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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

In the matter of
Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

Docket # 50-293

March 6, 2008

PILGRIM WATCH'S REBUTTAL DIRECTED TO ENTERGY'S INITIAL STATEMENT OF POSITION ON PILGRIM WATCH CONTENTION 1, JANUARY 8, 2008 AND NRC STAFF INITIAL STATEMENT OF POSITION – CONTENTION 1, JANUARY 29, 2008

Pursuant to § 2.1207 Process and Schedule for Submissions and Presentations in an Oral Hearing, both Entergy and the Nuclear Regulatory Commission presented their initial written statements of position and written testimony with supporting affidavits on the admitted contention. The Atomic Safety and Licensing Board Order and Notice (Regarding Hearing, Limited Appearances, and Additional Questions for Parties), February 21, 2008 allowed rebuttals directed to pre-filed testimony, filed March 6, 2008.

Pilgrim Watch's Statements of Position, Direct Testimony and Exhibits filed on January 29, 2008 [with additional citations and exhibits added, March 3, 2008, as requested by the ASLB] was submitted *after* Entergy's Statement of Position; and in it Pilgrim Watch provided facts that disputed what Entergy presented in their January 8, 2008 filing. NRC Staff's testimony raises essentially the same points as Entergy's testimony; therefore Pilgrim Watch's January 29, 2008 filing replies to NRC Staff's filing, also. Pilgrim Watch will not simply repeat everything submitted on January 29, 2008; but hereby incorporates that filing by reference. Please note that all documents referenced herein were included as Exhibits in Pilgrim Watch's Statements of Position, Direct Testimony and Exhibits, re-filed upon request on March 3, 2008. This rebuttal is supported by the Testimony of Arnold Gundersen Supporting Pilgrim Watch's Contention 1, March 6, 2008.

TEMPLATE = SECY-028

SECY-02

I. INTRODUCTION

The Order: The ASLB in response to Entergy's Motion for Summary Disposition of Contention 1 clarified the order saying that: the 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 within scope and under consideration 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.[1]

Entergy and NRC Staff Conclude that the AMPs are Sufficient: Entergy's Pre-filed testimony at 15 and NRC's Pre-filed testimony at 18 both incorrectly concluded that the AMPs alone are sufficient to manage aging of the buried pipes under consideration such that there is reasonable assurance that Pilgrim Station's buried pipes containing, or potentially containing, radioactive liquid will maintain their intended functions for the period of extended operation and will not develop leaks large enough to prevent the pipes from fulfilling their intended purpose. Both added that in their opinion the inspections and tests performed as routine maintenance and operation provide reasonable assurance, also. Further, neither Entergy nor NRC Staff provided the requisite proof (facts) to support their position.

Pilgrim Watch Concludes the AMPs are Insufficient: In contrast, Pilgrim Watch concludes from facts presented that neither the Aging Management Program for buried pipes and tanks, nor the inspections and tests performed as part of routine maintenance and operation, provide reasonable assurance that the effects of aging will be managed such that the buried pipes within scope and under consideration will perform their intended functions consistent with the current licensing basis for the period of extended operation. They are not sufficient [Gundersen A4, A15-20]. Therefore in order to protect

[1] Memorandum and Order, LBP-06-23, 64 N.R.C. 257, 315 (2006)

public safety, the aging management program must be enhanced or supplemented with a more robust inspection system and effective monitoring well program or the Application denied. [Gundersen A23].

Overview: Contention 1 is very straight-forward. The license renewal program is designed to ensure that aging issues for passive components do not pose a risk to public health and safety. Detection of potential leaks from passive components is logically part of the license renewal program.

Aging management is part of the re-licensing process for a simple reason – things are more likely to fail, or need repair, as they get older [2]– and new procedures are essential to deal with potential aging problems.

Repair of known leakages has always been part of on-going operation.[3] But repair of known leaks and detecting whether there is or might be a leak are two quite different things. The requirement for an aging management program is to manage the increased risk of failure of aging components within scope - to insure leakage of an aging component will be detected, and that necessary preventative repair of an aging component to prevent a leak will be accomplished.

An effective program to detect leaks and corroded regions that are likely to leak is not a big dollar item. There is only one ready explanation for Entergy's reluctance to provide an effective program – it doesn't want to know. Based on experience at other plants, Entergy rightly fears that if it should look for a problem it likely will find one – a buried

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[2] Testimony of Arnold Gundersen Supporting Pilgrim Watch's Contention 1, March 6, 2008 (Hereafter Gundersen], A12; Pilgrim Watch Statement of Position, Direct Testimony and Exhibits, March 3, 2008, [hereinafter "PW Statement"], Exhibit 10 (U.S. Nuclear Plants in the 21st Century: The Risk of a Lifetime, by David Lochbaum, Union of Concerned Scientists. (May 2004); and "Using Reliability - Centered Maintenance as the Foundation For An Efficient And Reliable Overall Maintenance Strategy," National Aeronautics and Space Administration (NASA), 2001.

[3] 10 CFR 50, Appendix B, XVI; Appendix C, Article C.12, "Operability Leakage from Class 1, 2, and 3 Components" to NRC Inspection Manual Part 9900, Technical Guidance, Attachment to RIS 2005-20

pipe that is corroded and may fail, or an actual leaking of radioactive liquid from a buried pipe. Entergy doesn't want to accept one consequence of finding a leak – shutting down until it is fixed; but it seems more than ready to risk another – public safety.

II. APPLICABLE LEGAL STANDARDS

Buried piping and tanks are within scope [10 C.F.R. § 54]. It has already been determined that these components are safety-related, passive, long-lived components and that the aging management program for these components has to be considered on a plant specific basis to ensure that adequate levels of safety are maintained throughout the extended license term. Questioning the wisdom of these rules is not permitted in these proceedings.

The Declaration of *Alan Cox in Support of Entergy's Motion for Summary Disposition of Pilgrim Watch Contention 1*, June 5, 2007, at A7, is instructive. In discussing the function and purpose of license renewal aging management programs, he says that,

> "PNPS has identified aging management programs (AMPs) to ensure that the effects of aging during the extended license renewal term are managed for the systems, structures, and components that are within scope of license renewal."

Pilgrim Watch agrees that managing the detrimental *effects of aging* is the purpose of license renewal aging management programs. Corrosion of buried pipes is a detrimental effect of aging; corroded pipes leak and break.

The only question is the sufficiency of those programs. In answering this question Entergy's lawyers say one thing and Entergy Corporation does another. Entergy's January 8, 2008 Initial Statement of Position Pre-filed Testimony at 15 concluded that the AMPs alone are sufficient to manage aging of the buried pipes under consideration over the period of extended operations; but Entergy's corporate actions contradict that statement.

Entergy designed a supplemental program - Entergy's, *Buried Piping and Tanks Inspection and Monitoring* Program [Entergy Initial Statement, January 8, 2008, Exhibit 5]. It says specifically at 5.1 that, "The risk of a failure caused by corrosion, directly or indirectly, is probably the most common hazard associated with buried piping and tanks." Further at 5.4, "Any buried piping or tank identified by applicable OE is designated High Impact requiring prompt attention until evaluated and dispositioned otherwise." In Table 1, "Radioactive Contamination" is defined as "High Impact." Pilgrim Watch could not agree more. The document goes on to outline steps – they are evaluated for Pilgrim Watch by our expert [PW Statement, Gundersen Decl., at 12; and Gundersen herein at A21].

The point we are making here is that if Entergy thought that the AMPs were sufficient they would not have written a 34 page Buried Piping and Tanks Inspection and Monitoring Program, effective date 11/19/07. Entergy Corporation and Pilgrim Watch seem to agree; Entergy's lawyers and NRC Staff appear to be the outliers - they alone conclude that the AMP is sufficient.

10 C.F.R. § 54.21(a)(3) requires that a license renewal application demonstrate, for each component within the scope of the license renewal rules, that the effects of aging are being adequately managed so that the intended functions will be maintained consistent with the current licensing basis during the period of extended operation. The standard for this demonstration is one of "reasonable assurance." See 10 C.F.R. § 54.29(a). See also Nuclear Power Plant License Renewal Final Rule, 60 Fed. Reg. 22,461, 22,479 (1995) (". . . the [license renewal] process is not intended to demonstrate absolute assurance that structures or components will not fail, but rather that there is reasonable assurance that they will perform such that the intended functions ... are *maintained consistent with the CLB*"). [Emphasis added].

What does "consistent with the CLB mean? Mr. Gundersen explains that, "Consistent with the CLB (Current Licensing Basis) for the period of extended operation means that Entergy is required to fully comply with its license and all NRC regulations" [Gundersen A8].

In order to determine whether 10 C.F.R. § 54.21(a) (3) requirements are met parties must: (1) clearly define reasonable assurance; (2) list the pipes within scope that contain or may contain radioactive liquid and describe their function; (3) and analyze the aging management program to determine if there is assurance that the pipes under consideration will perform their function consistent with the CLB; and whether more basically, Entergy and NRC Staff have proven that the AMPs are sufficient to detect and prevent leaks.

95% Confidence Level Required To Establish "Reasonable Assurance:" Pilgrim Watch holds based on factual evidence that reasonable assurance means that the applicant has demonstrated at a 95% level of certainty that the effects of aging will be managed so that the intended function of the pipes will be maintained consistent with the CLB during the license extension – that their aging management program is sufficient. Neither Entergy nor NRC Staff provided facts to even come close to meet this standard of proof.

Pilgrim Watch explained [PW Statement, beginning at 4; Gundersen's Decl. herein, A7] that in the context of determining which scientific evidence to admit into court, the U.S. Supreme Court [*Daubert v. Merrell Dow Pharms.* 509 U.S. 579, 592 (1993)] set the relationship between the admissibility of scientific evidence and the standard of proof required by the jury in civil proceedings. In setting the standard to exclude scientifically unreliable evidence, the court stated that scientific evidence must conform to the accepted convention of 95 percent probability to be admissible. This 95% standard of proof was followed in state courts - for example, in the Texas Supreme Court in *Merrell Dow Pharms., Inc., v. Havner*, 953 S.W.2d 706, 723-24 (Tex. Sup. Ct 1997). Further it was supported by federal government scientists as the minimum that is acceptable to prove each scientific fact in a case. [*See, e.g., U.S. v. Chase*, 2005 WL 757259, (Jan. 10, 2005 D.C. Super); *See generally,* Frederika A. Kaestle, et al., *Database Limitations on the*

Evidentiary Value of Forensic Mitochondrial DNA Evidence, 43 Am. Crim. L. Rev. 53 (2006)] Last, the 95% confidence standard was accepted and applied by the NRC as the measure of "reasonable assurance" [Transcript of ACRS Meeting (Sept. 6, 2001), PW Statement, Exhibit 4]

In order to meet the "not inimical" to public safety mandate of the AEA, the NRC must only permit licensees to use reliable scientific evidence. Federal courts have already determined that scientific proof to less than 95% confidence is unreliable. A licensee must be able to show, therefore, with 95% confidence that it has margins over minimum requirements to establish reasonable assurance of compliance with the CLB. Again, because Entergy did not make this showing, it cannot meet the statutory mandate of the AEA and the license should be denied.

III ARGUMENT

A. Confidence Level Required To Establish Assurance Not Met

Entergy's and NRC Staff's response to the question posed by the Licensing Board [at 18] that, "...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*" failed to provide evidence (facts) that met the 95% confidence level or whatever very high standard chosen to meet the "reasonable assurance requirement. It is Entergy who bears the ultimate burden of proof in a licensing proceeding [*Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1)*, ASLB-697, 16 NRC 1265, 1271 (1982), citing 10 CFR 2.325]. They failed.

