Upgrades**

*Notification: Only 10 percent of all procedures necessary for the effective operation of the Vermont Yankee nuclear power plant have been updated and revised. ENVY remains severely behind on this critical item, and the only person overseeing this process is the DPS engineer.*

One area of critical concern to the Public Oversight Panel is the improvement of ENVY's operating procedures. The Public Oversight Panel determined that procedure upgrades were critical due to ENVY's aging employees who are beginning to retire. Revised procedures were deemed necessary to transfer knowledge between VY's older staff and personnel who would run the plant for the next 20-years if it is relicensed. There are about 875 procedures that need to be rewritten. ENVY chose to rewrite 220 procedures in its "Phase 1", and those 220 procedures were to have been rewritten by September 2010. In actuality, ENVY has only completed the procedure writing on 70-procedures. The new goal agreed upon by DPS and ENVY is that the initial 220 procedures will be completed and approved for use sometime during the first quarter of 2011. Recently ENVY hired three contractors to assist in procedure writing to meet this new goal. So, although only 10 percent of ENVY's critical operating procedures have been rewritten and approved, the *procedure upgrade process* has been approved by NSA and therefore the

requirement has been reclassified as closed and color-coded Blue, meaning that no further action is required except for monitoring by the DPS State Engineer.

### **3.3. Staffing Levels**

*Notification: The number of on-site personnel has declined by at least 22-employees between January 2010 and September 2010; just as the plant has been facing reliability issues and leaks that require more personnel, not less.*

In September, Fairewinds asked the State's Engineer to investigate a troubling trend in staffing at VY that he is responsible for monitoring. Fairewinds identified to the State's Engineer that personnel in the "Site Cost Center" have decreased from 609 in January to 587 at the end of September. While the State's Engineer promised to investigate, there has been no response to Fairewinds query almost two months later. This is an area of concern that was also identified by the Public Oversight Panel. *See "Cooperation" Section below.*

### **3.4. Microbiologically Induced corrosion (MIC)**

At the end of September, the plant's MIC index showed that 77 percent of the plant is experiencing MIC. Specifically, plant data shows that the MIC index as 23% green (good), 17% red (bad), and 60% yellow (concern). Again, the State Engineer is responsible for monitoring these trends.

### **3.5. Condenser**

Most nuclear power plants replace their condenser at between 20 and 30 years of continued operation. Vermont Yankee's condenser has lasted 39-years. Condenser leaks adversely affect reliability and the water quality of the water that is used inside the nuclear plant as the primary reactor coolant. The earliest that ENVY plans to replace this aging Condenser is 2016.

Condensers have been known to fail catastrophically, as occurred at Entergy's Grand Gulf Plant shutting down the plant for several months. Thus failure of the Condenser would have a deleterious impact upon Vermont Yankee's overall reliability. In previous hearing testimony,

Fairewinds Associates noted that rather than invest \$200,000,000 (in 2016 dollars) in a new condenser, Entergy may choose instead to shut down the plant. If the price of electricity does not rebound, it would be difficult to recoup such a large investment during the final years of the plant's life.

### **3.6. Public Oversight Panel Supplemental Recommendations**

Finally, Fairewinds notes that the DPS and ENVY have not acted upon the Public Oversight Panel's recommendations presented in their July report to the Legislature. The panel noted that the plant staff lacked a questioning attitude and the ENVY was not providing adequate resources to improve Vermont Yankee in a timely fashion. The recent example of the "gamma port" failure in the feedwater system indicate both a lack of a questioning attitude and the fact that insufficient resources are being applied at VY on areas of reliability concern.

### **3.7. Degraded Reliability in 2010**

There have been three Unplanned Shutdowns Since May 2010. The Public Oversight Panel's supplemental report also acknowledged that between ENVY's Fall 2007 refueling outage and its November 2009 refueling outage, VY had a "breaker to breaker" run of 530 days without a shutdown. After reviewing the historical record, Fairewinds has determined Vermont Yankee ended its latest refueling outage on May 24, 2010, at which time Entergy issued a press release that stated:

"Early this morning (5/24), Vermont Yankee control room operators brought the 650 megawatt nuclear power plant back into service. ... The Entergy Vermont Yankee team and our specialized contract workers conducted this complex work initiative with safety and quality as the highest priorities".

