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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
Before the
ATOMIC SAFETY AND LICENSING BOARD

In the matter of
ENTERGY NUCLEAR GENERATION CO., LLC
and ENTERGY NUCLEAR OPERATIONS, INC.
(Pilgrim Nuclear Power Station)
License Renewal Application

January 26, 2008
Docket No. 50-293-LR
ASLBP No. 06-848-02-LR

DECLARATION OF ARNOLD GUNDERSEN
SUPPORTING
PILGRIM WATCH'S PETITION FOR
CONTENTION 1

I, Arnold Gundersen, declare as follows:

1. My name is Arnold Gundersen. I am sui juris. I am over the age of eighteen (18) years old. I have personal knowledge of the facts contained in this Declaration.

2. Pilgrim Watch has retained me as an expert witness in the above captioned matter.

3. I have a Bachelor's and a Master's Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude.

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. A copy of my Curriculum Vitae is attached.

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5. I have qualified as an expert witness before the NRC ASLB relating the proposed uprate at the Entergy Nuclear Vermont Yankee Nuclear Power Station and before the State of Vermont Public Service Board regarding that same matter.

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

7. My more than 35 years of professional nuclear experience include and are not limited to: 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, Cooling Tower Operation, Cooling Tower Plumes, 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.

8. My declaration is intended to support Pilgrim Watch's Contention 1 and is 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.

9. I have reviewed the Aging Management Program (AMP) for Pilgrim Station and conclude that the applicant has not adequately addressed the monitoring of its underground pipes and tanks to assure their integrity if in fact Pilgrim Nuclear Power Station's license to operate is extended by an additional twenty years. The information provided by the AMP is vague and non-specific and cannot be used to conclude that any and all underground piping will ever be examined during the license extension period.

10. Furthermore, I conclude that the applicant has not shown with 95 percent certainty that the proposed AMP will in fact be able to detect any defects in the underground pipes and tanks.

11. Moreover, based upon my review of Pilgrim's AMP, it is my opinion that the applicant has not shown that the proposed AMP is adequate to assess and assure that underground piping and tanks will be able to withstand the stresses of an additional 20-year license extension.

12. Apparently Entergy itself has recognized the inadequacy of its Aging Management Program, for *after* these proceedings began and *after* Pilgrim Watch brought these inadequacies to Entergy's attention through this Intervention, Energy initiated a new program that attempts to address the inadequacies of its AMP for buried tanks and pipes. Entitled, Buried Piping and Tanks Inspection Program and Monitoring Program, Exhibit 5 [Hereinafter called "The Program"], it was initiated on November 11, 2007 and just recently provided as an Appendix to Energy's Prefiled Testimony, January 8, 2008.

    12.1. By initiating this Program, Entergy has shown that it agrees with Pilgrim Watch that the current AMPs for buried components are not sufficiently effective to provide reasonable assurance that such components will perform their intended functions either now or during their proposed period of extended operations and therefore a supplemental program is required.

    12.2. The purpose of Entergy's document is to provide requirements for each of its nuclear power plant sites to develop a site specific Program. The evidence I reviewed shows that the Program as presented is only a framework. The Program specifies only the framework for the content, scope, ranking methodology, priorities and inspection frequency of the buried piping and tanks on a generic, one size fits all basis and is not specific to Entergy's Pilgrim Nuclear Power Plant.

    12.3. Considering that both the Petitioner and Applicant agree that more should be done to provide reasonable assurance, it is my opinion that the Program should be fully examined in order to determine what elements should be

enhanced and turned into formal commitments by the licensee in order to receive license extension approval. Given the recent tritium findings (see Section 16 in this Declaration), in my opinion the Public requires a firm commitment from Entergy Pilgrim, not simply a voluntary plan that the plant may choose to adhere to or not. Just as importantly, given the unique attributes of the Pilgrim Site, the Program must be plant specific, not simply a generic one-size fits all approach.

12.4. My Section by Section Analysis of Entergy's Buried Piping and Tanks Inspection Program and Monitoring Program (11/19/07)[1] is below:

12.4.1. Section 5.0, subsection [1] at page 7 acknowledges right at the beginning that "The risk of a failure caused by corrosion, directly or indirectly, is probably the most common hazard associated with buried piping and tanks.