In fact both the Applicant and NRC Staff skirted this issue by not providing any tangible definition of "reasonable assurance." Entergy in their Initial Statement, at 3, defined "reasonable assurance" by referring to the Nuclear Power Plant License Renewal Final Rule, 60 Fed Reg. 22,461, 22,479 (1995) ("... [the license renewal] process is not intended to demonstrate absolute assurance that structures or components will not fail, but rather that there is a reasonable assurance that they will perform such that the intended functions...are maintained consistent with the CLB"). This is not a definition. They never define "not intended to demonstrate absolute assurance?" We know that absolute certainty is 100%; but they fail to state what level of certainty constitutes assurance. Do they think it is any more than a flip of a coin?

We know that their so-called "engineering judgment" does not provide reasonable assurance; unless that judgment is backed up with verification –facts - at the required degree of certainty. For example, we know that engineers designed: the bridge that collapsed in Minneapolis; the Big Dig in Boston with its leaking tunnels and falling ceiling tiles; the Challenger; and Entergy's and NRC Staff's engineers missed identifying the corrosion in Vermont Yankee's cooling tower wall before it collapsed. Therefore a standard that relies simply on engineering judgment is not sufficient.

B. Entergy and NRC Staff Mischaracterize Which Buried Pipes Do or May Contain Radioactive Liquid; Their Function; and Failure Mechanisms

1. Buried Pipes Containing Radioactive Liquid include piping connected to the CSS, SSW discharge and Offgas System.

There is no disagreement about what buried pipes/tanks meet the scoping criteria of 10 CFR 54.4. They are the standby gas treatment, salt service water, fuel oil, station blackout diesel generator, fire protection, and condensate storage. There is no disagreement either that buried pipes connected to the CST and to the SSW discharge do or may contain radioactive liquid. There is disagreement about the piping connected to the offgas system; contrary to Entergy and NRC, Pilgrim Watch includes the Offgas system buried.

Pilgrim Watch recognizes that the ASLB never defined in the Order *how much* radioactively contaminated liquid that the pipe does or may contain. Therefore the question is simply whether the pipe does or may contain radioactively contaminated liquid.

Pilgrim Watch explained the reason the Offgas Piping must be included in this hearing in our response to Entergy's Motion for Summary Disposition, subsequent submissions and again here. Our expert explains at A7 that,

> The SGTS is used to improve the performance of the condenser by enabling it to "draw" more steam through the turbine. The condenser is maintained at a pressure that is as low as possible below atmospheric pressure. The Standby Gas Treatment System must extract air from the condenser in order to maintain it at a lower pressure than the outside air pressure. Furthermore, since part of this system includes a re-combiner to combine hydrogen and oxygen atoms to form water molecules, the non-condensable isotopes (xenon, krypton, iodine, etc) are transmitted via piping from the AOG Building to charcoal beds and then released from the main stack vent.
>
> This stream of non-condensable gases is contaminated with radioactive isotopes from neutron activation of the reactor water and from leaks in the fuel. While the preponderant gaseous activation product is Nitrogen-16, it has a very short half life and therefore is not a concern for this analysis. *However,* leaking fuel contributes gaseous fission products and their decay related daughter products, which is of great concern to this analysis. For instance, the short lived Krypton-90 is a gaseous fission product that decays to the long lived isotope Strontium-90. Therefore the Standby Gas Treatment System Piping contains many isotopes beyond the original noble gases that it is designed to contain including Strontium-90 which is a known bone seeking carcinogen with a known 30-year half-life.
>
> According to industry documentation, Pilgrim, like many reactors around the country, has used fuel assemblies with defective cladding. Therefore, when the plant shuts down during an outage or at any other time of shutdown, radioactive water might collect Standby Gas Treatment System and potentially leak from the

SGTS piping.

2. Contrary to Entergy and NRC Staff, Pilgrim Watch defines the function of pipes more broadly to include a requirement to keep the contents from seeping out into the environment, leaking.

Pilgrim Watch disagrees with Entergy's and NRC Staff's definition of the function of these pipes. The Applicant and NRC narrowly and incorrectly define "intended function" as simply "...the intended function(s) [i.e., "delivering water"][4].

Pilgrim Watch knows that the function of the pipes within scope is broader. Pilgrim Watch's expert explains, [Gundersen A6]

> The basic function of a pipe is to carry or transmit the contents inside the pipe to another location while also protecting the environment by keeping its contents from seeping out into the environment, or in other words, pipes must not leak any contents into the environment. Pipes must also keep the liquid inside the pipe, and not let it travel into the ground. A pipe cannot deliver water as designed if it has holes or cracks. Leaks or breaks are not part of the design. At a nuclear power plant like Entergy Nuclear Pilgrim, pipe leakage is especially critical given that many pipes are contaminated with radioactivity that might leach into water tables and Pilgrim's surrounding fragile estuaries.

It is obvious from Pilgrim's behavior that they know that the basic function of a pipe is to keep the liquid inside, not allow it to leak. For example, Pilgrim Station installed pipes and did not choose instead to transfer water from the condensate tanks via open ditches or by workers carrying buckets; and neither would they accept from a manufacturer a pipe that resembled a soaker hose. Entergy takes great pains to describe their program and procedures that attempt to prevent leaks and breaks [Entergy's Initial Statement of

[4] Entergy's Motion for Reconsideration, October 29, 2007 at 6

Position, January 8, 2008, summarized in Sections C-D]. If leaks did not matter, they would not have bothered.

Leaks or breaks are not part of the design – irrespective of whether the pipes happen to be above ground or below ground. Above ground pipes connected to safety components have to be inspected and then fixed if they are leaking, such as at Byron's ESW pipe on October 23, 2007[5]. The Applicant has to have sufficient programs to identify leaks and then fix them below ground, too. There cannot be a double standard.

10 C.F.R. § 54.21(a) (3) requires that a license renewal application demonstrate there is reasonable assurance that [the pipes within scope, in this case pipes connected to the CST, SSW and OGTS] will perform such that the intended functions ... are maintained consistent with the CLB".

In other words once a sufficient program is in place to identify the condition of the pipes and identify whether or not there are leaks, or will soon be leaks, rules and pertinent guidance must be met to fix them over the relicensed period.

NRC rules and guidance say that leaks in pipes have to be fixed. The rules and guidance do not allow a "pass" from the requirement depending on such factors as: how much water drops from a connecting tank; what other system may be used in a crisis to substitute for water lost from a leaking pipe; or by any of the myriad of "excuses" the applicant has come up with to justify letting CST, SSW pipes leak.

Key NRC Regulations and Guidance require that the licensee fix degradation.

[5] (NRC Preliminary Notification of Event or Unusual Occurrence, PNO-III-07-021, "Both Units at Byron Shut Down Due to Leak in Pipe", October 23, 2007) ML072960109. Union of Concerned Scientists Issue Paper, Help Wanted: Dutch Boy at Byron (October 25, 2007), PW Statement Exhibit 7.

a) 10 CFR 50 Appendix B requires that the licensee fix degradation; thus, Entergy is not allowed to know about and ignore piping degradation; nor can the ASLB give them a "pass" from this requirement.

> 10 CFR, Appendix B to Part 50--Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants [Gundersen A9]
>
> XVI. Corrective Action
>
> Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management.

However it is conceivable, but improbable, that Entergy could bypass the regulation if they committed to performing a real 10 CFR 50.59 evaluation that justified excavating the underground piping and poking lots of holes in it, then burying it again without compromising safety function, then Entergy could equally justify knowing about holes that they want to leave alone. Pilgrim Watch does not recommend it; neither do we believe Entergy or NRC Staff argues in favor of this approach.

But if you cannot do a 50.59 evaluation for the condition at hand (degraded piping), then you cannot fail to fix it without violating 10 CFR 50 Appendix B. Clearly the fact that there is this regulation means that these pipes are not supposed to leak during the license extension.

b) Appendix C, Article C.12, "Operability Leakage from Class 1, 2, and 3 Components", to NRC Inspection Manual Part 9900, Technical Guidance, Attachment to

RIS 2005-20, ADAMS Accession No. ML052060365, "Upon discovery of leakage from a Class 1,2 or 3 pressure boundary component (*pipe wall*, valve body, pump casing, etc), the licensee must declare the component inoperable." [Emphasis added] [Gundersen A9]

Therefore, the question is not how great a leak has to be before there is a crisis, or whether a crisis will ensue, but that there cannot be leaks in the pipes, period.

Rules and Guidance to one side, the fact that there is a required Aging Management Program for Buried Pipes and Tanks tells us that corrosion in piping was taken seriously by NRC when the relicensing rules were written and that, more simply, the pipes in scope are to be sufficiently inspected to provide assurance that they do not leak.

The ASLB's Order, February 21, 2008 asked questions to the parties concerning leakage from the CSS and SSW. Entergy and NRC Staff responded. Did their responses mean to somehow imply that leaks are acceptable?

Pilgrim Watch's expert, Arnold Gundersen, at A10 clarified this issue. He said,

- According to NRC regulations and guidance leaks are not acceptable. If pipes leak, they must be fixed, as the component is inoperable.
- Since the ***ASLB questions address an entirely separate issue***, it is difficult to determine if in fact Entergy and NRC staff are ignoring NRC regulations and guidance in their answers. [Emphasis added].
- In my opinion, the NRC, Pilgrim, and the ASLB seem to have turned the issue of underground leakage on its head. If the leaking pipe or tank were above ground, the system would be declared inoperable and fixed, regardless of the size of the leak. I am unaware of any NRC regulations that differentiate between the severity of a leak as opposed to the existence of an underground leaks

3. Failure mechanisms that may jeopardize the design and intended function of safety related systems and components at the Pilgrim Nuclear Power Station.

Mr. Gundersen goes on to say that, "In addition, according to 10 CFR 50 Appendix B leaks are required to be repaired and Entergy must look for leaks and fix them when found in order to comply with its CLB during the relicensed period. In my opinion, this regulation makes absolute sense because if there are any unidentified leaks in the aforementioned pipes, such leaks may jeopardize the design and intended function of safety related systems and components at the Pilgrim Nuclear Power Station."

Mr. Gundersen describes at least three possible scenarios. [A10]

1. In the first scenario, 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.

   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.

   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 radius of the hole.

   Given 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*".

   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.

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"*

   Under these conditions, the Venturi Effect[6] is the governing scientific principle. For illustrative purposes, let my use the simple example of applying lawn fertilizer to a lawn through a garden hose to explain this phenomena. Even though the hose water is at higher pressure than the fertilizer, the Venturi Effect from the moving water pulls the fertilizer into the moving fluid.

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

[6] **VENTURI EFFECT**—The increase in the velocity of a fluid stream as it passes through a constriction in a channel, pipe, or duct. Calculated by the *Continuity Equation*, or $Q = VA$ Q = VA where Q is the volumetric flow rate, A is the Area of flow, and V is the fluid velocity. Because Q does not change, as A gets smaller then V must increase.

"unable to perform the intended safety function".

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

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.

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.

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.

Pre-existing holes in underground piping might cause a failure during a design basis event, such as a SSE. Mr. Gundersen explained that, [A11]

To begin, let me give you an analogy. If the existence of holes appreciably increases the likelihood of failure, then essentially the plant has a similar condition to permanent removal of an emergency diesel generator. After all, the EDG might fail, the single failure criterion assumes a single failure, so the EDG is removed and it's the designated single failure.

In addition, let me address the core question of whether or not the existence of holes will appreciably increase the likelihood of failure? That answer depends upon the cause and nature of the holes. A thousand pinhole leaks distributed uniformly over the length of a 1,000-foot buried piping run is unlikely to cause its failure rate to rise. But the same area of through-wall leakage concentrated in one region - such as in a circumferential weld - might create an entirely different outcome. If Entergy knows that buried underground piping is leaking (for example by observing small, slow level drop in the CST), how would Entergy distinguish from that fact the cause and nature of the leakage? Entergy certainly could excavate the piping and eyeball whether or not the leak has been created by a series of pinhole leaks or a gaggle of weld defects. However, no licensee would excavate piping, determine the cause and nature of said holes and leaks, and not fix them; as such degradation would negatively impact performance and earnings. Besides, there is a federal regulation (10 CFR 50 Appendix B) that requires licensees to repair any degradation. Thus, by regulation, a licensee is not allowed to know about piping degradation and ignore it.

