January 5, 2010

SUSQUEHANNA RIVER BASIN COMMISSION

In the Matter of	)
RE: Bell Bend Nuclear Power Plant	)
Application for Groundwater Withdrawal	)
Application for Consumptive Use	)
BNP-2009-073	)

EXPERT WITNESS REPORT OF ARNOLD GUNDERSEN REGARDING CONSUMPTIVE WATER USE OF THE SUSQUEHANNA RIVER BY THE PROPOSED PPL BELL BEND NUCLEAR POWER PLANT

I, Arnold Gundersen, declare as follows:

1. My name is Arnold Gundersen. I am sui juris. I am over the age of 18-years-old.

2. Eric J. Epstein, a resident of 4100 Hillsdale Road, Harrisburg, PA 17112, and a PPL ratepayer and shareholder, has retained me as an expert witness. I have been asked to examine what alternative methods may be available and could be applied by PPL Bell Bend, LLC ("PPL" or "Applicant) for cooling the steam that is generated by the proposed Bell Bend plant in lieu of withdrawing and discharging significant quantities of water directly into the Susquehanna River. If any alternative methods are available, I have also been asked to discuss those alternatives so that the Susquehanna River Basin Commission (SRBC) will have the information necessary to complete its assessment.

3. I earned my Bachelor's Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude. I earned my Master's Degree in Nuclear Engineering from RPI via an Atomic Energy Commission Fellowship. Cooling tower operation and cooling tower plume theory were my area of study for my Master's Degree.

4. I began my career as a reactor operator and instructor in 1971 and progressed to the position of Senior Vice President for a nuclear licensee prior to becoming a nuclear engineering consultant and expert witness. My Curriculum Vitae is Attachment 1.

5. I have qualified as an expert witness before the Nuclear Regulatory Commission (NRC) Atomic Safety and Licensing Board (ASLB) and Advisory Committee on Reactor Safeguards (ACRS), in Federal Court, the State of Vermont Public Service Board, the State of Vermont Environmental Court, and the Florida Public Service Commission.

6. I am an author of the first edition of the Department of Energy (DOE) Decommissioning Handbook.

7. I have more than 38-years of professional nuclear experience *including and not limited to*: Cooling Tower Operation, Cooling Tower Plumes, Consumptive Water Loss, Nuclear Plant Operation, Nuclear Management, Nuclear Safety Assessments, Reliability Engineering, In-service Inspection, Criticality Analysis, Licensing, Engineering Management, Thermohydraulics, Radioactive Waste Processes, Decommissioning, Waste Disposal, Structural Engineering Assessments, Nuclear Fuel Rack Design and Manufacturing, Nuclear Equipment Design and Manufacturing, Prudency Defense, Employee Awareness Programs, Public Relations, Contract Administration, Technical Patents, Archival Storage and Document Control, Source Term Reconstruction, Dose Assessment, Whistleblower Protection, and NRC Regulations and Enforcement.

Introduction

8. My declaration is intended to alert the Susquehanna River Basin Commission (SRBC) to significant problems in consumptive water use of the Susquehanna River if the proposed PPL Bell Bend nuclear plant is built as designed and allowed to use the Susquehanna River as its primary resource for *make-up* water for cooling.

9. Specifically, PPL has filed an application to build a 1,600 MWe Evolutionary Power Reactor (EPR) designed by AREVA named Bell Bend because of its location on the

Bell Bend of the Susquehanna River. In my professional opinion, the Bell Bend Combined License Application (COLA)[1], as filed with the U.S. Nuclear Regulatory Commission (NRC), has significant deficiencies in its analysis resulting in serious unresolved issues with consumptive water use that will negatively impact the health and vitality of the Susquehanna River Watershed and the Chesapeake Bay Watershed.

10. If completed, the proposed PPL Bell Bend nuclear power plant will be one of the largest nuclear reactors in the world. Due to its sheer size and because it also has a lower thermodynamic efficiency (discussed in detail below), Bell Bend will draw an inordinately large amount of water from the Susquehanna River in order to cool the reactor. The amount of water anticipated for use by the PPL proposed Bell Bend nuclear power plant is detailed in a recent report written by Normandeau Associates, paid for by PPL, and submitted to the Susquehanna River Basin Commission.

11. In its November 2009 report, entitled, *Instream Flow Study Plan To Assess The Effects Of Consumptive Use Of Water On Fish Habitat At The Bell Bend Project*, Normandeau Associates said,

> "November 2009 The Bell Bend Nuclear Power Plant (BBNPP) proposed by PPL is estimated to consumptively use up to 43 cubic feet per second (cfs) or 28 million gallons per day (mgd) of water from the Susquehanna River. Up to approximately 64 cfs or 41 mgd will be withdrawn from an intake located about 300 ft downstream of the Susquehanna Steam Electric Station (SSES) intake structure (Figure 1-1). Water not consumed will be returned to the river via a submerged discharge diffuser approximately 680 ft downstream of the BBNPP

[1] **Combined license (COL)**
By issuing a combined license (COL), the U.S. Nuclear Regulatory Commission (NRC) authorizes the licensee to construct and (with specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations. A COL is valid for 40 years from the date of the Commission finding, under Title 10, Section 52.103 (g), of the *Code of Federal Regulations* [10 CFR 52.103(g)], that the acceptance criteria in the combined license are met. A COL can be renewed for an additional 20 years.
In a COL application [COLA], the NRC staff reviews the applicant's qualifications, design safety, environmental impacts, operational programs, site safety, and verification of construction with ITAAC. The staff conducts its review in accordance with the Atomic Energy Act, NRC regulations, and the National Environmental Policy Act. All stakeholders (including the public) are given notice as to how and when they may participate in the regulatory process, which may include participating in public meetings and opportunities to request a hearing on the issuance of a COL *http://www.nrc.gov/reactors/new-reactors/col.html*

> intake. PPL has applied to the Susquehanna River Basin Commission (SRBC) for approval to withdraw water from the river at BBNPP and to use some of this water consumptively. In its application to SRBC, PPL has requested approval for consumptive use of up to 31 mgd as a measure of conservatism and to account for variability within the range of monitoring accuracy required by SRBC."[2]

12. As a result, the PPL proposed Bell Bend nuclear power plant will withdraw at least 15,000,000,000 (15 billion) gallons of water from the Susquehanna River every year.

13. Consequently, each year the 4,000,000,000 (4 billion) gallons of water that will be returned to the river will have been heated and will contain additional chemical contaminants discussed below.

14. The difference between what is withdrawn from and what is returned to the Susquehanna River each year will be *consumed* by the PPL proposed Bell Bend nuclear power plant, and as a result, this consumptive use of water amounts to 11,000,000,000 (11 billion) gallons per year.

15. The 11,000,000,000 (11 billion) gallons of water withdrawn each year from the Susquehanna River will be emitted as water vapor from the proposed cooling towers.

16. It is hard to visualize exactly how much 11,000,000,000 (11 billion) gallons of water per year would be. To put the *consumed* water into a visual perspective, the 11 billion gallons of water would fill the equivalent of 50-football fields 500-hundred feet high with river water.

17. Subsequently, in addition to the environmental burden of 4 billion gallons of heated and chemically contaminated water that will be dumped into the River each year, the Susquehanna River Basin and the Chesapeake Bay will face an enormous yearly consumption of Susquehanna River Water that will be withdrawn and never returned.

18. According to the Susquehanna River Basin Commission's website, the mission of the SRBC

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[2] Page 1, *Instream Flow Study Plan To Assess The Effects Of Consumptive Use Of Water On Fish Habitat At The Bell Bend Project*, November 2009

> "…is to enhance public welfare through comprehensive planning, water supply allocation, and management of the water resources of the Susquehanna River Basin. To accomplish this mission, the SRBC works to: reduce damages caused by floods; provide for the reasonable and sustained development and use of surface and ground water for municipal, agricultural, recreational, commercial and industrial purposes; protect and restore fisheries, wetlands and aquatic habitat; protect water quality and instream uses; and ensure future availability of flows to the Chesapeake Bay. The SRBC is uniquely qualified to carry out this mission. As a federal-interstate compact commission, its focus is defined by the natural boundaries of the river basin rather than the political boundaries of the member states. As such, the SRBC serves as a forum to provide coordinated management, promote communication among the members, and resolve water resource issues and controversies within the basin."