12.4.1.1. Section 5.0, subsection [2] on page 7 lists the steps required in building a risk assessment tool. However, in my opinion, the Program fails in that it never requires a complete baseline review.

12.4.1.2. Moreover, it appears to me that there is no indication that the entire component is supposed to be examined; instead *escape clauses are provided to the licensee* - such as [at 2a] "the size of each section shall reflect practical considerations of operation, maintenance, and cost of data gathering with respect to the benefit of increased accuracy."

12.4.1.3. In my experience, any program worth its salt would require a thorough baseline inspection along the entire length of the pipe.

[1] Entergy's Buried Piping and Tanks Inspection Program and Monitoring Program, 11/19/07, Entergy's Pre-Filed Testimony, Exhibit 5, January 8, 2008.

12.4.2. _____

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12.4.3. In Section 5.4, Identification of Buried Piping and Tanks to be Inspected and Prioritized, page 9, Subsection [1] the licensee is directed to develop a list of all systems containing buried piping and tanks and to identify those sections by collecting physical drawings, piping/tank installation specifications, piping design tables and other data needed to support inspection activities.

12.4.3.1. In my experience, *the criteria must specify other key parts of the components*. For example:

- wall thickness,
- number and location of welds,
- elbows,
- flow restrictions,
- blank flanges,
- high velocity portions,
- the age of the components parts,
- cathodic protection,
- last inspection date and report number, and
- manufacturers warranty - if any.

12.4.3.2. The information specified above is the type of information that the NRC Staff requires when it conducts its safety evaluation so that the SER Report will be meaningful.

12.4.3.3. Since it was not available for NRC review, it is my opinion that the license application decision should be delayed until the information has not only been made available, but also has been critically reviewed.

12.4.4. Subsection [4] categorizes the piping into high, medium and low impact.

12.4.4.1. High impact components require prompt attention. I believe and Pilgrim Watch concurs that high impact components should receive prompt attention.

12.4.4.2. However Entergy's definition of "prompt" allows considerable delay in that they claim that high impact buried sections of piping shall be examined within 9-months of issuance of the procedure.

12.4.4.3. _____

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12.4.5. In Section 5.5 Table 4 on page 13, "Inspection Intervals vs. Inspection Priority" the Program Entergy proposes to initiate reflects the outcome from an assessment of the risks from buried piping and tanks. For example, buried piping and tanks having high risk are specified as having an initial inspection period of 5 years with a re-inspection interval of 8 years. In my opinion:

12.4.5.1. The time interval is proposed in the Program is too long.

12.4.5.2. It does not tell how much of the component will be inspected;

12.4.5.3. And, there is no requirement to shorten a subsequent inspection based upon the degree of corrosion discovered at the time of the prior inspection.

12.4.5.4. Also absent from this procedure is the prudent and practical guidance to conduct the inspection provisions of this procedure when opportunities present themselves, regardless of the inspection intervals noted in Table 4.

12.4.5.5. For example, if a section of buried piping categorized as having "Low" inspection priority is excavated for other reasons, my experience leads me to believe that this procedure should direct workers to take advantage of the opportunity and perform inspections when the pipe has been excavated for other purposes. Such an addition to the Program both protects public safety and health and protects the environment, and is also most cost effective.

12.4.5.6. Corrosion is neither linear nor constant across the component's length. Therefore, in my opinion it is a concern and not a sound engineering practice that in subsection [5], the Program specifies that the determination of inspection locations may also consider the "ease of access to inspection point." Industry evidence has proven time and again that ease of location and lack of corrosion do not necessarily go hand in hand. In fact, the odds are that if a component is difficult to access, then most likely it has never been inspected, which I believe is an even more important reason to inspect that particular pipe, pipe segment, elbow or weld.

12.4.6. In Section 5.6, entitled Parameters to be Inspected on page 13, the Program lists:

- external coatings and wrapping condition;
- pipe wall thickness degradation;
- tank plate thickness degradation; and
- cathodic protection system performance, if applicable.

12.4.6.1. In my opinion, the Program's attributes that must be considered in tabulating risk are simply too narrow. They include:

(a) soil resistivity measurement;
(b) drainage risk weight;

(c) material risk weight;
(d) cathodic protection/coating risk weight.