To conclude, Gundersen at A9 explains that, "Obviously it is important that leakage not occur so that Pilgrim does not unknowingly:

- expose members of the public to excessive doses of radiation by radioactive leaks migrating offsite;
- that workers on site are not exposed via inhalation, especially in the winter or during heavy rains when radioactive contaminated water could rise to the surface and become airborne;
- for decommissioning purposes to reduce Pilgrim becoming an expensive legacy site;
- and lastly to prevent failures that would impact the safety of the system."

Pilgrim Watch concludes that any leak from a pipe within scope is too great.

The ASLB Order (Denying Pilgrim Watch's Motion of Reconsideration) (January 11, 2008, at 8) said that the only issue remaining before the Board is that:

> Whether or not buried pipes and tanks containing radioactive fluids are leaking at such great rates that they cannot satisfy their respective designated safety functions, or that there are no such programs.

NRC rules [Appendix B to Part 50- Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, XVI. Corrective Action] make it clear that *any leak* is too great [Gundersen A14]. Consider, too, that if Entergy is not required to look with enough sufficiency, they will never know how big the leak is.

For example, regarding the CSS, we learned from the Applicant's and NRC Staff's responses that they cannot determine the leakage rate by the testing of the condensate storage tank ("CST") water level every four hours because according to Entergy "...the level indicator measurements cannot be readily correlated with a leak rate during normal operations because the water level is dynamic." [Affidavit Of Dr. James A. Davis And Andrea T. Keim In Response To Licensing Board Questions In, Feb 11, 2008, Page 2]. Further the "The quarterly HPCI and RCIC system surveillance tests are not designed or intended to quantify a potential leakage rate from buried piping" [Ibid].

In order to satisfy the regulation, to fix degradation so that these pipes will not fail (leak) and provide assurance that they will be maintained consistent with the CLB, means that Entergy has to look from 2012-2032; in other words to have sufficient programs to enable them to identify degradation and leaks.

The important question then becomes whether Pilgrim's AMP is rigorous enough to identify leaks in the buried pipes under consideration. The answer is "No;" and certainly neither the Applicant nor NRC Staff has demonstrated otherwise with the requisite standard of proof.

C. Entergy's and NRC Staff's Assurance That Entergy's Plan To Manage Internal And External Corrosion Is Adequate Is Incorrect

Both the Applicant and NRC explain that the following will be relied upon during license renewal: metals, linings, coatings, soil, and handling; the Buried Piping and Tanks Inspection Program; water chemistry and the service water integrity program; and additional monitoring programs for the CSS and SSW Systems. Entergy adds an additional program in the planning stage, *Entergy's Buried Piping and Tanks Inspection Program*, Entergy's Exhibit 5. Entergy claims that they are sufficient to provide assurance (Entergy at Section III C, page 8; NRC at Section III, page 10). NRC agrees [NRC Initial Statement at 18].

Pilgrim Watch's Initial Statement demonstrated in detail why these methods fail to provide reasonable assurance and how they need to be supplemented (PW Statement, Section III, beginning on page 37).

1. Entergy and NRC Staff Rely On False Assumptions about Corrosion

One reason for Entergy's and NRC's false assessment of the effectiveness of Entergy's aging management program is that they ignore basic facts and subscribe to dangerous and incorrect assumptions about corrosion. Key facts about corrosion are reviewed by Mr. Gundersen at A12.

Corrosion is not gradual or linear: Entergy and NRC Staff incorrectly assume that aging is gradual.[7] This false assumption justifies to them that a Buried Piping and Tank Inspection Program that occurs only once in 10 years is adequate. However, Pilgrim Watch's expert explains otherwise that, [A12]

> The older the pipe is, the more likely it is that corrosion and leaks will occur. Engineers explain the aging phenomenon by using what is known as the "Bathtub

[7] Example, NRC Staff Initial Statement of Position on Contention 1, January 29, 2008, page 6

Curve." The curve is a graph of failure rate according to age. The failure rate due to unidentified leaks is relatively high in the beginning when "kinks" are being worked out; it flattens out during the middle life phase; and it rises again sharply in the end-of-life or at the "wear-out phase." On average, 30 years usually marks the beginning of the wear-out phase. I would expect that most of Pilgrim Station's pipes, wraps and coatings would be in this "wear out phase" during the relicensed period. This adjudication process must flush out the precise age of each part of the pipes, wraps and coatings and provide documents from the manufacturer certifying their life expectancy. In my professional opinion, and the standard applied to aging management of systems, inspections at Pilgrim must increase as any component ages. Piping, coatings and wraps age, and just like human beings, require more doctor visits. Clearly, the rate of corrosion is not linear over time. Even the most meticulously maintained system, like the Space Shuttles, which are a much newer engineered technology than Pilgrim, are reaching the end of their useful life due to the aging phenomena of the Bathtub Curve.

Holes or cracks do not fix themselves; and once started, they grow. For example, this is self evident if one imagines a small hole in the Hoover Dam. 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 holes radius. And not only will a hole let the fluid out, it will also allow dirt and debris in which will foul or clog the system. Corrosion may not be assumed to be a gradual process, and corrosion is non-linear.

Entergy and NRC Staff must not understand either that corrosion is not even across a pipe. This lack of understanding justifies to them that a Buried Piping and Tank Inspection Program that does not specific precisely where inspections must occur. However, Pilgrim Watch's expert explains otherwise that, [A12]

Corrosion is not even across the pipe; it is hard to predict. Corrosion occurs more frequently at welds, elbows and dead spots. Therefore inspections cannot avoid the most susceptible locations; instead special attention must be given to examining these areas.

Entergy and NRC Staff must not understand either that the pipes are underground; consequently their condition is not readily apparent and they are in a far more corrosive environment than if they were not buried; further that they are made of metal and no metal is immune to corrosion.

Pilgrim Watch's expert explains, [A12]

> *Nuclear power plants rely upon buried piping.* Unfortunately, when a pipe is buried, its condition is not readily apparent. Therefore pipes must be inspected. Just as the ESW piping at Byron Station had to be fixed, the piping underground must be fixed and that requires looking via an Aging Management Program with frequent and comprehensive inspections. Furthermore because the CSS, SWS, SGTS piping are buried in the soil, these buried pipes are by definition in a more corrosive environment than any aboveground piping. For instance, oxygen, moisture, chloride, acidity, or microbes found in the soil, in one degree or another, corrode all piping materials. More specifically, because Pilgrim Station is located adjacent to Cape Cod Bay and at a low elevation, it is readily apparent that the soil surrounding the piping is not "friendly." No metal is immune to corrosion. Moreover, piping located near salt water or in salty soil is more easily corroded.

Also Entergy and NRC Staff do not properly consider human errors in installation or manufacturing when they conclude that the aging management program provides assurance. Mr. Gundersen says in his testimony that, "Human error either in manufacturing or installation may never be discounted. [A12]

Last, he says that, "Over time movement of the soil creates unanticipated stress on underground pipes; and "In conclusion, a most important basic fact to keep in mind is that corrosion rates are hard to predict and cannot be assumed to be either linear or gradual." [A12]

Entergy incorrectly attempts to provide assurance by mischaracterizing Pilgrim's environment as not especially conducive to corrosion; the truth is that they do not know.

Mr. Gundersen explains at A13 that,

> …the basic problem is that Entergy has not performed any recent and thorough hydro-geologic studies; or if Entergy has performed such studies, the results of those studies have not been shared with the parties or placed them in the public domain. Entergy's own Buried Piping and Tanks Inspection and Monitoring Program [provided in Entergy's Initial Statement as Exhibit 5] states that a corrosion risk evaluation should be performed within 9 months and that it should include soil resistivity measurements etc. and that "soil resistivity measurements must be taken at least every 10 years unless areas are excavated and backfilled or if soil conditions are known to have changed for any reason" [(Entergy) Exhibit 5, at 5.5]. Therefore, I believe that we (the NRC, Entergy, ASLB and the parties) are currently traveling "blind."
>
> Performing a Corrosion Risk Assessment is critical *before* any appraisal or decisions are made regarding Entergy's license application. In my opinion, the ASLB does not have the information in hand to make an adequate assessment of the AMP and meet NRC regulations without knowing either the extent of corrosion risk caused by the local environment and without knowing the corrosion status of the affected components.

Also important to consider when evaluating the adequacy of Entergy's AMP is the fact that Entergy has not provided any evidence that that they have instituted a Cathodic Protection Program (CPP). Gundersen explains [A13]

> … my review of the data has shown several concerns. To begin, the piping is

mainly made of carbon steel and stainless steel. There is no evidence that Entergy has instituted a thorough Cathodic Protection Program (CPP) for this piping. All metals corrode, and corrosion occurs on both external and internal surfaces. For instance, regarding external corrosion, it is a known fact that water and moisture are needed for corrosion to occur. Pilgrim Station is located in Plymouth, MA, which is a relatively moist environment adjacent to Cape Cod Bay. Plymouth's winter climate is characterized by periods of snow and ground freeze that thaws in Spring. Periods of rainfall occur throughout the year. Chloride speeds corrosion, and chloride is naturally abundant in seawater. Soil acidity is corrosive. Entergy described procedures to reduce the effects of oxygen from moisture and acidity from decaying organic material – removing vegetation and placing the piping on a bed of sand. However over a period of time vegetation reappears, decays and works its way down to the pipes. Soil above the sand migrates downward mixing with the sand to provide a moist environment. The low pH resulting from decayed organic matter, acid rain and stray electric currents will accelerate corrosion along with the oxygen from water seepage. Pipes corrode both externally and internally. The rate of degradation on interior surfaces is a function of aggressive chemicals, pH level, dissolved oxygen and biological elements at the site. *The recently discovered tritium leaks at Pilgrim, and the nationwide epidemic of tritium leaks from underground pipes clearly prove that these phenomena exist.*

Pilgrim's use of counterfeit or substandard pipe fittings and flanges is not explained adequately by Entergy. Gundersen at A13 explains,

> … according to a 1990 United States Government Accounting Office Report Pilgrim Station may have received counterfeit or substandard pipe fittings and flanges. Therefore, I believe it should be factually established whether or not the CSS, SSW, and SGTS piping has counterfeit and/or substandard pipe fittings and flanges. In my opinion, if any parts are counterfeit or substandard, then the probability of failure is increased. Review of the documents and notices

regarding counterfeit or substandard pipe fittings and flanges, shows that the NRC allowed the continued use of some or all of these components at numerous reactor sites. If this information is indeed accurate, then both Entergy and the NRC should have documentation that would indicate whether the NRC's decision to allow the use of these components was based upon Pilgrim's 40-year license or upon their use for a specific time period or an indefinite timeframe.

So, too, seismic activity and its effect on buried piping are not explained by the Applicant.

... Plymouth is not immune to soil compaction and seismic activity even though the probability of such an event may be low. Buried pipes and tanks are not flexible and the coatings become brittle with age and therefore are more susceptible to breakage during seismic events. [A13]

Last the precise configuration of the CSS, SSW and SGTS piping must be determined.