19. Moreover, the Susquehanna River Basin Commission has joined with other watershed commissions to form the Interstate Council on Water Policy and is a Chesapeake Bay Partner Community "committed to protecting water quality, the bay, and its many tributaries."

20. Since the Susquehanna River currently provides half of the fresh water that enters the Chesapeake Bay, I believe that the intended withdrawal *each day* of as much as 31,000,000 (31 million) gallons of the Susquehanna River's flow by the proposed PPL Bell Bend nuclear power plant will have a significant impact upon the downstream ecology that is not adequately addressed in the current application or appropriately reflected in the Susquehanna River Basin Commission's fee structure.

21. Consumptive water use is defined as "any use that permanently removes water from a watershed or a confined aquifer from which it is withdrawn by activities that result in substantial evaporation and evapotranspiration." Industrial cooling operations, like those intended for the proposed PPL Bell Bend nuclear power plant, are some of the activities that often result in substantial evaporation and evapotranspiration. http://www.njfb.org/waterquality/glossary.htm

22. A nuclear power plant like the PPL proposed Bell Bend unit uses steam created from water heated by the nuclear reactor to produce electricity. Any power plant, nuclear, coal or oil, that uses steam to turn a turbine that then creates electricity like the

proposed PPL Bell Bend nuclear power plant will do is governed by the laws of thermodynamics. Furthermore, according to the laws of thermodynamics, a physics rule known as the *Carnot cycle*[3] governs the maximum theoretical efficiency of these steam-generated turbine power plants.

23. In lay terms, the Carnot cycle simply means that no power plant is theoretically capable of converting one hundred percent of the heat it produces as steam into electricity. The maximum efficiency of a power plant like the PPL proposed Bell Bend Unit is capped by the difference between two key parameters: the high temperature of the steam (heat source) and the low temperature of the *heat sink*. The PPL Bell Bend nuclear power plant, like most current power plants located on rivers, would use as its heat sink the process of water evaporation in its cooling tower via water withdrawn from the Susquehanna River.

The Carnot Cycle

24. Whether a power plant operates with coal, oil, gas, or nuclear power as the PPL proposed Bell Bend Unit does, each method heats water in order to create steam. In turn the steam is used to turn a turbine and create electricity. By whatever method the steam is created, that is called the "heat source". After that steam turns the turbine, it is cooled, condensed back into water and returned back to the boiler or nuclear reactor from where was originally drawn.

25. This process of creating steam, turning a turbine, condensing the steam and returning it to a boiler or nuclear reactor is called the Carnot cycle. In a Carnot cycle, there must be a *heat source* to create the steam and a *heat sink* to cool the steam back into water. The *heat source* may be oil, coal, wood, gas or nuclear fuel, and the *heat sink* is always either water or air or a combination of both.

26. While all power plants may create heated steam through different *heat sources*, every power plant condenses its steam in a device called a condenser. Even though

[3] **Carnot cycle** – the most efficient thermal cycle possible, consisting of four reversible processes, two isothermal and two adiabatic. *Jones and Childers Glossary,* http://www.mhhe.com/physsci/physical/jones/student/olc/student_glossary.mhtml

each condenser varies in shape and size, each condenser fulfills the same function: that is, condensers take in steam from a *heat source* and condense it back to water. This cooled steam now becomes water that is called *condensate*. After the cooled steam becomes condensate, it is pumped back to the *heat source* to be heated again. This repeating loop is called the *steam cycle*.

27. In order to turn steam back into condensate, condensers are compartmentalized to separate the heated steam from the *heat source* with a physically separate second loop that is called the *heat sink*. This second loop is filled with either water or air that is the applied cooling mechanism. The heat that leaves a condenser and migrates to the *heat sink* is called *waste heat*.

28. Nuclear plants are inherently less efficient than oil, natural gas, and coal fired power plants because of the Carnot cycle. On a per megawatt basis, nuclear plants also release more waste heat per megawatt than coal, oil, or natural gas fired power plants. The hotter the heat source can be made, the higher the Carnot efficiency. Since both coal and natural gas create higher temperatures by which to create steam than nuclear plants, coal and natural gas plants have a higher Carnot efficiency.

29. Thus, for a nuclear power plant like the PPL proposed Bell Bend unit, more waste heat will be released because it is more inherently less efficient than either coal or natural gas.

30. Additionally, because the PPL proposed Bell Bend nuclear power plant would be the largest size nuclear power plant yet constructed, its sheer size will also increase the waste heat sent to the *heat sink*.

Various Types of Heat Sinks

31. When water is plentiful at nuclear power plants in ocean locations, the steam is passed on the outside of the tubes within the condenser while ocean water passes through the inside of tubes on the other side of the condenser. This is called once through cooling and the ocean is quite literally the heat sink. The advantage of once through cooling is that it makes the nuclear power plants rather inexpensive to build

and operate in comparison to other nuclear power plants that do not have access to such an abundant and infinite water supply. Once through cooling of the condenser has become increasingly rare because the methodology of using ocean or river water to cool the condenser makes the river or ocean too warm thereby killing various aquatic organisms and negatively impacting the ecosystem.

32. River flow is limited and power plant output and *heat sink* demand has increased dramatically with these much larger reactors, so once through cooling is rarely used in inland locations. Due to its large size and inherently inefficient cooling methodology, the proposed PPL Bell Bend nuclear power plant cannot use the Susquehanna River for once through cooling of its condenser. If constructed, the proposed Bell Bend nuclear plant will send all of its waste heat into the air via some type of cooling tower, because the river flow is simply too low to support the consideration of using a once through condenser.

33. Therefore, some form of cooling tower must be relied upon to help cool the steam inside the condenser at the PPL proposed Bell Bend nuclear power plant. There are three types of cooling tower designs currently in use by the power generation industry.

33.1. The first cooling tower design is the large hyperbolic, natural draft cooling tower, which has come to symbolize most nuclear power plants. The shape of these hyperbolic cooling towers creates lift in the air and naturally pulls the air across water that is falling inside them.

33.1.1. Some of this water that is withdrawn from a river evaporates causing large vapor clouds to exit from the top of the cooling tower.

33.1.2. The remaining water is then circulated back through the condenser where it again absorbs heat from the heat source.

33.1.3. A side effect of the process of evaporating water and heating the air is that natural draft cooling towers also concentrate any impurities that are in the river water, basically making that water dirtier.

33.1.4. Additionally, these hyperbolic towers create large plumes of water vapor leaving the top of the tower that have adverse visual and environmental effects.

33.2. Mechanical-draft cooling towers cool countless other power plants around the country, including many nuclear power plants. In this application short squat towers are used instead of the large hyperbolic tower, which does not have fans.

33.2.1. Since these short squat towers cannot rely upon the natural shape of the hyperbolic tower to cool the water, large fans are placed above these cooling towers so that the fans actually pull air through each cell.

33.2.2. These mechanical-draft cooling towers are also called forced draft cooling towers and are a modular design with a lower visual profile.

33.2.3. These forced draft cooling towers also withdraw water from a river and release plumes of water vapor out the top and also concentrate contaminants in the remaining water as did their hyperbolic cooling tower cousins.

33.2.4. While they cost less to build than hyperbolic towers, they have an added operational expense because electricity is required to operate the fans.

33.3. The third design for power generation cooling towers does not use any river water to cool the power plant. This design is called dry cooling and requires a different condenser design than that presently designed for PPL proposed Bell Bend nuclear power plant.