12.4.6.2. I believe that the list should be expanded to include, for example[2]:

- the age of the component's parts;
- the number of high risk corrosion areas in components such as welds, dead spots etc;
- counterfeit or substandard parts not replaced.

12.4.6.3. Moreover, the list appears to be silent on internal corrosion. My 35-years in nuclear engineering has shown me again and again that corrosion from the inside can bring about a failure.

Table 2 Corrosion Risk Assessment

Soil Resistivity, Ω-cm (Note 1)	Corrosivity Rating	Soil Resistivity Risk Weight
>20,000	Essentially Non-corrosive	1
10,001-20,000	Mildly Corrosive	2
5,001-10,000	Moderately Corrosive	4
3,001-5,000	Corrosive	5
1,000-3,000	Highly Corrosive	8
<1,000	Extremely Corrosive	10
Drainage		**Drainage Risk Weight**
Poor	Continually Wet	4.0
Fair	Generally Moist	2.0
Good	Generally Dry	1.0
Material (Note 2)		**Material Risk Weight**
Carbon and Low Alloy Steel		2.0
Cast and Ductile Iron		1.5
Stainless Steel		1.5
Copper Alloys		1.0
Concrete		0.5
Cathodic Protection	**Coating**	**CP/Coating Risk Weight**
No CP	No Coating	2.0
No CP	Degraded Coating	2.0
No CP	Sound Coating	1.0
Degraded CP	No Coating	1.0
Degraded CP	Degraded Coating	1.0
Degraded CP	Sound Coating	0.5
Sound CP	No Coating	0.5
Sound CP	Degraded Coating	0.5
Sound CP	Sound Coating	0.5

Notes:
1. Soil resistivity measurements must be taken at least once per 10 years unless areas are excavated and backfilled or if soil conditions are known to have changed for any reason.

2. Attachment 9.6 gives further insight to the corrosion of materials in soils.

12.4.6.4. Finally, and most importantly, this Section of Entergy's proposed Program is completely silent on the size of the sample required; its location; and the rational for the

[2] This Program list is meant to serve as an example and therefore should not be limited to only the components I have delineated in this brief Declaration.

sampling protocol – if, in fact, a sample is taken rather than an inspection of the entire component.

12.4.7. In my opinion, Section 5.7, on page 13 of the Program provides only vague remarks regarding the acceptance criteria for any degradation of external coating, wrapping and pipe wall or tank plate thickness.

12.4.7.1. Furthermore, the Program notes that degradation acceptance criteria should be based upon current plant procedures; *and* if not covered by current plant procedures then new procedures should be developed prior to any inspections.

12.4.7.2. In my opinion this alleged pass/fail grading system should be clearly defined. For example what precisely constitutes an unacceptable degraded external wrapping from an acceptably degraded external wrapping?

12.4.7.3. Most importantly, the LLTF was very specific that "significant" and other such descriptions require specific definitions.

12.4.8. In the Program's Section 5.8, Corrective Actions, on page 14, it is noted that "a condition report (CR) *shall* be written if acceptance criteria are not met.

12.4.8.1. Furthermore, the Program states that such corrective actions *may* include engineering valuations, scheduled inspections, and change of coating or replacement of corrosion susceptible components. Components that do not meet acceptance criteria shall be *dispositioned* by engineering. [Emphasis added].

12.4.8.2. In my opinion this aspect of the Program provides no assurance to public safety and health. The corrective actions *may [or may not]* include engineering valuations, scheduled inspections, and change of coating or replacement of corrosion susceptible components.

- Where are the Program's guarantees?
- Whatever happened to the concept that this Program would consist of layers of supervision so that the NRC would play some sort of oversight role in this program?
- Who will see these Condition Reports?
- – Or to put it another way, Where are the reports kept, who has access to those reports, do they have to be sent to the NRC and if so under what conditions and time schedule?

12.4.8.3. A more basic issue is that Condition Reports are unlikely to be written or, if they are written, to actually say anything as explained directly below.

12.4.9. Section 5.12 Inspection Methods and Technologies/Techniques, subsection [1] on page 15 specifies steps to be taken for Visual Inspections of buried piping and tanks. Step (g) directs the workers: "A CR [condition report] shall be initiated if the acceptance criteria are not met."