... as any entry-level engineer learns, straight piping is less susceptible to failure than welds, elbows and dead spots. What is the precise configuration of the CSS, SSW and SGTS piping? Pilgrim Watch has not been provided this information for review. Prior to commenting further regarding the failure possibility of Pilgrim's piping, I must review the precise configuration of the CSS, SSW, and SGTS piping. I will need this information prior well before my testimony, so that I will have adequate time to review the precise piping configuration. Yes, I did review the Diagrams that were sent to Pilgrim Watch by Entergy Pilgrim, but these were more of a cartoon-style schematic and did not have the accuracy necessary to adequately review the mechanisms required to inspect the CSS, SSW, and SGTS piping. [A13]

2. Entergy and NRC Staff Incorrectly Say That The Buried Piping and Tanks Inspection Program (BPTIP) Provides Assurance

The BPTIP is described in Appendix A.2.1.2. and B.1.2 of the License Renewal Application and it consists of three parts [Gundersen A16].

1) Appendix A.2.1.2. Buried Pipes and Tanks Inspection Program page A-14 states that buried components are inspected when excavated during maintenance and if "trending" identifies a susceptible location. For example, a specific area with a history of corrosion might have additional inspections, coating or replacement to assure that either no leaks occur or that if leaks do occur the leaks are quickly discovered and the requisite piping is repaired in order to achieve the two goals of protection of the entire system and mitigation of any release of any radioactive isotopes into the environment.

(2) Focused inspections will be performed within 10 years of the license renewal unless an "opportunistic inspection" which allows assessment of pipe condition without excavation, occurs within the ten-year period. The "opportunistic inspection" may be either visual or "Inspections via methods that allow assessment of pipe condition without excavation may be substituted for inspections requiring excavation solely for the purposes of inspection." These latter inspections can include phased array Ultrasonic Testing (UT) technology that provides indication of wall thickness for buried piping without excavation. The application says that use of such methods to identify the effects of aging is preferable to excavation for visual inspection, which could result in damage to coatings or wrapping. (Application, B.1.2, page B-17).

(3) *"Prior to entering the period of extended operation,* the applicant is to verify that at least one opportunistic or focused inspection is performed during the past ten years."

Pilgrim Watch's expert describes precisely why the program is deficient. He says, that "it is apparent that Entergy agrees with me. In its prefiled testimony, Entergy included a new framework for a company-wide Buried Pipes and Tanks Inspection Program [Entergy's, Exhibit 5]. Yet, Pilgrim Watch has not received any information noting how or when this new framework for a company-wide Buried Pipes and Tanks Inspection Program will be implemented at Pilgrim Station." [A17]

Mr. Gundersen describes the program and explains what is wrong with it so that it does not provide the requisite "reasonable assurance." [A18]

> Part (1) of the program notes that pipes are inspected if they are excavated during maintenance. The problem is that this leaves inspections and safety to happenstance and does not meet Pilgrim Station's Aging Management goals.
>
> Part (2) of the program requires a one-time inspection during the first 10-years of the license renewal period by either a visual or an as yet untested UT inspection.. The problem here is that the program lacks specificity and provides merely a general framework. By allowing total flexibility for the licensee, this loose framework once again neglects the very specific requirements of Aging Management Programs in general and, in my opinion, certainly neglects the very goals developed by Entergy for its Pilgrim Station Aging Management Program.
>
> For example, the BPTIP allows: "A determination of the sample size based on an assessment of materials of fabrication, environment, plausible aging effects, and operating experience." [NUREG-1801, Rev.1, X I M32].
>
> My review of the evidence provided by Entergy Pilgrim Station finds four problems with Entergy's alleged plan.

- The first problem is that operating experience at Pilgrim Station is limited according to the SER. From the evidence I have reviewed, I believe that Entergy Pilgrim Station has not performed a thorough baseline examination of the pipes, which of course should be a prerequisite to any license extension program.
- The second problem, as I see it, is that Pilgrim Station does not have a monitoring-well program that meets design standards, see Dr. Ahlfeld's declaration.
- In my opinion, the third problem is that Entergy's assessment of materials and the environment provided in Entergy's Initial Statement does not seem accurate. For instance Entergy's statements ignored the facts that all metals corrode, that Pilgrim's specific environment is conducive to corrosion, and that no recent hydrological and geological studies have been performed.
- Fourth and quite simply, there is no new hard data to review, as it seems that Entergy Pilgrim Station has only conducted cursory reviews of old studies via walkabouts on the property.

"Identification of the inspection locations in the system or component based on the aging effect; determination of examination technique; evaluation of the need for follow- up examinations if aging related degradation is found."
The problem with this portion of the Entergy Nuclear Pilgrim Station plan is that there is no requirement concerning the number of sample inspections or the location of said sample inspections.

In the statement "An evaluation of the need for follow-up examination", no mention is made regarding who will evaluate the need for follow-up examinations, and no statement as to the NRC's role is articulated. Furthermore, and more critical, is that there are no criteria whatsoever with which to determine when there must be "follow-up examination(s)."

In NUREG-1801, the BPTIP states: "The inspection includes a representative sample of the system population, *where practical*, focuses on the bounding or lead components most susceptible to aging due to time in service, severity of operating conditions, and lowest design margin." In my opinion, the obvious flaw here is the word, "Where practical." Such loose terminology does not meet any engineering standards and allows licensee convenience and profit margins to be the driving force for inspection rather than "public health and safety" as required by federal statute.

Lastly, in the BPTIP it is stated: "The one-time inspection, *or any other action or program*, created to verify the effectiveness of the AMP and confirm the absence of an aging effect, is to be reviewed by the staff on a plant-specific basis." In my opinion the inference presupposes that only on a plant specific basis will a "*one time inspection, or any other action or program*"... occur depending upon the effectiveness of the AMP as determined and reviewed by the Pilgrim Station staff. Once again, this is not a commitment to an inspection with formal criteria and trigger points by which to deepen an inspection should specific triggers be uncovered, instead this loose wording simply suggests that the inspection may not occur if Pilgrim Station staff determine such an inspection is not warranted.

Part (3) of the BPTIP says that, "Prior to entering the period of extended operation, the applicant is to verify that there is at least one opportunistic or focused inspection performed during the past ten years." The issue that I see is that any inspections prior to license renewal have all the weaknesses described above. Entergy has not stated when these inspection might occur or if they may have already occurred. Of additional concern is the fact that if Entergy plans to count inspections that occurred early in 2000 as part of this process, and is allowed to do so, than conceivably at least 19 years might lapse between inspections. The critical nature of these pipes requires more than one inspection over the entire period of license renewal.

> NUREG-1801, Rev 1, XI M-107, September 2005 states that, " ...the applicant should schedule the inspection no earlier than 10 years prior to the period of extended operation...as a plant will have accumulated at least 30 years of use before inspections under this program begin, sufficient times will have elapsed for aging effects, if any, to be manifest." Again the wording here is problematic in that there does not appear to be any requirement that the specific component areas sampled be at least 30-years-old.

Mr. Gundersen summarizes his key points, "There is not a requirement for a through baseline inspection prior to license renewal so that the NRC and Entergy know the condition of each component in order to make a rational Aging Management Plan for the renewal period. The required inspections are too infrequent. I explained that corrosion is not gradual, and that as components age they wear out at a greater frequency as predicted by the Bathtub Curve. Therefore they need to be inspected more frequently as time goes forward. Entergy's AMP has no specificity in the program delineating what must be inspected. Engineering experience shows that certain areas of piping are more susceptible than others to corrosion, like welds, elbows, and dead spots. Lastly, there are no clear requirements for reporting, repair or replacement of degraded piping." A18

3. Entergy and NRC Staff Incorrectly Say That The Water Chemistry & the Service Water Integrity Programs Provide Assurance

In addition to the BPTIP the Applicant claimed in its Initial Statement that other more routine programs are effective in preventing corrosion, like the Water Chemistry & the Service Water Integrity Program. However, as Mr. Gundersen explains at A19, these two programs address internal corrosion and do not provide adequate assurance in combination with the other programs the Applicant outlined.

Water Chemistry Program: Mr. Gundersen comments that, "the water chemistry program is a mitigation program and does not provide detection for aging effects. More frequent complete inspections as part of the overall program are the only effective assurance that defects created by aging components will be uncovered. Tritium leaks at reactors across the country belie the effectiveness of water chemistry alone to prevent leaks." A19

Further, Mr. Gundersen responds to Entergy's claim that the water chemistry program is effective because, "This is an existing program at PNPS that has been confirmed effective at managing the effects of aging on the CSS as documented by the operating experience review. See PNPS LRA at Appendix B, Section B.1.32.2, p. B-106-07. The continuous confirmation of water quality and timely corrective actions taken to address water quality issues ensure that the program is effective in managing corrosion for applicable components." This clearly is no defense of the program because, as Mr. Gundersen pointed out [A19], "Entergy's statement alludes to problems within the water chemistry program, and identifies that it has had problems and has improved the program. However, Entergy never discusses the potential damage caused while operating under the older methodology, nor what remediation steps have been taken regarding any damage that occurred. Furthermore, Entergy provides no factual evidence to validate its verbal assurance that the new program is effective." A19

Service Water Integrity Program (SPW): Again, Mr. Gundersen responds to Entergy's expert's claim that the SPW is effective because, "This program has been effective in detecting degradation of the internal rubber lining in the original SSW system carbon steel piping. As a result, the inlet pipes were replaced with titanium pipe, and portions of the discharge pipes were replaced with carbon steel piping coated internally and externally with an epoxy coating, and the entire lengths of the discharge pipes were internally lined with cured-in-place pipe linings. Thus, this program has been successfully implemented at PNPS to manage SSW system degradation from loss of material due to internal corrosion prior to the loss of its intended function. See PNPS LRA at Appendix B, Section B.1.28, p. B-92-93." [A19]

Mr. Gundersen points out the obvious further that, As I see it, the problem is that the program's effectiveness is ascribed to the fact that there was serious corrosion, which was not identified until after 23 years of operations, and it was identified only as a result of prodding from NRC, Generic Letter 89-13. This leads me to wonder how long there were significant corrosion problems and how long the licensee would have waited if it were not for the generic letter. [A19]

And that,

According to Entergy, Pilgrim replaced (2) 40' sections of SSW Discharge piping out of 240' in one loop and 225' in the other loop 1999. Once again there is insufficient data to make a valid assessment. The problem here is that there is no indication of the condition of the remainder of these loops.

In 2001, Entergy states that a new liner was placed in loop B and in 2003 a new liner was placed in Loop A. It strikes me as remarkably convenient that the life expectancy of the liners is given as 35-years, yet there is no factual data with which to corroborate that statement.

And last, he notes [A19] that in Entergy's Initial Statement, it said that,

the Service Water Integrity Program will be used to monitor the newly installed liner (CIPP). As the CIPP approaches the end of its expected life, increased inspections will be undertaken of the CIPP. The in-service inspection program for the SSW currently requires PNPS to undertake a complete ultrasonic or visual examination of the CIPP, analogous to those undertaken for the original rubber lining, after the CIPP has been in service for 20 years, well before the end of its expected 35 year life.

However, Mr. Gundersen says, "Once again, there is no timeline delineating the "increased inspections" or enumerating how many inspections will occur. Just as importantly, no definition of "complete ultrasonic or visual inspection" is provided nor is it clear whether this would be a stem to stem inspection or only a partial inspection.

4 Entergy and NRC Staff Claim That The Additional Surveillance Programs For the CSS and SSW Provide Assurance Is Incorrect

To manage internal and external corrosion at Pilgrim Station, Entergy's Initial Statement, at 8, explains that the additional monitoring programs for the CSS and SSW Systems also will be relied upon during license renewal. Mr. Gundersen describes what these programs entail and why they do not provide assurance, either. [Gundersen at A20]

Additional Surveillance Programs for the CST: The CST program consists of level indictors in the Condensate Tank and quarterly testing of the water flow from the RCIC pump and the HPIC pump. Entergy responded to the Board's questions on February 11 and stated in regard to the 4-hour testing of the CST water level that, "Under normal operation, the level of the CSTs is dynamic (i.e. the CST levels fluctuate as they provide makeup or receive condensate discharge to maintain appropriate condenser water level). Therefore, under normal operation, there is no specific leakage rate that would be detected by or could be readily correlated with the four-hour test results."