33.3.1. Instead of applying water to cool the steam and then cooling that water with either river water or a combination of fans and river water as in a wet cooling tower, this design cools the steam directly with air and utilizes no outside water.

33.3.2. This design is called an *air-cooled condenser*. These *air-cooled condensers* are short and squat, thereby resembling the forced air towers

discussed in the previous section.

34. Because both the hyperbolic tower and the forced draft tower evaporate water, as discussed in detail in the previous section, some river water must still be used to cool the power plant. *Make-up water* is the term used to describe the water used to replace the evaporated water.

35. All hyperbolic or forced-air cooling towers also create dirty water called *blowdown water* that is returned back to the river with contaminants concentrated within it. *Make-up* water is also used to replace *blowdown* water.

36. The dirty water released from the cooling towers back into the Susquehanna River as *blowdown* will be approximately 25% of the amount of water that is withdrawn. For every four gallons the plant withdraws, it sends back one gallon of *blowdown*. The blowdown is a pollutant for three reasons:

36.1. Three out of every four gallons of withdrawn evaporate water (consumptive use water) that will be initially drawn from the Susquehanna River will be returned to the river as blowdown with four times more concentration of pollutants and minerals than when that water was withdrawn.

36.2. In addition to concentrating contaminants and minerals that already existed in the river, the blowdown contains biocides and algaecides used within the cooling towers to prevent them from becoming clogged with mold and mildew.

36.3. Along with chemical contamination and highly concentrated minerals, the dirty blowdown water will be approximately 20 degrees hotter than the river water to which it is being returned.

37. The PPL proposed Bell Bend nuclear power plant will use about 1% of the flow in the Susquehanna River for its *make-up* water due to evaporation.

38. Whereas, in an air-cooled condenser design, the steam that leaves the turbine passes directly to a dry cooling tower thus using no river water. The air-cooled condenser sits at the base of a dry cooling tower.

38.1. This design has the unique advantage of not having a secondary loop of additional river water required to cool the steam.

38.2. In the air-cooled condenser design, steam heat from the power plant passes through a tube directly into the air.

38.3. Also, in the air-cooled condenser design, steam is directly condensed by the air and then sent back into the power plant.

38.4. No intermediate river water is ever used in the air-cooled condenser design.

39. Dry cooling and an air-cooled condenser have several key advantages:

39.1. The first advantage of dry cooling and an air-cooled condenser is that there is no consumption of river water.

39.2. The second advantage is that without dirty water (or blow down) being sent back into the river, contamination to the river is lessened.

39.3. The third advantage is that there is no cloud of hot moist air leaving the tower, so these towers never produce a cloud of water vapor that has so many additional negative meteorological, environmental, and esthetic impacts.

40. While the air-cooled condenser design would offer many significant advantages for the proposed PPL Bell Bend environment and the overall health of the Susquehanna and Chesapeake watershed areas, these air-cooled designs do have two disadvantages for PPL:

40.1. The first drawback to the air-cooled design is that this design lowers the efficiency of the power plant slightly by increasing the backpressure on the turbine thus providing less electricity to generate and less income for the power plant owner. However, for most of the year, when temperatures are lower than 70 degrees, the efficiency of the air-cooled design is quite comparable to other cooling techniques.

40.2. The second disadvantage of the air-cooled design is that, because it is less

effective at removing the heat from steam than wet evaporative cooling, the air-cooled towers are more expensive to operate than either the hyperbolic or forced air-cooling towers.

41. While installing an air-cooled condenser is slightly more expensive than the approach chosen by PPL to use on the Bell Bend project, air cooled condensers would completely eliminate the significant problem of consumptive water use of the Susquehanna River. If PPL equipped its proposed Bell Bend project with air-cooled condensers, then the Susquehanna River Watershed area would not be facing the negative environmental burden of the Bell Bend nuclear power plant's evaporative losses, including:

    41.1. A withdrawal of 31 million gallons per day of water of *make-up* water being drawn from the Susquehanna River to cool plant, or

    41.2. Any dirty water (*blowdown water)* being returned to the Susquehanna River.

Detailed Discussion of Air Cooled Condensers

42. Air-cooled condensers consist of a modular design, are pre-built, and then are delivered to the site in individual modules. The air-cooled condenser design is even simpler than the current PPL proposed design for the Bell Bend unit.

43. In my review of the PPL design for its Bell Bend cooling towers, the evidence shows that the overall layout of the main steam and condensate system can in fact accommodate an air-cooled condenser. Furthermore, the only limitation an air-cooled condenser may place upon the proposed PPL Bell Bend nuclear power plant is that backpressure on the steam turbine may change slightly as a result of using an air-cooled condenser.

    43.1. A slightly different turbine design will also be required to accommodate an air-cooled condenser due to the slight backpressure considerations with a dry cooling system. The additional cost of this turbine redesign and the backpressure considerations are nominal, especially when compared to the overall cost of the unit and the environmental costs of withdrawing 31 million gallons of water out

of the river daily.

43.2. Additionally, the efficiency of the proposed PPL Bell Bend Project will be reduced by no more than 1% from the slightly higher backpressure due to the use of an air-cooled condenser.

43.3. Moreover, with the air-cooled dry towers, when the ambient air temperatures are 70° or less there will be almost no difference in the electric output of the PPL proposed Bell Bend nuclear power plant as compared with the PPL currently designed evaporative towers.

43.4. At present, in the PPL proposed Bell Bend design, the turbine hall has a very large space underneath the turbine reserved for the intended water-cooled condenser. Therefore, removing the very large water-cooled condenser will provide more than enough space for steam lines to exit from the bottom of the turbine to an air-cooled condenser, seemingly without any additional major modifications.

44. While the Bell Bend design would have to be slightly modified to incorporate an air-cooled condenser, since no components have yet been bought, fabricated, or installed, the redesign cost to accommodate an air-cooled condenser is nominal in comparison to the overall cost of the project and compared to the significant and long-term environmental costs of using evaporative cooling towers to withdraw 15 billion gallons of water from the Susquehanna River every year.

45. Moreover, changing to an air-cooled condenser and air-cooled towers will not impact any aspect of the nuclear design that has already been approved by the Nuclear Regulatory Commission.

46. There are dozens of coal and natural gas-fired plants in the U.S. that use air-cooled condensers, and abundant examples of air-cooled condenser applications of similar or larger sized power plants worldwide.

46.1. For example, the largest air-cooled plant in the U.S. is the 1,650 MW Midlothian Energy natural gas combined cycle plant near Dallas, Texas, and the largest coal-fired air-cooled plant in the U.S. is the 330 MW Wyodak plant in Wyoming.

46.2. Worldwide, the largest air-cooled coal-fired plant in the world is the 4,000 MW Matimba power plant in South Africa.

Water Supply and Potential for Drought

47. In addition to water quality and consumptive water use, the Susquehanna River Watershed could be compromised due to drought. According to SRBC's comprehensive plan, SRBC is responsible for:

47.1. Supporting and encouraging "the sustainable use of water for domestic, industrial, municipal, commercial, agricultural, and recreational activities in the basin" by an inventory of available water resources.

47.2. Maintaining "an equitable system for allocating water for various uses, including the protection of instream flows and receiving waters of the Chesapeake Bay".

47.3. Ensuring "sustainability of water sources by improving systems and managing water resources more efficiently".

47.4. Mitigating "drought impacts through coordination and use of drought emergency powers".

48. If PPL used air-cooled condensers at its proposed Bell Bend nuclear power plant, no water would be drawn from the Susquehanna River.

48.1. My review of the evidence provided shows that PPL may not have considered the potential for a drought that would compromise the availability of Susquehanna River water in its engineering design of the 1600 MWe Bell Bend unit.

48.2. A modest but illustrious example of the magnitude of water used at nuclear power plant is readily evidenced at the Susquehanna Steam Electric Station (SSES), which is a two-unit nuclear power plant located on the Susquehanna

River very near to the location of the proposed Bell Bend nuclear power plant.