12.4.9.1. In my opinion, a review of steps (a) through (f) as written in Entergy's Program reveals a lack of objective, or even subjective, acceptance criteria that could trigger a condition report. Please note below:

a) When opportunities arise, buried sections of piping and tanks "should be examined to quantify deposit accumulation...and those results documented." According to the Program, as long as exposed piping is examined and damage chronicled, then the acceptance criteria are met and there is no condition report.

b) "Look for signs of damaged coatings or wrapping defects". Again, according to the Program, as long as workers do an examination, then the acceptance criteria are met. Only not looking would fail to meet the acceptance criterion and trigger a condition report.

c) "The interior of piping may be examined by divers, remote cameras, robots or moles when appropriate." In my opinion, the combination of "may" and "when appropriate" means the acceptance criterion is met whether examinations are performed or not.

d) "Use holiday tester to check excavated areas of piping for coating defects." Following the Program, when coating defects are found for exposed area of piping using a holiday tester, then the acceptance criteria is met and again no condition report is required.

e) If a visual inspection reveals coatings or wrappings not to be intact, further inspection of piping for signs of pitting, MIC, etc is required. However, the way the Program has been created, once the additional inspection is performed, the acceptance criterion is satisfied and no condition report is warranted whether or not damage is uncovered.

f) Inspect below grade concrete for indication of cracking and loss of material. Finally, once again, the Program is

designed so that as long as the inspection is performed, the acceptance criterion is satisfied whether or not damage is uncovered, nor is any record of the status of damage or its significance recorded.

12.4.10. In Section 5.12 subsection [2] on page 16 the Program specifies the steps to be taken for Non-Destructive Testing of buried piping and tanks. No steps direct workers to initiate condition report(s) regardless of how extensive the piping and/or tank damage identified may be.

12.4.11. On page 14 Section 5.9 Preventive Measures, the Program stated that "...the existing cathodic protection system *may* be updated or a new Cathodic Protection system *may* be installed. Pilgrim Watch has explained that cathodic protection *should* be installed. The emphasis should be on prevention not waiting to discover failures before acting.

12.5. Most revealing of all Entergy's proposed Program contains no provision for root cause analysis of any identified degradations. Furthermore, the Program does not expand the sample size when problems are identified. I believe this is a critical weakness, which treats each failure as an isolated situation rather than look at the broader ramifications of the problem.

12.6. In summary, it is my opinion that reasonable assurance is not provided by this new Entergy Program. In order to be even minimally effective, Entergy's Program needs real commitments and the Public needs to see how the Pilgrim specific Program will be designed and what recommended site specific safeguards will be put into place at Pilgrim, rather than accepting a loosely designed generic one size fits all style program. Therefore, I believe that the ASLB should delay its

determination on the application until the program is in place and may be evaluated.

13. Already, the record to date in these proceedings support my conclusion that the AMP may not be adequate to prevent or detect leaks in underground pipes and tanks. The Atomic Safety and Licensing Board (ASLB) has suggested that it is not necessary for the existing AMP to prevent or detect failures in underground pipes and tanks. Accordingly, the ASLB said,

    13.1. "...prevention of leaks per se is not a stated objective of any relevant aging management program. On the other hand, prevention of an aging- induced leak large enough to compromise the ability of buried pipes or tanks to fulfill their intended safety function is a clear goal of an AMP. Thus at issue here is the following fundamental question: Do the AMPs for buried pipes and tanks, by themselves, ensure that such safety-function-challenging leaks will not occur, or must some sort of leak detection devices such as monitoring wells proposed by Intervenors be installed to meet the obligation?" *Memorandum and Order, Docket No. 50-293-LR, ASLB No. 06-848-02-LR, October 17, 2007, P.17*

    Additionally, the ASLB also noted that:

    13.2. "...only issue remaining before this licensing Board regarding Contention 1 is whether or not monitoring wells are necessary to assure that the buried pipes and tanks at issue will continue to perform their safety function during the license renewal period -, or, put another way, whether Pilgrim's existing AMPs have elements that provide appropriate assurance as required under relevant NRC regulations that the buried pipes and tanks will not develop leaks so great as to cause those pipes and tanks to be unable to perform their intended safety functions." *Ibid., P.17*

14. My understanding of NRC regulations is that in operating license proceedings, the licensee bears the ultimate burden of proof.