Mr. Gundersen concludes that, "In my opinion, Entergy's response clearly indicates that the monitors cannot predict the level of corrosion in the pipes and whether or not the pipes are leaking." A20.

In response to the same question, the NRC Staff said at 5, "there is no CS system leak rate that would challenge HPCI/RCIC performance for purposes of § 54.4(a)(1), and only a very large leak would compromise the performance for purposes of § 54.4(a)(3). And if there were a large drop in water in the CST, it would be noticed and corrective action taken."

Mr. Gundersen comments that, "While the NRC staff assessment may be interesting and informative, in my opinion, it does not address the core question, which is: whether or not leaks will be identified and will be repaired in order to protect public health and safety."A20.

Additional Surveillance Programs for the SSW do not provide assurance either. Entergy's Testimony at 17, A30 states that,

> "By the time the cooling water is in the buried discharge piping, it has completed its intended safety function of providing cooling water for the RBCCW. Therefore, if a leak develops in the discharge piping, it will not affect the intended safety function. There is no correlation between any potential leak in the buried discharge piping and any potential plugs in them that might prevent them from discharging water from the SSW. The SSW system is designed so that no active component failure nor any single passive component failure, or any other system, can prevent it from achieving its safety objective. There are two loops of discharge piping, so if one were inoperable, the second loop could be used to return the cooling water back to the bay. Each loop can transfer the full heat capacity required for its intended safety objective."

NRC Staff Exhibit 17, said that,

> "... the system would retain the ability to remove heat from the RBCCW. The Staff does not believe that there is any credible mechanism for the discharge piping to become plugged. The discharge piping is constructed using carbon steel which is ductile and would deform before it would rupture. In addition, the pressure from the water inside the pipe would keep it from collapsing. But, even if it did become plugged, the second loop is still available to return the water to the bay"

Mr. Gundersen explains why their arguments do not hold water, perhaps no better than the buried pipes. He says at A20 that,

> Waiting for a leak to grow so big as to effect the intended function of the system would be unthinkable in an above ground portion of the same system. Single failure criteria do not apply when a system is known to be leaking significantly, in which case it should be considered inoperable already. Therefore, in my opinion, a second single failure should be postulated given that Entergy's Pilgrim Station plans to wait an excessive amount of time to repair any leaks.
>
> In my opinion, the central question of identifying leaks, that is leaks of any size, is not addressed so that the responses and questions, although of general interest, do not answer the question at hand, which is the sufficiency of the AMPs to assure leaks will be detected and promptly repaired in order to comply with regulation and thereby protect the public health and safety.

5. Entergy's *Buried Piping and Tanks Inspection Program and Monitoring Program,* [Entergy's Prefiled Testimony, Exhibit 5] Does Not Provide Assurance

We learned that on November 19, 2007, Entergy announced its initiation of a new program entitled *Buried Piping and Tanks Inspection Program and Monitoring Program.* The Program indicates that Entergy agrees with the Petitioners that the programs and procedures currently in place that would determine whether or not the buried pipes containing radioactive fluids are leaking in such a manner as to be unable to satisfy their respective safety functions are inadequate.

The program is analyzed and shortcomings described by Pilgrim Watch's expert, at A21. Mr. Gundersen notes that,

> "Entergy's own corporate program, the _Buried Piping and Tanks Inspection Program and Monitoring Program_ (Entergy's Prefiled Testimony, Exhibit 5), which was introduced quite late during the discovery process on November 19, 2007, should be specifically applied to the Pilgrim site prior to anyone drawing any conclusion based upon the adequacy of Pilgrim's proposed solutions to inspecting underground systems. Absent specific implementing procedures to Entergy's elective corporate guidance, the ASLB and the Petitioners are forced to guess, rather than have the requisite 95% assurance in the adequacy of Pilgrim's program."

Last a voluntary program cannot be counted on to protect public safety; licensing requirements are needed to provide the public with real and perceived assurance that our safety is being protected.

6. Entergy and NRC Staff incorrectly contend that reasonable assurance is provided based upon conformance to: NRC Guidance; the GALL Report; industry practices; PNPS operating experience; and the SER review

Mr. Gundersen disputes their claim that assurance is provided by conformance to the Gall. He says that,

> The GALL Report simply represents general guidance and is not a mandate. The NRC has repeatedly stated that plant specific data such as operating experience must be considered. Furthermore, the GALL Report is changed periodically

informing us that it is neither plant specific nor a regulatory mandate. [A22]

Conformance to NRC Guidance does not provide assurance either. Mr. Gundersen says that,

> Conformance to NRC Guidance again is not convincing because guidance is simply "guidance not mandate" and like the GALL, NRC Guidance continues to evolve as industry-wide lessons are learned. In my opinion, the proliferation of leaks from buried pipes and tanks at nuclear power plants around the country is a good example of exactly why public health and safety standards are not met by nuclear power plants by simply referring these firms to either NRC Guidance or industry practices. [A22]

Industry experience nationwide, and specifically at Pilgrim, also fails to provide assurance. Our expert commented that,

> As I have previously stated, a thorough baseline inspection has not been performed or required, so there is no baseline data by which to judge Pilgrim's past operating experience. Also, there is no industry-wide experience with which to compare corrosion and leakage in buried components at 40 to 60-year-old reactors. More regrettably the NRC did not perform a thorough "autopsy" of the parts from reactors which have been closed and dismantled, like Yankee Atomic and Maine Yankee. Such an analysis and study of the impact of aging on various materials and components would have enabled the entire industry to make predictions based upon sound data. Finally, there is no operating experience for the AMP and the UT examinations are completely untested. [A22]

Last Entergy's and NRC Staff's pointing to the SER as a reason to find assurance in Entergy's aging management program rings hollow.

The SER review was recently evaluated by the NRC Office of Inspector General.

Since the NRC OIG found serious flaws with the review process, in my opinion, the SER review should not be applied to Pilgrim until the process has been corrected and once again reviewed by the NRC OIG.[8] [A22]

D. Pilgrim Watch Contends That On The Basis Of Facts Presented That The AMP Requires Supplements To Provide Assurance That The Buried Pipes And Tanks Within Scope Will Perform Their Intended Safety Function

Pilgrim Watch and their experts have reviewed the Aging Management Program for Pilgrim Station and conclude that the frequency and thoroughness of the aging management program 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.

In Section 18 from Mr. Gundersen's Declaration Supporting Pilgrim Watch's Contention 1, January 26, 2008 and Gundersen's Declaration herein at A23, he states that there are at least four solutions available to Entergy to minimize this problem.

1. Establish critical Baseline Data;
2. Reduce the future corrosion rate;
3. Improve monitoring frequency and coverage.
4. Increase the Monitoring Well Program to actively look for leaks once they have occurred, as described by Dr. David Ahlfeld. [Pilgrim Watch Initial Statement, Exhibit 2].

8 OIG-07-A-15, Pilgrim Watch Prefiled Statement, March 3, 2008, Exhibit 21.

Specifically, Mr. Gundersen's recommends the following: [A23]

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.

<u>18.4. Increase the Monitoring Well Program to actively look for leaks once they have occurred:</u> 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. Therefore in my opinion, and given Pilgrim's proximity to the environmentally sensitive Bay and salt marshes, a rigorous and expanded Monitoring Well program should be ordered and immediately undertaken at and around the Pilgrim Nuclear Power Plant Site."

In closing, Mr. Gundersen, reiterates that in his opinion, "... until Entergy Nuclear Pilgrim Station implements Entergy's corporate guidance concerning inspection of underground pipes and tanks, provides those implementing procedures to the Petitioners for complete review and assessment, and begins implementation of concrete procedures, these proceedings should be halted, and the license extension should not be granted." [A23]

V. CONCLUSION

For the foregoing reasons, Pilgrim Watch's position is that the record shows that Pilgrim Station cannot be re-licensed because the aging management program for buried pipes and tanks do not provide reasonable assurance that *by themselves,* that such safety-function-challenging leaks will not occur, and that they must be supplemented with more robust and frequent inspections and a comprehensive monitoring well program.

Respectfully submitted

Mary Lampert

Mary Lampert
Representing Pilgrim Watch, pro se
March 6, 2008

TESTIMONY OF ARNOLD GUNDERSEN SUPPORTING PILGRIM WATCH'S CONTENTION 1

MARCH 6, 2008

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of **Docket # 50-293**

Entergy Corporation
Pilgrim Nuclear Power Station
License Renewal Application

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March 6, 2008

TESTIMONY OF ARNOLD GUNDERSEN ON PILGRIM WATCH'S CONTENTION 1 REGARDING THE ADEQUACY OF THE AGING MANAGEMENT PROGRAM FOR BURIED PIPES AND TANKS

<u>WITNESS BACKGROUND</u>

Q1. Please state your name.

A. Arnold Gundersen

Q2. Please state your residential address.

A. 376 Appletree Point Road, Burlington, VT 05408

Q3. Please summarize your educational and professional experience.

A. My CV is attached. I have a bachelor's and a Master's Degree in Nuclear Engineering from Rensselaer Polytechnic Institute (RPI) cum laude; and began my career as a reactor operator and instructor in 1971 and progressed to the position of Senior Vice President for a nuclear licensee. 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.

Q4. What is the purpose of your testimony?

A. My testimony is in support of Pilgrim Watch's Contention 1 that the programs and procedures Entergy uses for the Aging Management of the Pilgrim Nuclear Power Plant's buried pipes are insufficient. Moreover, in my review of the record, the Order has changed significantly during the course of these proceedings.

OVERVIEW

Q5. What buried pipes and tanks within the "revised scope" contain or may contain radioactive liquid?

A. The buried pipes connected to the following systems: Condensate Storage System (CSS); Salt Water Service System (SSW), discharge piping; and the Standby Gas Treatment System (SGTS).

Entergy's Testimony and the questions issued by the ASLB have focused solely on the CSS and SSW Discharge piping; however both are silent on the SGTS (Standby Gas Treatment System) piping. The SGTS piping may indeed have radioactive liquids, perhaps not in the same quantity as the CSS, however, in my review of the evidence, the volume of contaminated water was not specified in the Order.

The SGTS is used to improve the performance of the condenser by enabling it to "draw" more steam through the turbine. The condenser is maintained at a pressure that is as low as possible below atmospheric pressure. The Standby Gas Treatment System must extract air from the condenser in order to maintain it at a lower pressure than the outside air pressure. Furthermore, since part of this system includes a re-combiner to combine hydrogen and oxygen atoms to form water molecules, the non-condensable isotopes (xenon, krypton, iodine, etc) are transmitted via piping from the AOG Building to charcoal beds and then released from the main stack vent.

This stream of non-condensable gases is contaminated with radioactive isotopes from neutron activation of the reactor water and from leaks in the fuel. While the preponderant gaseous activation product is Nitrogen-16, it has a very short half life and therefore is not a concern for this analysis. *However,* leaking fuel contributes gaseous fission products and their decay related daughter products, which is of great concern to this analysis. For instance, the short lived Krypton-90 is a gaseous fission product that decays to the long lived isotope Strontium-90. Therefore the Standby Gas Treatment System Piping contains many isotopes beyond the original noble gases that it is designed to contain including Strontium-90 which is a known bone seeking carcinogen with a known 30-year half-life.

According to industry documentation, Pilgrim, like many reactors around the country, has used fuel assemblies with defective cladding. Therefore, when the plant shuts down during an outage, or at any other time of shutdown, radioactive water might collect Standby Gas Treatment System and potentially leak from the SGTS piping.

Q6. From an engineering viewpoint, what is the basic function of a pipe?