48.2.1. *Every day* SSES loses 14.93 million gallons of water as evaporative cooling tower water vapor from each of its two units.

48.2.2. Each day 11 million gallons of contaminated cooling tower basin *blowdown* water is returned to the Susquehanna River.

48.2.3. *At the present time, SSES takes on average 29.86 million gallons of water per day from the Susquehanna River that is not returned. However,* according to the NRC, once the Extended Power Uprate is fully implemented at the SSES, the plants will withdraw more than double the amount of water, with an upper limit of 65.4 million gallons per day, totaling almost 24 billion gallons of Susquehanna River Water per year.

> "…will withdraw an average of 60.9 gallons per day (mgd) (230 million L/d) of water from the Susquehanna River for cooling tower evaporative losses and other plant needs, with a maximum daily water withdraw estimate of 65.4 mgd (248 million L/d). This represents a 4.5 and 12.2 percent increase, respectively, in intake water withdrawn from the Susquehanna River from the pre-EPU conditions (NRC 2007a). Some of this water would be returned to the river as cooling tower blowdown, with the difference equaling the amount of the consumptive water use by SSES. Consumptive water use due to evaporation and drift of cooling water through the SSES cooling towers is expected to increase from 38 mgd (144 million L/d) to 44 mgd (166 million L/d). Based on the Susquehanna River's annual mean flow rate, an average annual loss of 0.5 percent of river water at the SSES location would result. During low-flow conditions, which usually occur in late August, the average evaporative loss at SSES could approach 1 percent of the river flow (PPL 2006b)."[4]

48.2.4. As currently designed, the proposed single unit Bell Bend station would withdraw an additional 31,000,000 (31 million) gallons per day.

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[4] US NRC, Environmental Impacts of Operation, Draft NUREG-1437, Supplement 35, 4-15, April 2008

49. According to the U.S. Geological Survey,

> "…changes in evaporation and transpiration during a drought depend on the availability of moisture at the onset of a drought and the severity and duration of a drought. Also, weather conditions during a drought commonly include below-normal cloud cover and humidity and above-normal wind speed. **These factors will increase the rate of evaporation from open bodies of water** and from the soil surface, if soil moisture is available." [Emphasis Added]
> http://geochange.er.usgs.gov/sw/changes/natural/et/

50. One of the considerations for review is plant reliability, and the potential for drought would reduce the reliability of the plant during the middle of the summer exactly at the time the area's need is greatest.

50.1. Droughts on the Susquehanna are not merely a theoretical consideration. According to the SRBC Drought Management Information Sheet[5], droughts and low-water flow but have occurred quite recently, with droughts occurring every decade except the 1970s.

> "Like floods, the magnitude of drought events can be categorized based on historical frequency, i.e., 5-year droughts, 10-year droughts, 50-year droughts, etc. (The higher numbers indicate more severe, and less frequent, droughts.) Droughts can affect the entire basin or cause localized water shortages.
>
> Since the beginning of the 1900s, the basin has experienced droughts in every decade except the 1970s. The worst droughts occurred in 1930, 1939 and 1964. During the 1990s through mid-2000s, periodic low flows throughout the basin or in regions resulted in frequent droughts, including in 1991, 1995, 1997, 1998, 1999, 2000, 2002 and 2006."

50.1.1. The 4,500 businesses in the Susquehanna River Basin employ 230,537 people, add $6.8 Billion (Dollars) to the region's economy, and depend upon the water from the Susquehanna River.[6]

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[5] *SRBC Drought Management Information Sheet*, http://www.srbc.net/hydrologic/docs/Drought%20Management%20(5_07).PDF

[6] *Economic Value of Water Resources: Direct Water-Dependent Businesses in the Susquehanna Basin*, Susquehanna River Basin Commission, Revised: November 2006.

50.1.2. Water shortages on the Lower Susquehanna reached critical levels during the summer of 2002, but during the 2002 drought, the Susquehanna Steam Electric Station's (SSES) two nuclear power plants were in fact exempted from water conservation efforts in order to meet the Region's demand for electricity.

50.1.3. During the month of August 2002, 66 of 67 Pennsylvania counties had below normal precipitation levels, while the Susquehanna Steam Electric Station's nuclear plants *did not take any measures or precautions to conserve water*.

50.1.4. The Bell Bend unit proposed by PPL would withdraw an additional 31,000,000 (31 million) gallons per day from the river obviously exacerbating a frequent drought situation in one of the nation's most critical watershed areas already facing many added usage burdens at the same time it is attempting to heal an environmentally challenged and fragile ecosystem.

51. The June 2009 issue of Power Magazine featured an article entitled *Air Cooled Condensers Eliminate Plant Water Use* in which author William Wurtz said,

> "The pragmatic developer may also select dry cooling early in a project because it increases plant siting options and its use can significantly accelerate approval of construction permits because water use issues are taken off the table. Shortening a project schedule by even six months can completely change the economics of a project and easily balance the increased capital cost of dry cooling options.
>
> Dry cooling applications in the U.S. have not been limited to arid regions but have also been specified for plants sited in eastern, northern, and mountain areas where water is typically more abundant…"

52. The evaporative cooling tower approach planned for Bell Bend and for which PPL has applied is a less costly construction alternative. Moreover, by applying SRBC'S current rate structure for water withdrawal, PPL has a financial incentive to use the low cost Susquehanna River water at the proposed Bell Bend unit rather than designing more environmentally compatible alternative.

53. If the full financial cost accounting of the environmental impact of extracting 20 million gallons per day of water from the Susquehanna River were applied to the PPL Bell Bend project, it is doubtful that the construction design for the PPL Bell Bend project would include evaporative cooling towers that feature large consumptive water losses. Realistic environmental cost accounting applied through a more stringent consumptive water use fee schedule would make the air-cooled condenser design a financially desirable alternative.

The Cost of Water

54. Presently, the Susquehanna River Basin Commission sets the rate schedule for water withdrawal from the Susquehanna River. A new schedule of fees was adopted December 17, 2009.

55. According to the newly instituted Application Fee Schedule in effect beginning January 1, 2010 through December 31, 2010:

55.1. PPL would be charged an application fee of $28,650 for up to ten million gallons per day plus $4,875 for every million gallons per day additional usage beyond that withdrawal rate. Because of its enormous withdrawal rates and the low application fee structure, the PPL proposed Bell Bend project will be charged an application fee of less than 3 tenths of one cent (3/10 of 1¢) per gallon for Bell Bend.

55.2. In comparison, smaller users will be charged $4,400 to apply for water withdrawal of 100,000 gallons per day. On a per gallon basis, smaller users will be charged an application fee of more than 4 cents (4¢) per gallon.

55.3. Thus, the Susquehanna River Basin Commission plans to charge small users 10 times more per gallon to apply for withdrawal from the Susquehanna River than it plans to charge PPL its proposed Bell Bend project.

55.4. The environmental impact of a 100,000 (100 Thousand) gallon per day withdrawal pales in comparison to a 31,000,000 (31 million) gallon per day withdrawal proposed by PPL it its COLA for Bell Bend.

55.5. The data reviewed shows that the consumptive water use intended by the PPL proposed Bell Bend project may require significant additional environmental review. The new SRBC fee schedule appears to erroneously encourage the consumptive water use of 31,000,000 (31 million) gallons per day proposed by PPL. Therefore, other users of the river water are effectively subsidizing the PPL Bell Bend application.

56. Furthermore, according to the Susquehanna River Basin Commission's new fee schedule, all users will be charged the same "Consumptive Use Mitigation Fee $0.28 for every 1,000 gallons consumed". The same fee is assessed to users drawing 100 times less water than the PPL proposed Bell Bend project is anticipated to withdraw. Therefore the "Consumptive Use Mitigation Fee" of $0.28, rewards large-scale users thereby encouraging large-scale use and its resulting negative environmental impact upon the River. Moreover, if Bell Bend were allowed to withdraw 31,000,000 (31 million) gallons of water under this fee schedule, then hundreds of other small water users will be precluded water use and access to water rights for the anticipated 60-year life of the PPL proposed Bell Bend nuclear power plant.