15. In my opinion the factual record submitted by the applicant Entergy does not meet the burden of proof required by a licensee, much less with 95% certainty, that the Aging Management Program will identify leaks, or that any leaks already identified by the AMP will not expand further in the pipes or tanks thereby leaving the Pilgrim Nuclear

Power Station and its environs without a critical back-up safety system. For example, the Byron Station Nuclear Power Plant in Illinois recently detected what appeared to be a very small weeping pipe. However, upon closer inspection, the integrity of the pipe was grossly undermined and was in imminent danger of a catastrophic failure.

16. All parties involved in these proceedings to evaluate the viability of a 20-year life extension at the aged Pilgrim Nuclear Power Station are certainly aware that leaks in underground piping and tanks have frequently occurred at other operating nuclear power plants. As recently as November 29, 2007, the presence of Tritium was discovered at the Pilgrim Nuclear Power Plant Site. At the concentrations detected the Tritium undoubtedly came from the plant. Experience in isolating Tritium leaks at other nuclear plants has shown that it will take at least one year to accurately determine the origin of the leak and how broadly it has spread and contaminated surrounding areas. More importantly for this discussion, until the source and magnitude of the leak is uncovered, one cannot determine which system or systems may be compromised.

17. Based upon my professional experience as the Senior Vice-President of an ASME XI In-Service Inspection Division, it is my opinion there are several challenging scenarios in which these unidentified leaks can and will jeopardize the design and intended function of safety related systems and components at the Pilgrim Nuclear Power Station. More specifically, the recently discovered Tritium releases show that undetected leaks may already have occurred, in Pilgrim's underground pipes and tanks, thereby causing them to malfunction in such a way as to be "*unable to perform the intended safety function*". Therefore in my estimation, there are at least <u>three possible scenarios</u> that may be the result of the flaws in Pilgrim's AMP.

    17.1. <u>In the first scenario</u>, there may be a loss of intended safety function if a leak has occurred and has gone undetected by the Applicant's AMP. If a leak could spontaneously heal itself, we would not need an AMP for pipes and tanks. Unfortunately, leaks, once begun and whether observed or not, will continue to grow as evidenced by the newly discovered Tritium leaks.

These leaks may be caused by external abrasion, internal corrosion, galvanic attack or other factors as yet to be uncovered.

17.1.1. Leaks not only continue to increase in flow, but in fact the rate of expansion for leaks actually accelerates once a pinhole has been created in the pipe or tank wall.

17.1.2. After the initial pinhole, water begins to exit the tank or pipe, at an ever-accelerating rate as the hole expands. In fact, mathematically speaking, the leak rate growth is proportional to the square of the hole's radius.

17.1.3. Given that the Aging Management Plan has not detected some underground leaks as suggested in paragraph 12 and by the newly discovered Tritium leaks, it then becomes quite likely that if a safety function is required, the leak may either divert the required water or reduce the required line pressure rendering the pipe and tank system "*unable to perform the intended safety function*".

17.1.4. Transient flow and pressure changes that would occur if there is a design basis event will exacerbate leak growth and further reduce the ability "*to perform the intended safety function*". According to the NRC's website, a design basis accident (event) is "a postulated accident that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to assure public health and safety." In my opinion, the recent pipe failures at the Byron Nuclear Power Station in Illinois are the perfect example for this discussion. At Byron, safety-related flanges on pipes were weeping so badly that they certainly would have been unable to have withstand the flow and pressure transient associated with actually requiring the system to operate in its safety mode. Without adequate Aging Management oversight,

such a scenario could be mirrored at the Pilgrim Nuclear Power Station.

17.2. The second scenario is similar to the first in that a growing leak remains undetected by an inadequate Aging Management System. However, unlike the first scenario, in which a system failure is caused by allowing water to exit the expanding hole(s), in this scenario rust particles, dirt and other contamination enter the pipe or tank through the hole thereby clogging downstream filters and heat exchangers, or the debris abrades the moving parts thus rendering the system "*unable to perform the intended safety function*".

17.3. The third scenario acknowledges the presence of the initial leak that may or may not have grown significantly. However, in this scenario, it is the structural weakness created by the hole or holes in the pipe or tank, which render the system "*unable to perform the intended safety function*".

17.3.1. The hole or holes act as stress risers and increase the likelihood of gross failure under the stress of accident conditions.