On May 26, 2010, the plant tripped off line and Entergy released the following press release:

"The Vermont Yankee nuclear power station automatically shut down today at approximately 3:25 p.m. The plant was at 70 percent of its normal output after restarting from its refueling and maintenance outage. Plant systems responded safely as designed. Plant technicians are investigating the cause of the shutdown. Initial indications are that the shutdown was caused by a problem 345KV switchyard located outside the plant. There has been no release of radiation."

After repairs were made, Vermont Yankee started back up once again on May 29. As it's nuclear chain reaction began to generate steam and the off gas system was placed in service

again, operators noticed a new leak and once again shut the plant down. Entergy issued the following press release:

“During plant start-up activities Friday night, plant operators identified a condition described as vapor and water dripping in the Advanced Off Gas excavated area. The volume was estimated to be extremely small and occurred over a period of approximately four hours.

This was a new leak. The leak has been stopped and there is no leak at this time.

There is no threat to public health or safety.

The vapor and water dripping was identified at approximately 730 pm during warm up of the AOG system.

No leakage was visible after warm up and shortly after the AOG system was placed in service.

The leak has been located on a two-inch drain line and is approximately one eighth of an inch in diameter.

The vapor and water dripping was observed coming from the end of a concrete enclosure surrounding a two-inch drain line in the AOG excavation just before the pipe enters the wall of the drain tank room.

Soil testing of the area has been performed and tested positive for several radioisotopes in a one-foot radius from the leak source.”

Once again, after this leak was repaired, the plant started up again and ran for 163 days before shutting down once again because of a leak in the feedwater system on November 7, 2010.

Entergy issued the following press release at that time:

“The Vermont Yankee Nuclear Power Plant in Vernon is commencing a plant shutdown at approximately 7:00 p.m. Sunday night. On Sunday plant operators identified leakage of approximately 60 drops per minute from a system pipe. Subsequent investigation by technicians and engineers identified the leak to be in the feedwater system piping. Because the leak is in a 24-inch piping section, which cannot be repaired with the plant in operation, a conservative decision was made to take the plant out of service to perform a repair.

The NRC Resident Inspector has been informed of the issue and of the plan to remove the station from service. The plant had been operating at reduced power for a scheduled rod pattern adjustment and to support line work by Public Service Company of New Hampshire. The plant had been on line for 163 days of continuous operation.”

The NRC usually applies increased inspection attention to reactors that shutdown unexpectedly three or more times in 7,000 hours. However, the NRC has decided that since these additional

shut-downs did not occur while VY was operating at full power, it will not provide additional inspections until VY shuts down two more times.

#### **Section 4. Cooperation Between The DPS And Fairewinds Associates, Inc**

The Department of Public Service and its state nuclear engineer are tasked with monitoring ENVY's progress on a variety of issues, including but not limited to its compliance with Legislative Statue Act 189. Fairewinds Associates, Inc specifically wrote to the DPS state engineer requesting progress graphs that the DPS is required to monitor. Incredibly, the DPS wrote back that it does not have any ENVY progress graphs. If the DPS is unable to answer these reliability issues, then ENVY is not receiving the requisite oversight Act 189 required in order to ascertain and assure ENVY's continued operating reliability. Such oversight is especially critical given the DPS decision to designate unfinished items as complete.

The following exchange is the most recent example of communication difficulties. These requested graphs include the staffing issues that are required post Act 189 monitoring issues.

From: Arnie Gundersen  
Sent: Monday, November 29, 2010 8:38 AM  
To: Vanags, Uldis  
Subject: copies

Hi Uldis,

May I have copies of the performance graphs that are posted on the wall outside Mike Coulomb's office? I believe they are updated monthly, so as they are updates, would you send those along each month.

Thanks, Arnie

On Nov 30, 2010, at 4:10 PM, Vanags, Uldis wrote:

Hi Arnie: I don't have copies of the performance graphs outside of the nuclear station. Please submit your information requests to Mike McKenney at Vermont Yankee so they can process it.

I sent you Mike's contact information earlier but if you can't locate it I will be glad to send it to you.

Hope you had a good holiday,

Uldis

Uldis Vanags

State Nuclear Engineer

Vermont Department of Public Service

112 State Street

Montpelier, VT 05620-2601

From: Arnie Gundersen  
Date: November 30, 2010 4:23:48 PM EST  
To: "Vanags, Uldis" "Hofmann, Sarah"  
Subject: Re: copies

Uldis, Thanks for replying. Arnie

In order to fulfill its consultancy role to the Joint Fiscal Committee, Fairewinds Associates, Inc has asked appropriate questions of the DPS and believes is not receiving adequate or appropriate answers in reply. The evidence and job description show that in its oversight role as the state agency designated with monitoring the operation of Vermont Yankee, the DPS should know the answers to the questions Fairewinds Associates, Inc is asking, but the DPS engineer instead has attempted to make this issue a jurisdictional issue among the Legislature, Fairewinds Associates, Inc, and Entergy Nuclear Vermont Yankee. After refusing to answer two questions from Fairewinds Associates, the DPS claimed it would reply to Fairewinds Associates' third question in a timely manner, but as of the publication of this report, DPS still has not responded.