57. By choosing low fees for water withdrawal, the Susquehanna River Basin Commission appears to subsidize the consumptive water use anticipated by the PPL Bell Bend project. In turn, this subsidy reduces available water to downstream communities and increases the down stream pressures on the Susquehanna River and the Chesapeake Bay.

58. Before a Joint Meeting of the Senate Environmental Resources & Energy Committee and the Senate Agriculture and Rural Affairs Committee on September 20, 2005, Kathleen A. McGinty, Pennsylvania's former Secretary of the Department of Environmental Protection, submitted testimony entitled *Pennsylvania's Chesapeake Bay Tributary Strategy*[7]. Secretary McGinty said,

> "…a court order directed the federal agency to take action to restore the Chesapeake. Mandatory directives from EPA will come to Pennsylvania and other Bay states in 2010 if sufficient measures are

[7] http://www.depweb.state.pa.us/dep/cwp/view.asp?a=3&q=474519

> not in place by then to restore water quality in the Bay and its tributaries.
>
> More than half of our Commonwealth is within the Chesapeake Bay Watershed, with the Susquehanna River, the Bay's largest tributary, providing roughly half of the total freshwater flow…
>
> Pennsylvania is working with communities, watershed groups, farmers and businesses to develop new tools and put practical solutions on the ground to improve the quality of our waterways. It is imperative that we work aggressively to clean up what is one of our Commonwealth's greatest natural resources. It is true that the work we do at home ultimately serves to help the Bay. But our efforts are about making sure the water in Pennsylvania is safe to drink, healthy enough to sustain aquatic life and abundant in supply to sustain our economy."

59. Reiterating what the Secretary stated, an "abundant supply" of water is important to "sustain our economy". Yet as proposed, the PPL Bell Bend project reduces the River's flow at the same time it introduces more contaminated water back into the Susquehanna River. The PPL intended intensive consumptive water use at Bell Bend and its resulting reduction in water flow in the Susquehanna River seems counterproductive to the goals stated by the Pennsylvania's Secretary of the Department of Environmental Protection, especially when an air-cooled condenser design is available for substitution.

60. Since the Susquehanna River provides half of the fresh water that enters the Chesapeake Bay, the withdrawal of 31,000,000 gallons per day of the River's flow will have a significant impact on the down stream ecology that is not reflected in the SRBC fee structure.

61. The PPL proposed withdrawal of fresh water from the river, while also reintroducing concentrated contaminants back into the river, has the net effect of concentrating the pollutants that move downstream into Chesapeake Bay. Achieving Secretary McGinty's goal "to restore water quality in the Bay and its tributaries" will be nearly impossible if PPL is allowed to have the Bell Bend nuclear plant withdraw such a significant portion of river flow while providing almost no financial remuneration to the SRBC for the use of that water and remediation of the Susquehanna River. A realistic financial cost accounting of the environmental impact of the PPL Bell Bend

project upon the Susquehanna River and Chesapeake Bay Watersheds may help to ascertain how much money will be required to remediate the River.

62. In my opinion, the present design of the PPL Bell Bend nuclear power plant that calls for the withdrawal of huge amounts of water from the Susquehanna will exacerbate downstream problems in the Chesapeake Bay. The problem of such water intensive use would be entirely mitigated by the installation of an air-cooled condenser and air-cooled cooling towers prior to construction.

63. First, if the Susquehanna's flow is used by the PPL proposed Bell Bend nuclear power plant, more significant economic opportunities may be lost. The enormous consumptive water use of the PPL proposed Bell Bend project would limit Pennsylvania's ability to pursue other economic opportunities in the future. Specifically, there may be a need to use river water to extract natural gas in the Marcellus Shale deposits. The extraction and sale of natural gas from the Marcellus Shale will provide significant economic advantages in the form of revenue and employment, but only if adequate river water is available. The Bell Bend COL application will significantly reduce the amount of river water available for any additional projects.

64. Second, I have identified three additional problems with the PPL proposed Bell Bend application to withdraw large amounts of water from the Susquehanna River.

    64.1. It would increase downstream contamination of the Chesapeake,

    64.2. This loss of available water for small businesses would reduce employment opportunities all along the Susquehanna River.

    64.3. It would also limit the possible economic development of the Marcellus Shale that would benefit of the State of Pennsylvania.

65. All of these problems would be completely eliminated by the installation of air-cooled condensers on by PPL before construction begins on its proposed Bell Bend project. These air-cooled condensers are already in use in the electric industry but cannot be retrofitted for use at Bell Bend after the plant has begun construction.

66. The most likely reason that PPL is proposing such a large withdrawal of water from

the Susquehanna River for its Bell Bend nuclear power plant is that the SRBC present fee structure is so low that PPL has no motivation to address the long-term economic and environmental damage that would be mitigated by the installation of air-cooled condensers at Bell Bend.

Conclusion

67. In conclusion, air-cooled condensers could be successfully integrated into the PPL Bell Bend project design and the use of such air-cooled condensers would completely eliminate the need for the PPL Bell Bend nuclear power plants to have such a projected massive consumptive water use from the Susquehanna River.

68. However, the proposal presently in front of the Susquehanna Basin River Commission never discusses this viable alternative. Moreover, it is critical that the substitution of an air-cooled condenser and air-cooled cooling towers receive adequate analysis now, prior to final design and preliminary construction, as it is impossible to adapt the plant to the use of air-cooled condensers after the construction process is initiated.

69. Finally, the *Draft* fee schedule as presently proposed by the Susquehanna River Basin Commission subsidizes huge consumptive water use at great risk to the Susquehanna River Watershed and the Chesapeake Bay Watershed. These two vital watershed communities are already challenged by frequently occurring drought conditions as well as the negative environmental impact of dirty water (*blowdown*) on the Susquehanna River and Chesapeake Bay fragile aquatic ecosystems.

Attachments:

Attachment 1 – Curriculum Vitae

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

Executed this day, January 5, 2010 at Burlington, Vermont.

1/7/10

Arnold Gundersen, MSNE
Chief Engineer, Fairewinds Associates, Inc

I HEREBY CERTIFY that on this 5th day of January 2010, Arnold Gundersen, resident of Burlington Vermont, who is personally known to me or who produced the following identification, personally appeared before me, and he swore, subscribed, and acknowledged before me that he executed the foregoing as his free act and deed as an expert witness of said case, for the uses and purposes therein mentioned, and that he did take an oath.

In witness whereof, I have hereunto set my hand and seal in the County and State aforesaid.

OFFICIAL NOTARY _____, NOTARY PUBLIC
STATE OF VERMONT

MY COMMISSION EXPIRES: Feb 2011

CURRICULUM VITAE
Arnold Gundersen
Chief Engineer, Fairewinds Associates, Inc
December 2009

Education and Training

ME NE	Master of Engineering Nuclear Engineering Rensselaer Polytechnic Institute, 1972 U.S. Atomic Energy Commission Fellowship Thesis: Cooling Tower Plume Rise
BS NE	Bachelor of Science Nuclear Engineering Rensselaer Polytechnic Institute, Cum Laude, 1971 James J. Kerrigan Scholar
RO	Licensed Reactor Operator, U.S. Atomic Energy Commission License # OP-3014

Qualifications – including and not limited to:

- Chief Engineer, Fairewinds Associates, Inc
- Nuclear Engineering, Safety, and Reliability Expert
- Federal and Congressional hearing testimony and Expert Witness testimony
- Former Senior Vice President Nuclear Licensee
- Former Licensed Reactor Operator
- 39-years of nuclear industry experience and oversight
    - Nuclear engineering management assessment and prudency assessment
    - Nuclear power plant licensing and permitting – assessment and review
    - Nuclear safety assessments, source term reconstructions, dose assessments, criticality analysis, and thermohydraulics
    - Contract administration, assessment and review
    - Systems engineering and structural engineering assessments
    - Cooling tower operation, cooling tower plumes, thermal discharge assessment, and consumptive water use
    - Nuclear fuel rack design and manufacturing, nuclear equipment design and manufacturing, and technical patents
    - Radioactive waste processes, storage issue assessment, waste disposal and decommissioning experience
    - Reliability engineering and aging plant management assessments, in-service inspection
    - Employee awareness programs, whistleblower protection, and public communications
    - Quality Assurance (QA) & records

Publications

Co-author — *DOE Decommissioning Handbook, First Edition*, 1981-1982, invited author.