A. The basic function of a pipe is to carry or transmit the contents inside the pipe to another location while also protecting the environment by keeping its contents from seeping out into the environment, or in other words, pipes must not leak any contents into the environment. Pipes must also keep the liquid inside the pipe, and not let it travel into the ground. A pipe cannot deliver water as designed if it has holes or cracks. Leaks or breaks are not part of the design. At a nuclear power plant like Entergy Nuclear Pilgrim, pipe leakage is especially critical given that many pipes are contaminated with radioactivity that might leach into water tables and Pilgrim's surrounding fragile estuaries.

REQUIREMENTS

Q7. 10 C.F.R. § 54.21(a)(3) requires that Entergy's license renewal application show that for these pipes, "...the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation." Based on your professional experience, what does "adequately managed" mean?

A. Based upon my professional experience of more than 35-years as a nuclear engineer, "adequately managed" means that the licensee has demonstrated with "reasonable assurance" at approximately a 95% level of certainty that the effects of aging will be managed so that the intended function of the pipes will be maintained consistent with the Current Licensing Basis (CLB) during the license extension and that the pipes in question will perform their respective safety functions. It does not mean a requirement to demonstrate absolute assurance that structures or components will not fail.

The 95 percent confidence standard was accepted and applied by the NRC as the measure of "reasonable assurance" [Transcript of ACRS Meeting (Sept. 6, 2001), Citizens' Ex. 62 at 3].

Therefore, it is my professional opinion that the Applicant must be held to the same reasonable assurance standard of proof by the ASLB that the NRC presented to support its assertion that its programs and procedures for managing the aging of these pipes *does in fact* provide reasonable assurance to relicense Entergy Nuclear Pilgrim Station. Neither the Applicant nor the NRC may simply rely upon "engineering judgment", unless that judgment is grounded in facts that provide the 95% level of certainty. If a factual analysis is unavailable, the Applicant's judgment may be driven by convenience and/or economics. Assuring a 95% confidence level for license extension upon a 40-year-old reactor is critical, especially given that NRC has loosened regulations to make them less prescriptive by allowing for voluntary initiatives rather than promulgating measurable regulations.

Q8. Besides, 10 C.F.R. § 54.21(a)(3) requires that Entergy's license renewal application show that for these pipes, "...the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation." What does consistent with the CLB (Current Licensing Basis) for the period of extended operation mean?

A. In my opinion, consistent with the CLB (Current Licensing Basis) for the period of extended operation means that Entergy *is required* to fully comply with its license and all NRC Regulations.

Q9. Therefore, in your professional experience, would you list some key NRC regulations that pertain to buried piping that apply to Pilgrim and explain your reasoning why Entergy is required to comply with said regulations?

A. Yes, let me answer this by first listing the regulation and guidance and then discussing the importance of each one.

10 CFR Appendix B to Part 50 – Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, XVI. Corrective Action that reads:

> "Measures shall be established to assure that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and nonconformances are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. The identification of the significant condition adverse to quality, the cause of the condition, and the corrective action taken shall be documented and reported to appropriate levels of management."

Appendix C, Article C.12, "Operability Leakage from Class 1, 2, and 3 Components", to NRC Inspection Manual Part 9900, Technical Guidance, Attachment to RIS 2005-20 states:

> "Upon discovery of leakage from a Class 1,2 or 3 pressure boundary component (*pipe wall*, valve body, pump casing, etc), the licensee must declare the component inoperable."

I believe these rules and guidance make sense. Obviously it is important that leakage not occur so that Pilgrim does not unknowingly:

- expose members of the public to excessive doses of radiation by radioactive leaks migrating offsite;
- that workers on site are not exposed via inhalation, especially in the winter or during heavy rains when radioactive contaminated water could rise to the surface and become airborne;
- for decommissioning purposes to reduce Pilgrim becoming an expensive

legacy site;

- and lastly to prevent failures that would impact the safety of the system.

More importantly, the declaration of inoperability assures that a repair will occur in a timely fashion so as to meet the NRC statutory requirements of not jeopardizing public health and safety.

Q10. In your opinion, do the answers Entergy and NRC staff applied to the ASLB's questions regarding leakage from the CSS and SWW discharge pipes incorrectly imply that leaks are acceptable?

A. First, let me summarize what Entergy and the NRC staff has after which I will state my professional opinion.

- According to NRC regulations and guidance leaks are not acceptable. If pipes leak, they must be fixed, as the component is inoperable.
- Since the ASLB questions address an entirely separate issue, it is difficult to determine if in fact Entergy and NRC staff are ignoring NRC regulations and guidance in their answers.
- In my opinion, the NRC, Pilgrim, and the ASLB seem to have turned the issue of underground leakage on its head. If the leaking pipe or tank were above ground, the system would be declared inoperable and fixed, regardless of the size of the leak. I am unaware of any NRC regulations that differentiate between the severity of a leak as opposed to the existence of an underground leak. Let me elaborate.

To begin: The ASLB's question (c) read, "*What is the smallest leakage rate that could reasonably be expected to challenge the ability of the CSS system piping at issue to fail to satisfy its intended function(s) as relevant* *for license renewal? Provide a detailed statement of the basis of and sources for your answer."*

<u>Entergy responded that</u>, "At the outset, no amount or rate of leakage from the CSS buried piping could challenge the ability of the HPCI and RCIC systems to perform their intended functions. While the CSTs are the preferred source of water for HPCI and RCIC (because of water purity), the assured (i.e. safety-related) source of water is the torus. If the CSS were unable to deliver water to the HPCI and RCIC pumps, for any reason, the HPCI and RCIC suction path would be switched to the torus."

And, "While leakage from the CSS piping would not prevent the HPCI and RCIC functions from being performed, it could affect the ability of the CSTs to serve as the preferred source of water for HPCI and RCIC. Make-up to the CSTs is supplied from the demineralized water storage tank (DWST). The demineralized water transfer system (DWTS), which transfers water from the DWST to either CST, is supplied by two pumps each of which is rated at 110 gallons per minute. Since only one of the two pumps is normally in service, a maximum of 110 gallons per minute of makeup could be provided to either CST to compensate for a leak. If leakage from buried CSS piping were to exceed this rate, the volume of water in the CST could not be maintained, which would eventually impact its ability to provide the preferred source of water to the HPCI and RCIC systems.

The smallest leakage rate that would challenge the ability of a CST to serve as the preferred source for HPCI and RCIC within a 4 hour interval is on the order of 500 gallons per minute. With regard to a leakage rate that would be detected by the 4 hour monitoring, one could hypothesize the following: Assume initial tank level is at the procedural minimum of 30 feet. A leak develops such that the level drops to the alarm setpoint (12.5 feet) just before the next 4 hour observation. In this case, a level reduction of 17.5 feet over a 4 hour period would represent a leakage rate of over 500 gpm. Because this leakage rate exceeds the make-up capability of the DWTS, the capability of the CST to act as the preferred source would not be recovered without corrective action. However, such a large leakage rate would likely cause visible effects, such as water leaking into the building, erosion of exterior ground surfaces, or significant amounts of visible water in exterior areas, that would be noticeable well within the 4-hour observation period.

1. For example, if the leakage rate from a CST were 220 gallons per minute (twice the makeup rate of a DWTS pump), it would take about 20 hours before the CST level would be reduced below the level reserved for HPCI and RCIC. The volume of water that would have to be lost to reduce the water level in the CST from its normal minimum (30 feet) to the level reserved for HPCI and RCIC (10.5 feet) is 136,500 gallons ([30 feet – 10.5 feet] x 7,000 gallons/foot). Assuming a single DWST pump provides makeup at its rated capacity, a leak of 220 gallons per minute would correspond to a net loss rate of 110 gallons per minute (220 gallons per minute leakage rate minus 110 gallons per minute makeup rate). The time it would take for this net loss rate to reduce the volume by 136,500 gallons is: 136,500 gallons ÷ [110 gallons per minute x 60 minutes/hour] ~ 20 hours.

Leakage from the buried piping would not be expected to affect the flow of water through the buried CSS line. The positive pressure in the piping would cause any leakage to flow out of the line, not in, so leakage would not be expected to introduce debris or cause blockage of the piping. Further, the key consideration in system operation is maintaining adequate suction pressure (i.e. net positive suction head) to the pumps. The CST and piping system design, in conjunction with the setpoints for swapping the HPCI and RCIC suction source to the torus, ensure adequate net positive suction head to the pumps. Thus, while some amount of water would be diverted from the piping to the ground which would serve to increase the rate of level decrease in the CST, this would merely accelerate the time at which the suction swap to the torus would be required. HPCI and RCIC functions would be unaffected.

ASLB 2. With Regard to the Salt Service Water ("SSW") system – Explain how any leak in the SSW buried pipes that might carry radioactive water from the plant to the canal that dumps into the bay could challenge the ability of the SSW system to satisfy its intended function(s)? For example, is there any correlation between any potential leak in those pipes and any potential plugs in them that might prevent them from discharging water from the SSW, thereby impeding the ability to remove heat from the RBCCW? Provide a detailed statement of the basis of and sources for your answer.

Entergy Response: The SSW system discharge piping is an open-ended run of unobstructed piping. Leakage is generally not a concern for an open-ended discharge pipe.

The external surface of the carbon steel discharge pipe is protected by either a coal tar wrapping or epoxy coating. The interior of the discharge piping is protected by a ½" thick cured-in-place-pipe (CIPP) lining, consisting of polyester felt material with a resin and catalyst system or an epoxy resin and hardener system, which forms a smooth, hard inner protective surface. These coatings and linings are designed to prevent internal and external corrosion. For leakage to occur, there would have to be a failure of the external coating, a through wall failure of the metal pipe, and a failure of the CIPP liner. The likelihood of these three barriers being breached is remote.

Further, in the unlikely event of leakage from the discharge piping, such leakage would not be expected to have any effect on the SSW system's ability to perform its intended function. Leakage would simply result in some salt water being discharged to the ground rather than to the bay. Further, because there is a positive pressure differential within the discharge piping, in-leakage of dirt or debris that might block the discharge line would not be expected. Indeed, even if dirt were introduced, it would likely be swept away with the discharge flow. Moreover, if dirt or debris were somehow accumulating, any significant diminishment of flow would be detected by the daily monitoring of the heat exchange capability of the SSW system. Thus, only if degradation of the SSW discharge piping were somehow to progress to the point of pipe collapse would the SSW system's ability to satisfy its intended function be challenged. The design and construction of the SSW discharge piping, including external coatings and internal liner, make such a failure mechanism not credible."

<u>NRC Staff Response ASLB Questions Regarding CSS</u>

ASLB Q. *What is the smallest leakage rate that could reasonably be expected to challenge the ability of the CSS system piping at issue to fail to satisfy its intended function(s) as relevant for license renewal? Provide a detailed statement of the basis of the sources for your answer?*

> NRC Staff response at 5: "In sum, there is no CS system leak rate that would challenge HPCI/RCIC performance for purposes of § 54.4(a)(1), and only a very large leak would compromise the performance for purposes of § 54.4(a)(3)."

In addition, according to 10 CFR 50 Appendix B leaks are required to be repaired and Entergy must look for leaks and fix them when found in order to comply with its CLB during the relicensed period. In my opinion, this regulation makes absolute sense because if there are any unidentified leaks in the aforementioned pipes, such leaks may jeopardize the design and intended function of safety related systems and components at the Pilgrim Nuclear Power Station.

Therefore, in my opinion, there are at least <u>three possible scenarios</u>:

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.

   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.

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 radius of the hole.

Given 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*".

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.

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*"

Under these conditions, the Venturi Effect[1] is the governing scientific principle. For illustrative purposes, let my use the simple example of applying lawn fertilizer to a lawn through a garden hose to explain this phenomena. Even though the hose water is at higher pressure than the fertilizer, the Venturi Effect from the moving water pulls the fertilizer into the moving fluid.