17.3.2. Given that the inadequacies of the Aging Management Plan have allowed the creation of a hole or holes, and that the applicant has not structurally analyzed the presence of such holes, it is my opinion that the system would be operating outside its regulatory design basis criteria.

17.3.3. Holes that reduce the structural integrity of pipes are particularly worrisome at elbows and flanges (similar to the aforementioned Byron incident) and would render the pipe or tank "*unable to perform the intended safety function*" in the event of a Safe Shutdown Earthquake (SSE). As the nuclear industry well knows, the small earthquake at the Perry Nuclear Power Plant in Ohio did

cause leaks in plant piping, and this mild earthquake was not at all comparable to a SSE.

17.3.4. According to NRC regulations, all nuclear power stations must have certain structures, systems, and components requisite to safety, designed to sustain and remain functional in the event of maximum earthquake potential. Unidentified holes in safety related underground pipes place those pipes in an unanalyzed condition outside the scope of the regulatory design basis for the Applicant's Pilgrim Nuclear Power Plant.

17.4. In light of the newly discovered Tritium leaks, it may in fact be true that a significant safety system has already been compromised. Moreover, it seems in fact that the applicant Entergy's Aging Management System did not uncover those leaks, or did not do so in a timely manner.

18. It is my belief, as the Expert Witness retained by Pilgrim Watch, that there are at least four solutions available to Entergy and the ASLB to mitigate the serious consequences of undetected leaks. Contention 1, as delineated in this proceeding, is that the frequency of the monitoring proposed by the Applicant is insufficient to ensure that the required safety margins would be maintained throughout any extended period of operation. The Board appropriately suggested a possible weakness in the Applicant's (Pilgrim Nuclear Power Station) Aging Management Program to detect leaks, and this problem seems to be borne out by the recently discovered on-site Tritium leaks. I suggest that this problem may be minimized by four separate approaches:

- Establish critical Baseline Data;
- Reduce the future corrosion rate;
- Improve monitoring frequency and coverage;
- Increase the Monitoring Well Program to actively look for leaks once they have occurred.

18.1. Establish Critical Baseline Data: In view of the fact that industry as a whole and Pilgrim, specifically, have experienced corrosion and leaks, as evidenced at Pilgrim by the recently discovered Tritium leaks, it is important that critical Baseline Data be collected via a top to bottom examination of the safety-related buried pipes/tanks.

18.1.1. Such an inspection must entail special attention to points of vulnerability – such as at elbows, welds, joints, and at any dead spaces where liquid can sit.

18.1.2. Examinations must include inspection both inside and outside.

18.1.3. Special attention must also be given to those welds located upstream or downstream of a flow disturbance.

18.1.4. Since it is not possible to assess possible damage below the coating in the pipe body, in addition all piping must be pressure tested to at least twice the operating pressure. Inability to perform pressure tests for any reason should not be cause for relief.

18.1.5. Baseline data is critical so that trending is established. NUREG/CR 6876 states, at 32, "...it is evident that predicting an accurate degradation rate for buried piping systems is difficult to achieve..."

18.1.6. After a baseline is established then regular examinations afterwards can better determine the need for mitigation before, not after, a problem develops.

18.2. Reduce corrosion rates: The Applicant can and should implement a thorough Cathodic Protection Program (CPP) on all underground pipes and tanks. I found no reference to such a program in the application submitted by Energy. A CPP would reduce the likelihood of leaks.

18.3. Improve monitoring frequency and coverage: In an attempt to minimize the size and frequency of leaks, in my opinion, the AMP should be augmented to require more frequent and more comprehensive inspections of all underground pipes and tanks.

18.3.1. Specifically, I believe that a 100 percent internal visual inspection of all underground pipes and tanks must be implemented.

18.3.2. The inspection cycle should be such that all pipes and tanks are inspected every ten years, however, I believe that the Applicant should be required to break the testing interval down such that one sixth of all pipes and tanks are inspected during each refueling outage. (This assumes 18 month refueling outages, or six every ten years.)

18.3.3. Finally, it is my opinion that the Applicant should be required to inspect one sixth of the lineal piping, one sixth of the elbows and flanges, and one sixth of the tank seams at each outage, even if such inspections lengthen the outage time.