Co-author — *Decommissioning the Vermont Yankee Nuclear Power Plant: An Analysis of Vermont Yankee's Decommissioning Fund and Its Projected Decommissioning Costs*, November 2007, Fairewinds Associates, Inc.

Co-author — *Decommissioning Vermont Yankee – Stage 2 Analysis of the Vermont Yankee Decommissioning Fund – The Decommissioning Fund Gap*, December 2007, Fairewinds

Associates, Inc. Presented to Vermont State Senators and Legislators.
Co-author — *Vermont Yankee Comprehensive Vertical Audit – VYCVA – Recommended Methodology to Thoroughly Assess Reliability and Safety Issues at Entergy Nuclear Vermont Yankee*, January 30, 2008 Testimony to Finance Committee Vermont Senate
Co-author — *Act 189 Public Oversight Panel Report*, March 17, 2009, to the Vermont State Legislature by the Vermont Yankee Public Oversight Panel.
Author — Fairewinds Associates, Inc *First Quarterly Report to the Joint Legislative Committee*, October 19, 2009.

Patents

Energy Absorbing Turbine Missile Shield – U.S. Patent # 4,397,608 – 8/9/1983

Committee Memberships

Vermont Yankee Public Oversight Panel – appointed 2008 by President Pro-Tem Vermont Senate
National Nuclear Safety Network – Founding Board Member
Three Rivers Community College – Nuclear Academic Advisory Board
Founding Member of Connecticut Low Level Radioactive Waste Advisory Committee – 10 years
Founding Member Radiation Safety Committee, NRC Licensee
ANSI N-198, Solid Radioactive Waste Processing Systems

Honors

U.S. Atomic Energy Commission Fellowship, 1972
B.S. Degree, Cum Laude, RPI, 1971, 1st in nuclear engineering class
Tau Beta Pi (Engineering Honor Society), RPI, 1969 – 1 of 5 in sophomore class of 700
James J. Kerrigan Scholar 1967–1971
Teacher of the Year – 2000, Marvelwood School
Publicly commended to U.S. Senate by NRC Chairman, Ivan Selin, in May 1993 – "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service."

Nuclear Consulting and Expert Witness Testimony

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Declaration of Arnold Gundersen Supporting Supplemental Petition of Intervenors Contention 15: Detroit Edison Cola Lacks Statutorily Required Cohesive QA Program, December 8, 2009.

U.S. NRC Region III Allegation Filed by Missouri Coalition for the Environment
Expert Witness Report entitled: *Comments on the Callaway Special Inspection by NRC Regarding the May 25, 2009 Failure of its Auxiliary Feedwater System,* November 9, 2009.

Vermont State Legislature Joint Fiscal Committee Expert Witness regarding Entergy Nuclear Vermont Yankee
The First Quarterly Report to the Joint Legislative Committee regarding reliability issues at Entergy Nuclear Vermont Yankee, issued October 19, 2009 and oral testimony to the Vermont State Legislature Joint Fiscal Committee.
(http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm).

Florida Public Service Commission (FPSC)
Gave direct oral testimony to the FPSC in hearings in Tallahassee, FL, September 8 and 10, 2009 in support of Southern Alliance for Clean Energy (SACE) contention of anticipated licensing and construction delays in newly designed Westinghouse AP 1000 reactors proposed by Progress Energy Florida and Florida Power and Light (FPL).

Florida Public Service Commission (FPSC)
NRC announced delays confirming my original testimony to FPSC detailed below. My supplemental testimony alerted FPSC to NRC confirmation of my original testimony regarding licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Supplemental Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy*, FPSC Docket No. 090009-EI, August 12, 2009.

Florida Public Service Commission (FPSC)
Licensing and construction delays due to problems with the newly designed Westinghouse AP 1000 reactors in *Direct Testimony In Re: Nuclear Plant Cost Recovery Clause By The Southern Alliance For Clean Energy*, FPSC Docket No. 090009-EI, July 15, 2009.

Vermont State Legislature Joint Fiscal Committee Expert Witness Oversight Role for Entergy Nuclear Vermont Yankee (ENVY)
Contracted by the Joint Fiscal Committee of the Vermont State Legislature as an expert witness to oversee the compliance of ENVY to reliability issues uncovered during the 2009 legislative session by the Vermont Yankee Public Oversight Panel of which I was appointed a member along with former NRC Commissioner Peter Bradford for one year from July 2008 to 2009. Entergy Nuclear Vermont Yankee (ENVY) is currently under review by Vermont State Legislature to determine if it should receive a Certificate for Public Good (CPG) to extend its operational license for another 20-years. Vermont is the only state in the country that has legislatively created the CPG authorization for a nuclear power plant. Act 160 was passed to ascertain ENVY's ability to run reliably for an additional 20 years. Appointment from July 2009 to May 2010.

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Combined Operating License Application (COLA) at North Anna Unit 3 *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions* (June 26, 2009).

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Through-wall Penetration of Containment Liner and Inspection Techniques of the Containment Liner at Beaver Valley Unit 1 Nuclear Power Plant *Declaration of Arnold Gundersen Supporting Citizen Power's Petition* (May 25, 2009).

U.S. Nuclear Regulatory Commission
Expert Witness Declaration regarding Quality Assurance and Configuration Management at Bellefonte Nuclear Plant *Declaration of Arnold Gundersen Supporting Blue Ridge Environmental Defense League's Contentions in their Petition for Intervention and Request for Hearing*, May 6, 2009.

Pennsylvania Statehouse
Expert Witness Analysis presented in formal presentation at the Pennsylvania Statehouse, March 26, 2009 regarding actual releases from Three Mile Island Nuclear Accident. Presentation may be found at: http://www.tmia.com/march26

Vermont Legislative Testimony and Formal Report for 2009 Legislative Session
As a member of the Vermont Yankee Public Oversight Panel, I spent almost eight months examining the Vermont Yankee Nuclear Power Plant and the legislatively ordered Comprehensive Vertical Audit. Panel submitted Act 189 Public Oversight Panel Report March 17, 2009 and oral testimony to a joint hearing of the Senate Finance and House Natural Resources March 19, 2009. (See: http://www.leg.state.vt.us/JFO/Vermont%20Yankee.htm)

Finestone v FPL (11/2003 to 12/2008) Federal Court
Plaintiffs' Expert Witness for Federal Court Case with Attorney Nancy LaVista, from the firm Lytal, Reiter, Fountain, Clark, Williams, West Palm Beach, FL. This case involved two plaintiffs in cancer cluster of 40 families alleging that illegal radiation releases from nearby nuclear power plant caused children's cancers. Production request, discovery review, preparation of deposition questions and attendance at Defendant's experts for deposition, preparation of expert witness testimony, preparation for Daubert Hearings, ongoing technical oversight, source term reconstruction and appeal to Circuit Court.

U.S. Nuclear Regulatory Commission Advisory Committee Reactor Safeguards (NRC-ACRS)
Expert Witness providing oral testimony regarding Millstone Point Unit 3 (MP3) Containment issues in hearings regarding the Application to Uprate Power at MP3 by Dominion Nuclear, Washington, and DC. (July 8-9, 2008).