ASLB Question 2 relates to the SSW system. *Regard to the Salt Service Water ("SSW") system – Explain how any leak in the SSW buried pipes that might carry radioactive water from the plant to the canal that dumps into the bay could challenge the ability of the SSW system to satisfy its intended function(s)? For example, is there any correlation between any potential leak in those pipes and any potential plugs in them that might prevent them from discharging water from the SSW, thereby impeding the ability to remove heat from the RBCCW?*

> NRC Staff response, at 5, "The Staff does not believe that there is any credible mechanism for the discharge piping to become plugged. The discharge piping is

[1] **VENTURI EFFECT**—The increase in the velocity of a fluid stream as it passes through a constriction in a channel, pipe, or duct. Calculated by the *Continuity Equation*, or $Q = VA$ Q = VA where Q is the volumetric flow rate, A is the Area of flow, and V is the fluid velocity. Because Q does not change, as A gets smaller then V must increase.

> constructed using carbon steel which is ductile and would deform before it would rupture. In addition, the pressure from the water inside the pipe would keep it from collapsing. But, even if it did become plugged, the second loop is still available to return the water to the bay."

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*".

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

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.

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.

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.

Consequently, 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.

Q11. In your professional opinion, explain how pre-existing holes in underground piping might cause a failure during a design basis event, such as an SSE?

A. To begin, let me give you an analogy. If the existence of holes appreciably increases the likelihood of failure, then essentially the plant has a similar condition to permanent removal of an emergency diesel generator. After all, the EDG might fail, the single failure criterion assumes a single failure, so the EDG is removed and it's the designated single failure.

In addition, let me address the core question of whether or not the existence of holes will appreciably increase the likelihood of failure? That answer depends upon the cause and nature of the holes. A thousand pinhole leaks distributed uniformly over the length of a 1,000-foot buried piping run is unlikely to cause its failure rate to rise. But the same area of through-wall leakage concentrated in one region - such as in a circumferential weld - might create an entirely different outcome. If Entergy knows that buried underground piping is leaking (for example by observing small, slow level drop in the CST), how would Entergy distinguish from that fact the cause and nature of the leakage? Entergy certainly could excavate the piping and eyeball whether or not the leak has been created by a series of pinhole leaks or a gaggle of weld defects. However, no licensee would excavate piping, determine the cause and nature of said holes and leaks, and not fix them, as such degradation would negatively impact performance and earnings. Besides, there is a federal regulation (10 CFR 50 Appendix B) that requires licensees to repair any degradation. Thus, by regulation, a licensee is not allowed to know about piping degradation and ignore it.

<u>CORROSION</u>

Q12. From your professional experience, please review for us some basic facts about pipe corrosion so that we can better evaluate the sufficiency of Entergy's aging management program and procedures.

A. Yes, some key points follow.

a. The older the pipe is, the more likely it is that corrosion and leaks will occur. Engineers explain the aging phenomenon by using what is known as the "Bathtub Curve." The curve is a graph of failure rate according to age. The failure rate due to unidentified leaks is relatively high in the beginning when "kinks" are being worked out; it flattens out during the middle life phase; and it rises again sharply in the end-of-life or at the "wear-out phase." On average, 30 years usually marks the beginning of the wear-out phase. I would expect that most of Pilgrim Station's pipes, wraps and coatings would be in this "wear out phase" during the relicensed period. This adjudication process must flush out the precise age of each part of the pipes, wraps and coatings and provide documents from the manufacturer certifying their life expectancy. In my professional opinion, and the standard applied to aging management of systems, inspections at Pilgrim must increase as any component ages. Piping, coatings and wraps age, and just like human beings, require more doctor visits. Clearly, the rate of corrosion is not linear over time. Even the most meticulously maintained system, like the Space Shuttles, which are a much newer engineered technology than Pilgrim, are reaching the end of their useful life due to the aging phenomena of the Bathtub Curve.

b. Corrosion is not even across the pipe; it is hard to predict. Corrosion occurs more frequently at welds, elbows and dead spots. Therefore inspections cannot avoid the most susceptible locations; instead special attention must be given to examining these areas.

c. Holes or cracks do not fix themselves; and once started, they grow. For example, this is self evident if one imagines a small hole in the Hoover Dam. 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. And not only will a hole let the fluid out, it will also allow dirt and debris in which will foul or clog the system. Corrosion may not be assumed to be a gradual process, and corrosion is non-linear.

d. *Nuclear power plants rely upon buried piping*. Unfortunately, when a pipe is buried, its condition is not readily apparent. Therefore pipes must be inspected. Just as the ESW piping at Byron Station had to be fixed, the piping underground must be fixed and that requires looking via an Aging Management Program with frequent and comprehensive inspections. Furthermore because the CSS, SWS, SGTS piping are buried in the soil, these buried pipes are by definition in a more corrosive environment than any aboveground piping. For instance, oxygen, moisture, chloride, acidity, or microbes found in the soil, in one degree or another, corrode all piping materials. More specifically, because Pilgrim Station is located adjacent to Cape Cod Bay and at a low elevation, it is readily apparent that the soil surrounding the piping is not "friendly." No metal is immune to corrosion. Moreover, piping located near salt water or in salty soil is more easily corroded.

e. Human error either in manufacturing or installation may never be discounted. Over time movement of the soil creates unanticipated stress on underground pipes.

In conclusion, a most important basic fact to keep in mind is that corrosion rates are hard to predict and cannot be assumed to be either linear or gradual.

Q13. In your professional opinion, is Pilgrim Station's environment more or less conducive to the probability of the plant's buried piping corroding?

A. Let me answer this question in two (2) parts.

First, the basic problem is that Entergy has not performed any recent and thorough hydro-geologic studies; or if Entergy has performed such studies, the results of those studies have not been shared with the parties or placed them in the public domain. Entergy's own Buried Piping and Tanks Inspection and Monitoring Program [provided in Entergy's Initial Statement as Exhibit 5] states that a corrosion risk evaluation should be performed within 9 months and that it should include soil resistivity measurements etc. and that "soil resistivity measurements must be taken at least every 10 years unless areas are excavated and backfilled or if soil conditions are known to have changed for any reason" [Exhibit 5, at 5.5].

Therefore, I believe that we (the NRC, Entergy, ASLB and the parties) are currently traveling "blind."

Performing a Corrosion Risk Assessment is critical *before* any appraisal or decisions are made regarding Entergy's license application. In my opinion, the ASLB does not have the information in hand to make an adequate assessment of the AMP and meet NRC regulations without knowing either the extent of corrosion risk caused by the local environment and without knowing the corrosion status of the affected components.

<u>Second</u>, my review of the data has shown several concerns. To begin, the piping is mainly made of carbon steel and stainless steel. There is no evidence that Entergy has instituted a thorough Cathodic Protection Program (CPP) for this piping. All metals corrode, and corrosion occurs on both external and internal surfaces. For instance, regarding external corrosion, it is a known fact that water and moisture are needed for corrosion to occur. Pilgrim Station is located in Plymouth, MA, which is a relatively moist environment adjacent to Cape Cod Bay. Plymouth's winter climate is characterized by periods of snow and ground freeze, that thaws in Spring. Periods of rainfall occur throughout the year. Chloride speeds corrosion, and chloride is naturally abundant in seawater. Soil acidity is corrosive. Entergy described procedures to reduce the effects of oxygen from moisture and acidity from decaying organic material – removing vegetation and placing the piping on a bed of sand. However over a period of time vegetation reappears, decays and works its way down to the pipes. Soil above the sand migrates downward mixing with the sand to provide a moist environment. The low pH resulting from decayed organic matter, acid rain and stray electric currents will accelerate corrosion along with the oxygen from water seepage. Pipes corrode both externally and internally. The rate

of degradation on interior surfaces is a function of aggressive chemicals, pH level, dissolved oxygen and biological elements at the site. *The recently discovered tritium leaks at Pilgrim, and the nationwide epidemic of tritium leaks from underground pipes clearly prove that these phenomena exist.*

Third, according to a 1990 United States Government Accounting Office Report Pilgrim Station may have received counterfeit or substandard pipefittings and flanges. Therefore, I believe it should be factually established whether or not the CSS, SSW, and SGTS piping has counterfeit and/or substandard pipefittings and flanges. In my opinion, if any parts are counterfeit or substandard, then the probability of failure is increased. Review of the documents and notices regarding counterfeit or substandard pipefittings and flanges, shows that the NRC allowed the continued use of some or all of these components at numerous reactor sites. If this information is indeed accurate, then both Entergy and the NRC should have documentation that would indicate whether the NRC's decision to allow the use of these components was based upon Pilgrim's 40-year license or upon their use for a specific time period or an indefinite timeframe.

Fourth, Plymouth is not immune to soil compaction and seismic activity even though the probability of such an event may be low. Buried pipes and tanks are not flexible and the coatings become brittle with age and therefore are more susceptible to breakage during seismic events.

Fifth, as any entry-level engineer learns, straight piping is less susceptible to failure than welds, elbows and dead spots. What is the precise configuration of the CSS, SSW and SGTS piping? Pilgrim Watch has not been provided this information for review. Prior to commenting further regarding the failure possibility of Pilgrim's piping, I must review the precise configuration of the CSS, SSW, and SGTS piping. I will need this information prior well before my testimony, so that I will have adequate time to review the precise piping configuration. Yes, I did review the Diagrams that were sent to Pilgrim Watch by Entergy Pilgrim, but these were more of a cartoon-style schematic and did not have the accuracy necessary to adequately review the mechanisms required to inspect the CSS, SSW, and SGTS piping.

MANAGING INTERNAL AND EXTERNAL CORROSION

Q14. In your professional opinion, do you think that any leak should be tolerated or that if a pipe within a specific system leaks then that component should be declared inoperable until the leak(s) are repaired?

A. Once again, NRC rules [Appendix B to Part 50--Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, XVI. Corrective Action] make it clear that any leak is a leak at too great a rate. My response above regarding failure mechanisms explains why this must be so (Answer to Q13).

Q15. What do you believe Entergy Pilgrim Station's Aging Management Plan and Program requires Pilgrim Station to do regarding the detection of leaks when they occur? Is this sufficient?

A. Entergy is required to have a sufficient aging management plan and programs to detect leaks when they occur, and those leaks should be repaired as soon as they are discovered in order to achieve the purpose of their Aging Management Program.

Q16. Earlier in this declaration, in your answer to Q13, you stated that you had difficulty deciphering the cartoon-style schematic for the diagrams pertaining to the inspection of the CSS, SSW, and SGTS piping. In spite of that obstacle,

would you please describe the inspection and Aging Management Programs for underground pipes and tanks at Entergy Nuclear Pilgrim Station?

A. Certainly. The Buried Pipes and Tanks Inspection Program (BPTIP) is described in Appendix A.2.1.2. and B.1.2 of the renewal filing. It consists of three parts.

(1) Appendix A.2.1.2. Buried Pipes and Tanks Inspection Program page A-14 states that buried components are inspected when excavated during maintenance and if "trending" identifies a susceptible location. For example, a specific area with a history of corrosion might have additional inspections, coating or replacement to assure that either no leaks occur or that if leaks do occur the leaks are quickly discovered and the requisite piping is repaired in order to achieve the two goals of protection of the entire system and mitigation of any release of any radioactive isotopes into the environment.

(2) Focused inspections will be performed within 10 years of the license renewal unless an "opportunistic inspection" which allows assessment of pipe condition without excavation, occurs within the ten-year period. The "opportunistic inspection" may be either visual or "Inspections via methods that allow assessment of pipe condition without excavation may be substituted for inspections requiring excavation solely for the purposes of inspection." These latter inspections can include phased array Ultrasonic Testing (UT) technology that provides indication of wall thickness for buried piping without excavation. The application states that use of such methods to identify the effects of aging is preferable to excavation for visual inspection, which could result in damage to coatings or wrapping. (Application, B.1.2, page B-17).