18.3.4. For example, when I was reviewing the Aging Management System at Entergy's Nuclear Vermont Yankee (ENVY) Power Station, I noted that the AMP was often neglected in order to assure the outage was not extended. Therefore is my opinion that the Applicant Entergy should certify that each portion of the AMP on the pipes and tanks is accomplished in the order agreed upon and completed at every outage. As an Intervenor with standing on Contention 1, Pilgrim Watch should be allowed to review copies of the certified piping inspection reports prior to the end of each outage to assure that the work was completed as ordered.

18.4. Increase the Monitoring Well Program to actively look for leaks once they have occurred: According to Pilgrim Watch's expert, Dr. David P.

Ahlfeld, in order to meet the minimum criteria for an effective monitoring well program at Pilgrim, such a program should made part of the license going forward so that it is enforceable and not simply voluntary and must follow the steps in monitoring network design as outlined in Dr. Ahlfeld's declaration. In the absence of any leaks at the Applicant's Pilgrim Nuclear Power Station, I believe that my recommendations would be necessary to the evaluation of Pilgrim's application for a 20-year extension to its current operating license. However, given the recently discovered Tritium leaks at Entergy's Pilgrim Plant and other reactors around the country, my recommendations are critical to the continued operation of Pilgrim to the end of its current license, without any consideration of a license extension.

18.4.1. In light of the newly discovered Tritium leaks, it may in fact be true that a significant safety system has already been compromised.

18.4.2. I believe it will most likely take at least one year to trace the path of the unanticipated Tritium releases.

18.4.3. The release of Tritium indicates a leak in a system that in the past was radioactive.

18.4.4. I believe such a leak means that testing should immediately be undertaken that searches for Cesium 134 and Cesium 137, Cobalt 60, and other gamma emitters as well as Strontium 90.

18.4.5. As a nuclear engineering senior vice-president overseeing decommissioning of nuclear sites and an author of the DOE Decommissioning Handbook, I believe it is critical that these newly discovered Tritium releases be accurately monitored. The evidence I reviewed as an expert witness regarding Florida Power and Light's St. Lucie Nuclear Power Plant, and the documents I have reviewed pertaining to the decommissioning effort at the

former Connecticut Yankee Nuclear Power Plant Site, clearly show how far and wide Tritium and other radioactive isotopes may spread before their release is uncovered.

18.4.6.

REDACTED

Conclusion:

Based upon my 35-year nuclear safety and nuclear engineering experience, it is my professional opinion that the issues discussed above are serious safety considerations germane to the subject of this ASLB proceeding: Entergy's application to extend the operation of its Pilgrim Nuclear Power Station for an additional 20 years. Furthermore, following my complete review of the facts as delineated in the above discussion, it is my professional opinion that the proposed AMP is inadequate and that several remedies are available to the Applicant that will minimize the probability of a leak occurring, minimize detection of any possible leaks and meet the SSE and design basis accident regulatory criteria by enabling all systems to *"perform the intended safety function"*.

I declare under penalty of perjury that the foregoing is true and correct.
Executed this day, January 26, 2008 at Burlington, Vermont.

Arnold Gundersen, MSNE, RO
1/26/08 Fairewinds Associates, Inc

CURRICULUM VITAE

Arnold Gundersen
January 2008

Family Data

REDACTED

Education And Training

ME NE	Masters 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, 1971 Cum Laude, 3.74 out of 4.0 James J. Kerrigan Scholar
RO	Licensed Reactor Operator, U.S. Atomic Energy Commission License # OP-3014

Special Qualifications – including and not limited to:
Nuclear Safety Expert Witness; 37-years of nuclear industry experience and oversight; former nuclear industry Senior Vice President; nuclear engineering management assessment; prudency assessment; Employee Awareness Programs; nuclear power plant licensing and permitting production, assessment, and review; public communications, contract administration, assessment and review; former Licensed Reactor Operator; systems engineering, radioactive waste processes and storage issue assessment, technical patents, federal and congressional hearing testimony, decommissioning, waste disposal, source term reconstructions, thermal discharge assessment, aging plant management assessment, and systems engineering.

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

- 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 in order to thoroughly remove radioactive material from nuclear plants and their surrounding environs.
- 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.