In October, Fairewinds made the following request of the DPS:

From: Arnie Gundersen  
Sent: Wednesday, October 20, 2010 9:16 AM  
To: Vanags, Uldis; Hofmann, Sarah  
Subject: keep me informed about...  
Hi Uldis

I would like to be kept informed about:

- The cause of crack/leak in the HPCI and when VY enters an LCO condition. Generic Letter 91-18 Supplement 1 established the agency's expectations for determining when degraded conditions do not render a system inoperable. It covers things like missing a required surveillance test and when in-plant discoveries reveal a component to be other than as designed.
- Can you confirm that VY followed this guidance and provided reasonable engineering judgment that the leaking weld would not impair the safety function of the HPCI system throughout the entire length of that safety mission? If 91-18 was properly applied, HPCI could be operable now, but would become inoperable when workers cut into the pipe for the repairs to the weld. That analysis would also have to consider the pre-existing leak of radioactive fluid into either primary containment (if the leaking weld is inside the drywell) or secondary containment. Most safety analyses assume a leak of up to 25 gpm of fluid containing the post-accident source term into the secondary containment for worker and EQ doses.

Could you explain what the two different staffing titles mean? "Site Cost Center" and "Site Total" as well as the red line "Total Budgeted Positions". It looks like the Site Cost Center has dropped from 609 in January to 587 in September (22 fewer people in the Site Cost Center) and the "Site Total" has dropped from 640 in January to 620 in September (20 fewer people in the Site Total). It is unclear if the horizontal red line marked "Total Budgeted Positions" (@ 609 people) applies to the Site Total or to the Site Cost Center. Could you explain?

In response, the DPS sent the following email to Fairewinds:

From: "Vanags, Uldis"  
Date: October 20, 2010 2:56:21 PM EDT  
To: 'Arnie Gundersen' "Hofmann, Sarah"  
Subject: RE: keep me informed about...  
Hi Arnie: I read over the information request you have below, and while I enjoy discussing these topics with you when we get together, I feel that the first two questions concerning the HPSI would be better addressed by Vermont Yankee. If you remember in your JFO capacity the Department does not serve as "middleman" as it did with the POP. Please see the email I pasted below for the address to whom to send your questions. I will answer your third question about the staffing which I discussed with the NSA folks.  
Uldis