Appointed by President Pro-Tem of Vermont Senate to Legislatively Authorized Nuclear Reliability Public Oversight Panel
To oversee Comprehensive Vertical Audit of Entergy Nuclear Vermont Yankee (Act 189) and testify to State Legislature during 2009 session regarding operational reliability of ENVY in relation to its 20-year license extension application. (July 2, 2008 to present).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness providing testimony regarding *Pilgrim Watch's Petition for Contention 1 Underground Pipes* (April 10, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness supporting *Connecticut Coalition Against Millstone In Its Petition For Leave To Intervene, Request For Hearing, And Contentions Against Dominion Nuclear Connecticut Inc.'s*

Millstone Power Station Unit 3 License Amendment Request For Stretch Power Uprate (March 15, 2008).

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert Witness supporting *Pilgrim Watch's Petition For Contention 1*: *specific to issues regarding the integrity of Pilgrim Nuclear Power Station's underground pipes and the ability of Pilgrim's Aging Management Program to determine their integrity*. (January 26, 2008).

Vermont State House – 2008 Legislative Session

- House Committee on Natural Resources and Energy – Comprehensive Vertical Audit: *Why NRC Recommends a Vertical Audit for Aging Plants Like Entergy Nuclear Vermont Yankee (ENVY)*
- House Committee on Commerce – Decommissioning Testimony

Vermont State Senate – 2008 Legislative Session

- Senate Finance – testimony regarding Entergy Nuclear Vermont Yankee Decommissioning Fund
- Senate Finance – testimony on the necessity for a Comprehensive Vertical Audit (CVA) of Entergy Nuclear Vermont Yankee
- Natural Resources Committee – testimony regarding the placement of high-level nuclear fuel on the banks of the Connecticut River in Vernon, VT

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
MOX Limited Appearance Statement to Judges Michael C. Farrar (Chairman), Lawrence G. McDade, and Nicholas G. Trikouros for the "Petitioners": Nuclear Watch South, the Blue Ridge Environmental Defense League, and Nuclear Information & Resource Service in support of *Contention 2: Accidental Release of Radionuclides, requesting a hearing concerning faulty accident consequence assessments made for the MOX plutonium fuel factory proposed for the Savannah River Site*. (September 14, 2007).

Appeal to the Vermont Supreme Court (March 2006 to 2007)
Expert Witness Testimony in support of *New England Coalition's Appeal to the Vermont Supreme Court Concerning: Degraded Reliability at Entergy Nuclear Vermont Yankee as a Result of the Power Uprate*. New England Coalition represented by Attorney Ron Shems of Burlington, VT.

State of Vermont Environmental Court (Docket 89-4-06-vtec 2007)
Expert witness retained by New England Coalition to review Entergy and Vermont Yankee's analysis of alternative methods to reduce the heat discharged by Vermont Yankee into the Connecticut River. Provided Vermont's Environmental Court with analysis of alternative methods systematically applied throughout the nuclear industry to reduce the heat discharged by nuclear power plants into nearby bodies of water and avoid consumptive water use. This report included a review of the condenser and cooling tower modifications.

U.S. Senator Bernie Sanders and Congressman Peter Welch (2007)
Briefed Senator Sanders, Congressman Welch and their staff members regarding technical and engineering issues, reliability and aging management concerns, regulatory compliance, waste storage, and nuclear power reactor safety issues confronting the U.S. nuclear energy industry.

State of Vermont Legislative Testimony to Senate Finance Committee (2006)
Testimony to the Senate Finance Committee regarding Vermont Yankee decommissioning costs, reliability issues, design life of the plant, and emergency planning issues.

U.S. Nuclear Regulatory Commission Atomic Safety and Licensing Board (NRC-ASLB)
Expert witness retained by New England Coalition to provide Atomic Safety and Licensing Board with an independent analysis of the integrity of the Vermont Yankee Nuclear Power Plant condenser (2006).

U.S. Senators Jeffords and Leahy (2003 to 2005)
Provided the Senators and their staffs with periodic overview regarding technical, reliability, compliance, and safety issues at Entergy Nuclear Vermont Yankee (ENVY).

10CFR 2.206 filed with the Nuclear Regulatory Commission (July 2004)
Filed 10CFR 2.206 petition with NRC requesting confirmation of Vermont Yankee's compliance with General Design Criteria.

State of Vermont Public Service Board (April 2003 to May 2004)
Expert witness retained by New England Coalition to testify to the Public Service Board on the reliability, safety, technical, and financial ramifications of a proposed increase in power (called an uprate) to 120% at Entergy's 31-year-old Vermont Yankee Nuclear Power Plant.

International Nuclear Safety Testimony
Worked for ten days with the President of the Czech Republic (Vaclav Havel) and the Czech Parliament on their energy policy for the 21st century.

Nuclear Regulatory Commission (NRC) Inspector General (IG)
Assisted the NRC Inspector General in investigating illegal gratuities paid to NRC Officials by Nuclear Energy Services (NES) Corporate Officers. In a second investigation, assisted the Inspector General in showing that material false statements (lies) by NES corporate president caused the NRC to overlook important violations by this licensee.

State of Connecticut Legislature
Assisted in the creation of State of Connecticut Whistleblower Protection legal statutes.

Federal Congressional Testimony
Publicly recognized by NRC Chairman, Ivan Selin, in May 1993 in his comments to U.S. Senate, "It is true...everything Mr. Gundersen said was absolutely right; he performed quite a service." Commended by U.S. Senator John Glenn for public testimony to Senator Glenn's NRC Oversight Committee.

PennCentral Litigation
Evaluated NRC license violations and material false statements made by management of this nuclear engineering and materials licensee.

Three Mile Island Litigation
Evaluated unmonitored releases to the environment after accident, including containment breach, letdown system and blowout. Proved releases were 15 times higher than government estimate and subsequent government report.

Western Atlas Litigation
Evaluated neutron exposure to employees and license violations at this nuclear materials licensee.

Commonwealth Edison
In depth review and analysis for Commonwealth Edison to analyze the efficiency and effectiveness of all Commonwealth Edison engineering organizations, which support the operation of all of its nuclear power plants.

Peach Bottom Reactor Litigation
Evaluated extended 28-month outage caused by management breakdown and deteriorating condition of plant.

***Special Remediation Expertise*:**
Director of Engineering, Vice President of Site Engineering, and the Senior Vice President of Engineering at Nuclear Energy Services (NES).

- NES was a nuclear licensee that specialized in dismantlement and remediation of nuclear facilities and nuclear sites. Member of the radiation safety committee for this licensee.
- Department of Energy chose NES to write *DOE Decommissioning Handbook* because NES had a unique breadth and depth of nuclear engineers and nuclear physicists on staff.
- Personally wrote the "Small Bore Piping" chapter of the DOE's first edition Decommissioning Handbook, personnel on my staff authored other sections, and I reviewed the entire Decommissioning Handbook.
- Served on the Connecticut Low Level Radioactive Waste Advisory Committee for 10 years from its inception.
- Managed groups performing analyses on dozens of dismantlement sites to thoroughly remove radioactive material from nuclear plants and their surrounding environment.
- Managed groups assisting in decommissioning the Shippingport nuclear power reactor. Shippingport was the first large nuclear power plant ever decommissioned. The decommissioning of Shippingport included remediation of the site after decommissioning.
- Managed groups conducting site characterizations (preliminary radiation surveys prior to commencement of removal of radiation) at the radioactively contaminated West Valley site in upstate New York.
- Personnel reporting to me assessed dismantlement of the Princeton Avenue Plutonium Lab in New Brunswick, NJ. The lab's dismantlement assessment was stopped when we uncovered extremely toxic and carcinogenic underground radioactive contamination.

- Personnel reporting to me worked on decontaminating radioactive thorium at the Cleveland Avenue nuclear licensee in Ohio. The thorium had been used as an alloy in turbine blades. During that project, previously undetected extremely toxic and carcinogenic radioactive contamination was discovered below ground after an aboveground gamma survey had purported that no residual radiation remained on site.