Publications

Co-author — *DOE Decommissioning Handbook, First Edition*, 1981-1982, Authorship solicited by DOE

Co-author — *Decommissioning the Vermont Yankee Nuclear Power Plant: An Analysis of Vermont Yankee's Decommissioning Fund and Its Projected Decommissioning Costs*, November 2007, Presented to Vermont State Senator Ginny Lyons and Vermont State Auditor Tom Salmon

Co-author — *Decommissioning Vermont Yankee – Stage 2 Analysis of the Vermont Yankee Decommissioning Fund – The Decommissioning Fund Gap*, December 2007, 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 2008, Presented to US Senator Bernie Sanders and to the Vermont State Senate Finance Committee

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

Committee Memberships
ANSI N-198, Solid Radioactive Waste Processing Systems
Three Rivers Community College Nuclear Academic Advisory Board
Founding Member of Connecticut Low Level Radioactive Waste Advisory Committee (Member for 10 years)
Founding Member National Nuclear Safety Network

Honors
James J. Kerrigan Scholar 1967–1971
Tau Beta Pi (Engineering Honor Society), RPI, 1969
(1 of 5 in Sophomore class of 700)
B.S. Degree, Cum Laude, RPI (3.74 GPA) 1971
U.S. Atomic Energy Commission Fellowship, 1972
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."

Teacher of the Year – 2000, Marvelwood School

Nuclear Consulting and Expert Witness Testimony

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

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.

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

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

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."

State of Connecticut
Assisted the State in drafting Whistle-blower Protection legal statutes, the strongest in the United States.

Nuclear Regulatory Commission (NRC)
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 license violations.

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. Continue to work with Czech Friends of the Earth on Czech Energy and Environmental Issues

State of Vermont Public Service Board
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. April 2003 to present

U.S. Senators Jeffords and Leahy (2003 to 2005)
Provided the Senators and their staff 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
Filed 10CFR 2.206 petition with NRC requesting confirmation of Vermont Yankee's compliance with all General Design Criteria.

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

Finestone v FPL
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 twenty-six families in a cancer cluster alleging 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.

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 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 Environmental Court
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. This report included the review of condenser and cooling tower modifications. (Docket 89-4-06-vtec 2007)

Appeal to the Vermont Supreme Court
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 (March 2006 to 2007)

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 he "Petitioners": Nuclear Watch South, the Blue Ridge Environmental Defense League, and Nuclear Information & Resource Service have filed 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)

Experience

Teaching and Academic Administration

Burlington High School

Mathematics Teacher – 2001 to present

Physics Teacher – 2004 to 2006

The Marvelwood School – 1996-2000

Chairman: Mathematics and Physics Department

Taught both mathematics and physics.

Director of Summer School and Director of Residential Life

Awarded Teacher of the Year – June 2000

Additional teaching experience: The Forman School, St. Margaret's School, and college level Advanced Nuclear Reactor Physics Lab at RPI (Rensselaer Polytechnic Institute).

Nuclear Engineering 1970 to 1990

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.

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 product and services required by nuclear utilities.

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

Supervisor, Reliability Engineering

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

Responsible 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

Responsible 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.

Vetted as expert witness in nuclear litigations, federal, international, and state hearings including but not limited to: Three Mile Island, US Federal Court, US NRC ASLB, Vermont State 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 OIG NRC.

Public Service, Cultural, and Community Activities

Sunday School Teacher, Christ Episcopal Church, Roxbury, CT
Parents Association Washington Montessori School
High School Guest Lecturer on Nuclear Safety Issues (30+ times)
Episcopal Marriage Encounter: Basic Training & Group Leadership Training, Presenting Team [with wife] – Provided weekend communication and dialogue workshops weekend retreats/seminars, Administrative Couple – supervised Connecticut Episcopal Marriage Encounter – 5 years
Co-Founder Parents Association Berkshire School
Co-Chair Annual Appeal Berkshire School
Featured Nuclear Safety Expert for Television, Newspaper and Radio, including but not limited to CNN (Earth Matters), The Crusaders, WPTZ VT, WZBG CT
Founding Board Member NNSN – National Nuclear Safety Network
Ongoing Public Testimony to Committees of the Vermont State Legislature
Tutoring of Refugee Students – Lost Boys of the Sudan and others
Certified Foster Parent State of Vermont – 2004 to 2007
Working with Burlington Electric Department (BED) on solar modifications to Burlington High School (BHS)
Mentoring former students regarding college and employment questions and applications.