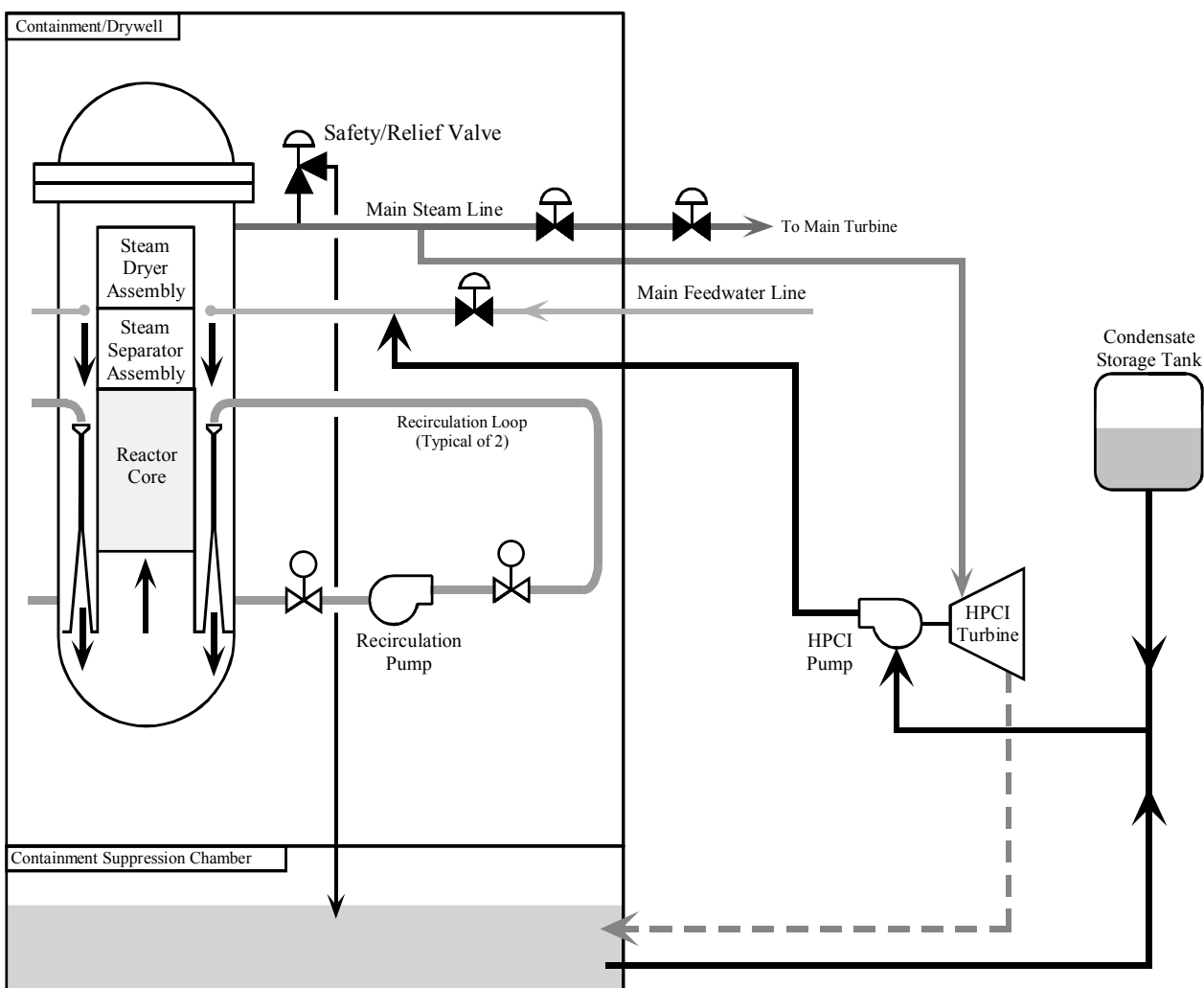
From: Vanags, Uldis Sent: Monday, March 15, 2010 2:23 PM To: 'Arnie Gundersen' Cc: Hofmann, Sarah; Cotter, John; 'McKenney, Michael P'; McCann, John  
Subject: Process to submit questions to Vermont Yankee  
Arnie: As I mentioned at the RIC, questions to Vermont Yankee via your JFO capacity need to be submitted to the plant directly by you. I discussed this with John McCann and he stated that questions are to be submitted in letter form mailed to Michael McKenney, Acting State Liaison Engineer, and copied to Michael Colomb, Site Vice President.

The address is:

Michael McKenney  
Acting State Liaison Engineer  
Entergy Nuclear Operations Inc.  
Vermont Yankee Nuclear Power Station  
320 Governor Hunt Road  
Vernon, Vt. 05354

Let me know if you have any questions. Uldis

During the September and October meetings among the Act 189 consultants at Vermont Yankee, which Mr. Gundersen attended, note was made regarding the tracking issues that the DPS engineer must continue in his ongoing responsibility to make sure ENVY is implementing the corrections determined by the Vermont Yankee Public Oversight Panel. The questions asked by Mr. Gundersen all pertain to the specific issues regarding Vermont Yankee's aging management and reliability. If the DPS is not able to answer these reliability issues, then ENVY is not receiving the requisite oversight Act 189 required in order to ascertain and assure ENVY's continued reliable operation. Fairewinds Associates, Inc believes such oversight is especially critical given the DPS decision to designate unfinished items as complete.



## High Pressure Emergency Core Cooling Systems

The high pressure coolant injection (HPCI) system is an independent emergency core cooling system requiring no auxiliary ac power, plant air systems, or external cooling water systems to perform its purpose of providing make up water to the reactor vessel for core cooling under small and intermediate size loss of coolant accidents. The high pressure coolant injection system can supply make up water to the reactor vessel from above rated reactor pressure to a reactor pressure below that at which the low pressure emergency core cooling systems can inject.

The automatic depressurization system (ADS) consists of redundant logics capable of opening selected safety relief valves, when required, to provide reactor depressurization for events involving small or intermediate size loss of coolant accidents if the high pressure coolant injection system is not available or cannot recover reactor vessel water level.