Teaching and Academic Administration Experience

Rensselaer Polytechnic Institute (RPI) – Advanced Nuclear Reactor Physics Lab
Community College of Vermont – Mathematics Professor – 2007 to present
Burlington High School
Mathematics Teacher – 2001 to June 2008
Physics Teacher – 2004 to 2006
The Marvelwood School – 1996 to 2000
Awarded Teacher of the Year – June 2000
Chairperson: Physics and Math Department
Mathematics and Physics Teacher, Faculty Council Member
Director of Marvelwood Residential Summer School
Director of Residential Life
The Forman School & St. Margaret's School – 1993 to 1995
Physics and Mathematics Teacher, Tennis Coach, Residential Living Faculty Member

Nuclear Engineering 1970 to Present

Vetted as expert witness in nuclear litigation and administrative hearings in federal, international, and state court and to Nuclear Regulatory Commission, including but not limited to: Three Mile Island, US Federal Court, US NRC, NRC ASLB & ACRS, Vermont State Legislature, Vermont State Public Service Board, Florida Public Service Board, Czech Senate, Connecticut State Legislature, Western Atlas Nuclear Litigation, U.S. Senate Nuclear Safety Hearings, Peach Bottom Nuclear Power Plant Litigation, and Office of the Inspector General NRC.

Nuclear Engineering, Safety, and Reliability Expert Witness 1990 to Present

- Fairewinds Associates, Inc – Chief Engineer, 2005 to Present
- Arnold Gundersen, Nuclear Safety Consultant and Energy Advisor, 1995 to 2005
- GMA – 1990 to 1995, including expert witness testimony regarding the accident at Three Mile Island.

Nuclear Energy Services, Division of PCC (Fortune 500 company) 1979 to 1990
Corporate Officer and Senior Vice President - Technical Services
Responsible for overall performance of the company's Inservice Inspection (ASME XI), Quality Assurance (SNTC 1A), and Staff Augmentation Business Units – up to 300 employees at various nuclear sites.

Senior Vice President of Engineering
Responsible for the overall performance of the company's Site Engineering, Boston Design Engineering and Engineered Products Business Units. Integrated the Danbury based, Boston based and site engineering functions to provide products such as fuel racks, nozzle dams, and transfer mechanisms and services such as materials management and procedure development.

Vice President of Engineering Services
Responsible for the overall performance of the company's field engineering, operations engineering, and engineered products services. Integrated the Danbury-based and field-based engineering functions to provide numerous products and services required by nuclear utilities, including patents for engineered products.

General Manager of Field Engineering
Managed and directed NES' multi-disciplined field engineering staff on location at various nuclear plant sites. Site activities included structural analysis, procedure development, technical specifications and training. Have personally applied for and received one patent.

Director of General Engineering
Managed and directed the Danbury based engineering staff. Staff disciplines included structural, nuclear, mechanical and systems engineering. Responsible for assignment of personnel as well as scheduling, cost performance, and technical assessment by staff on assigned projects. This staff provided major engineering support to the company's nuclear waste management, spent fuel storage racks, and engineering consulting programs.

New York State Electric and Gas Corporation (NYSE&G) — 1976 to 1979
Reliability Engineering Supervisor
Organized and supervised reliability engineers to upgrade performance levels on seven operating coal units and one that was under construction. Applied analytical techniques and good engineering judgments to improve capacity factors by reducing mean time to repair and by increasing mean time between failures.

Lead Power Systems Engineer
Supervised the preparation of proposals, bid evaluation, negotiation and administration of contracts for two 1300 MW NSSS Units including nuclear fuel, and solid-state control rooms. Represented corporation at numerous public forums including TV and radio on sensitive utility issues. Responsible for all nuclear and BOP portions of a PSAR, Environmental Report, and Early Site Review.

Northeast Utilities Service Corporation (NU) — 1972 to 1976
Engineer
Nuclear Engineer assigned to Millstone Unit 2 during start-up phase. Lead the high velocity flush and chemical cleaning of condensate and feedwater systems and obtained discharge permit for chemicals. Developed Quality Assurance Category 1 Material, Equipment and Parts List. Modified fuel pool cooling system at Connecticut Yankee, steam generator blowdown system and diesel generator lube oil system for Millstone. Evaluated Technical Specification Change Requests.

Associate Engineer
Nuclear Engineer assigned to Montague Units 1 & 2. Interface Engineer with NSSS vendor, performed containment leak rate analysis, assisted in preparation of PSAR and performed radiological health analysis of plant. Performed environmental radiation survey of Connecticut Yankee. Performed chloride intrusion transient analysis for Millstone Unit 1 feedwater system. Prepared Millstone Unit 1 off-gas modification licensing document and Environmental Report Amendments 1 & 2.

Rensselaer Polytechnic Institute (RPI) — 1971 to 1972
Critical Facility Reactor Operator, Instructor
Licensed AEC Reactor Operator instructing students and utility reactor operator trainees in start-up through full power operation of a reactor.

Public Service Electric and Gas (PSE&G) — 1970
Assistant Engineer
Performed shielding design of radwaste and auxiliary buildings for Newbold Island Units 1 & 2, including development of computer codes.

Public Service, Cultural, and Community Activities

2005 to Present – Public presentations and panel discussions on nuclear safety and reliability at University of Vermont, NRC hearings, Town and City Select Boards, Legal Panels, Television, and Radio

2007-2008 – Created Concept of Solar Panels on Burlington High School; worked with Burlington Electric Department and Burlington Board of Education Technology Committee on Grant for installation of solar collectors for Burlington Electric peak summer use

Vermont State Legislature – Ongoing Public Testimony to Legislative Committees

Certified Foster Parent State of Vermont – 2004 to 2007

Mentoring former students – 2000 to present – college application and employment application questions and encouragement

Tutoring Refugee Students – 2002 to 2006 – Lost Boys of the Sudan and others from educationally disadvantaged immigrant groups

Designed and Taught Special High School Math Course for ESOL Students – 2007 to 2008

Featured Nuclear Safety and Reliability Expert (1990 to present) for Television, Newspaper, Radio, & Internet
Including, and not limited to: CNN (Earth Matters), NECN, WPTZ VT, WTNH, VPTV, WCAX, Cable Channel 17, The Crusaders, Front Page, Mark Johnson Show, Steve West Show, Anthony Polina Show, WKVT, WDEV, WVPR, WZBG CT, Seven Days, AP News Service, Houston Chronicle, Christian Science Monitor, New York Times, Brattleboro Reformer, Rutland Herald, Times-Argus, Burlington Free Press, Litchfield County Times, The News Times, The New Milford Times, Hartford Current, New London Day, evacuationplans.org, Vermont Daily Briefing, Green Mountain Daily, and numerous other national and international blogs

NNSN – National Nuclear Safety Network, Founding Advisory Board Member, meetings with and testimony to the Nuclear Regulatory Commission Inspector General (NRC IG)

Berkshire School Parents Association, Co-Founder

Berkshire School Annual Appeal, Co-Chair

Sunday School Teacher, Christ Episcopal Church, Roxbury, CT

Washington Montessori School Parents Association Member
Episcopal Marriage Encounter National Presenting Team with wife Margaret
Provided weekend communication and dialogue workshops weekend retreats/seminars
Connecticut Episcopal Marriage Encounter Administrative Team – 5 years
Northeast Utilities Representative Conducting Public Lectures on Nuclear Safety Issues

Personal and Family Data

Born January 4, 1949, Elizabeth, NJ
Married in 1979 to Margaret Gundersen, certified paralegal and founder of Fairewinds Associates, Inc, www.fairewinds.com
Children:
Elida Gundersen, age 27, paramedic & crew chief, Charleston County EMS, Charleston, SC
Eric Gundersen, age 30, founder Development Seed, www.developmentseed.org, Washington, DC

Contact Information

Address: 376 Appletree Point Road, Burlington, VT 05408
E-Mail: arnie@fairewinds.com
Telephones: Office: (802) 865-9955 Cell: (802) 238-4452 Fax: (802) 304-1051

End