(3) *"Prior to entering the period of extended operation,* the applicant is to verify that at least one opportunistic or focused inspection is performed during the past ten years."

Q17. In your professional opinion, do you believe that Entergy's BPTIP is sufficient?

A. My short answer is "No." And, in my opinion, it is apparent that Entergy agrees with me. In its prefiled testimony, Entergy included a new framework for a company-wide Buried Pipes and Tanks Inspection Program [Entergy's, Exhibit 5]. Yet, Pilgrim Watch has not received any information noting how or when this new framework for a company-wide Buried Pipes and Tanks Inspection Program will be implemented at Pilgrim Station.

Q18. Briefly, please describe Entergy's BPTIP and indicate how it is insufficient?

A. Let me respond to this question by first describing the program and then explaining what I see wrong with it.

<u>Part (1)</u> of the program notes that pipes are inspected if they are excavated during maintenance. The problem is that this leaves inspections and safety to happenstance and does not meet Pilgrim Station's Aging Management goals.

<u>Part (2)</u> of the program requires a one-time inspection during the first 10-years of the license renewal period by either a visual or an as yet untested UT inspection.. The problem here is that the program lacks specificity and provides merely a general framework. By allowing total flexibility for the licensee, this loose framework once again neglects the very specific requirements of Aging Management Programs in general and, in my opinion, certainly neglects the very

goals developed by Entergy for its Pilgrim Station Aging Management Program.

For example, the BPTIP allows: "A determination of the sample size based on an assessment of materials of fabrication, environment, plausible aging effects, and operating experience." [NUREG-1801, Rev.1, X I M32].

My review of the evidence provided by Entergy Pilgrim Station finds four problems with Entergy's alleged plan.

- The first problem is that operating experience at Pilgrim Station is limited according to the SER. From the evidence I have reviewed, I believe that Entergy Pilgrim Station has not performed a thorough baseline examination of the pipes, which of course should be a prerequisite to any license extension program.
- The second problem, as I see it, is that Pilgrim Station does not have a monitoring-well program that meets design standards, see Dr. Ahlfeld's declaration.
- In my opinion, the third problem is that Entergy's assessment of materials and the environment provided in Entergy's Initial Statement does not seem accurate. For instance Entergy's statements ignored the facts that all metals corrode, that Pilgrim's specific environment is conducive to corrosion, and that no recent hydrological and geological studies have been performed.
- Fourth and quite simply, there is no new hard data to review, as it seems that Entergy Pilgrim Station has only conducted cursory reviews of old studies via walkabouts on the property.

"Identification of the inspection locations in the system or component based on the aging effect; determination of examination technique; evaluation of the need for follow- up examinations if aging related degradation is found." The problem with this portion of the Entergy Nuclear Pilgrim Station plan is that there is no requirement concerning the number of sample inspections or the location of said sample inspections.

In the statement "An evaluation of the need for follow-up examination", no mention is made regarding who will evaluate the need for follow-up examinations, and no statement as to the NRC's role is articulated. Furthermore, and more critical, is that there are no criteria whatsoever with which to determine when there must be "follow-up examination(s)."

In NUREG-1801, the BPTIP states: "The inspection includes a representative sample of the system population, *where practical,* focuses on the bounding or lead components most susceptible to aging due to time in service, severity of operating conditions, and lowest design margin." In my opinion, the obvious flaw here is the word, "Where practical." Such loose terminology does not meet any engineering standards and allows licensee convenience and profit margins to be the driving force for inspection rather than "public health and safety" as required by federal statute.

Lastly, in the BPTIP it is stated: "The one-time inspection, *or any other action or program*, created to verify the effectiveness of the AMP and confirm the absence of an aging effect, is to be reviewed by the staff on a plant-specific basis." In my opinion the inference presupposes that only on a plant specific basis will a "*one time inspection, or any other action or* *program"*... occur depending upon the effectiveness of the AMP as determined and reviewed by the Pilgrim Station staff. Once again, this is not a commitment to an inspection with formal criteria and trigger points by which to deepen an inspection should specific triggers be uncovered, instead this loose wording simply suggests that the inspection may not occur if Pilgrim Station staff determine such an inspection is not warranted.

Part (3) of the BPTIP says that, "Prior to entering the period of extended operation, the applicant is to verify that there is at least one opportunistic or focused inspection performed during the past ten years." The issue that I see is that any inspections prior to license renewal have all the weaknesses described above. Entergy has not stated when these inspection might occur or if they may have already occurred. Of additional concern is the fact that if Entergy plans to count inspections that occurred early in 2000 as part of this process, and is allowed to do so, than conceivably at least 19 years might lapse between inspections. The critical nature of these pipes requires more than one inspection over the entire period of license renewal.

NUREG-1801, Rev 1, XI M-107, September 2005 states that, " ...the applicant should schedule the inspection no earlier than 10 years prior to the period of extended operation...as a plant will have accumulated at least 30 years of use before inspections under this program begin, sufficient times will have elapsed for aging effects, if any, to be manifest." Again the wording here is problematic in that there does not appear to be any requirement that the specific component areas sampled be at least 30-years-old.

To summarize my key points: There is not a requirement for a through baseline inspection prior to license renewal so that the NRC and Entergy know the condition of each component in order to make a rational Aging Management Plan for the renewal period. The required inspections are too infrequent. I explained that corrosion is not gradual, and that as components age they wear out at a greater frequency as predicted by the Bathtub Curve. Therefore they need to be inspected more frequently as time goes forward. Entergy's AMP has no specificity in the program delineating what must be inspected. Engineering experience shows that certain areas of piping are more susceptible than others to corrosion, like welds, elbows, and dead spots. Lastly, there are no clear requirements for reporting, repair or replacement of degraded piping.

Q19. In addition to the BPTIP the Applicant has claimed in its Initial Statement that other more routine programs are effective in preventing corrosion, like the Water Chemistry & the Service Water Integrity Program. Since these two programs address internal corrosion, in your professional opinion, do you believe that these two programs provide adequate assurance in combination with the other programs the Applicant has outlined?

A. No, the water chemistry program is a mitigation program and does not provide detection for aging effects. More frequent complete inspections as part of the overall program are the only effective assurance that defects created by aging components will be uncovered. Tritium leaks at reactors across the country belie the effectiveness of water chemistry alone to prevent leaks.

In its Prefiled Testimony (Testimony at A93), Entergy stated that the Water Chemistry Program was effective because,

> "This is an existing program at PNPS that has been confirmed effective at managing the effects of aging on the CSS as documented by the operating experience review. See PNPS LRA at Appendix B, Section B.1.32.2, p. B-106-07. The continuous confirmation of water quality and timely corrective actions taken to address water quality issues ensure that the program is effective in managing corrosion for applicable components."

In my opinion, Entergy's statement alludes to problems within the water chemistry program, and identifies that it has had problems and has improved the program. However, Entergy never discusses the potential damage caused while operating under the older methodology, nor what remediation steps have been taken regarding any damage that occurred. Furthermore, Entergy provides no factual evidence to validate its verbal assurance that the new program is effective.

The Service Water Integrity Program addresses internal corrosion. In the Applicant's Testimony, A96, in Entergy's Initial Statement, they describe the program as,

> "(SPW) Under the program, the components of the SSW system are routinely inspected for internal loss of material and other aging effects that can degrade the SSW system. The inspection program includes provisions for visual inspections, eddy current testing of heat exchanger tubes, ultrasonic testing, radiography, and heat transfer capability testing of the heat exchangers. The periodic inspections include direct visual inspections and video inspections accomplished by inserting a camera-equipped robotic device into the SSW system piping. In addition, chemical treatment using biocides and chlorine and periodic cleaning and flushing of infrequently used loops are methods used under this program."

At, A97, Entergy's expert says that the program is effective because

> "This program has been effective in detecting degradation of the

internal rubber lining in the original SSW system carbon steel piping. As a result, the inlet pipes were replaced with titanium pipe, and portions of the discharge pipes were replaced with carbon steel piping coated internally and externally with an epoxy coating, and the entire lengths of the discharge pipes were internally lined with cured-in-place pipe linings. Thus, this program has been successfully implemented at PNPS to manage SSW system degradation from loss of material due to internal corrosion prior to the loss of its intended function. See PNPS LRA at Appendix B, Section B.1.28, p. B-92-93."

As I see it, the problem is that the program's effectiveness is ascribed to the fact that there was serious corrosion, which was not identified until after 23 years of operations, and it was identified only as a result of prodding from NRC, Generic Letter 89-13. This leads me to wonder how long there were significant corrosion problems and how long the licensee would have waited if it were not for the generic letter.

According to Entergy, Pilgrim replaced (2) 40' sections of SSW Discharge piping out of 240' in one loop and 225' in the other loop 1999. Once again there is insufficient data to make a valid assessment. The problem here is that there is no indication of the condition of the remainder of these loops.

In 2001, Entergy states that a new liner was placed in loop B and in 2003 a new liner was placed in Loop A. It strikes me as remarkably convenient that the life expectancy of the liners is given as 35-years, yet there is no factual data with which to corroborate that statement.

Last at A98 in Entergy's Initial Statement, it is noted that,

"the Service Water Integrity Program will be used to monitor the

> newly installed liner (CIPP). As the CIPP approaches the end of its expected life, increased inspections will be undertaken of the CIPP. The in-service inspection program for the SSW currently requires PNPS to undertake a complete ultrasonic or visual examination of the CIPP, analogous to those undertaken for the original rubber lining, after the CIPP has been in service for 20 years, well before the end of its expected 35 year life."

Once again, there is no timeline delineating the "increased inspections" or enumerating how many inspection will occur. Just as importantly, no definition of "complete ultrasonic or visual inspection" is provided nor is it clear whether this would be a stem to stem inspection or only a partial inspection.

Q20. In its Initial Statement Entergy describes additional surveillance programs for the CSS and SSW. In your professional opinion do these additional programs provide the assurance required?

A. First in regard to the additional programs for the CSS, the simple answer is "No." The CST program consists of level indictors in the Condensate Tank and quarterly testing of the water flow from the RCIC pump and the HPIC pump.

Entergy responded to the Board's questions on February 11 and stated in regard to the 4-hour testing of the CST water level that,

> "Under normal operation, the level of the CSTs is dynamic (i.e. the CST levels fluctuate as they provide makeup or receive condensate discharge to maintain appropriate condenser water level). Therefore, under normal operation, there is no specific leakage rate that would be detected by or could be readily correlated with the four-hour test results."

In my opinion, Entergy's response clearly indicates that the monitors cannot predict the level of corrosion in the pipes and whether or not the pipes are leaking.

In response to the same question, the NRC Staff said at 5,

> "there is no CS system leak rate that would challenge HPCI/RCIC performance for purposes of § 54.4(a)(1), and only a very large leak would compromise the performance for purposes of § 54.4(a)(3). And if there were a large drop in water in the CST, it would be noticed and corrective action taken.

While the NRC staff assessment may be interesting and informative, in my opinion, it does not address the core question, which is: whether or not leaks will be identified and will be repaired in order to protect public health and safety.

<u>The second part of the question addresses the surveillance programs for the SSW, and again the simple answer is "No." they do not provide assurance, either.</u>

Entergy Testimony at 17, A30 states that,

> "By the time the cooling water is in the buried discharge piping, it has completed its intended safety function of providing cooling water for the RBCCW. Therefore, if a leak develops in the discharge piping, it will not affect the intended safety function. There is no correlation between any potential leak in the buried discharge piping and any potential plugs in them that might prevent them from discharging water from the SSW. The SSW system is designed so that no active component failure nor any single passive component failure, or any other system, can prevent it from achieving its safety objective. There are two loops of

> discharge piping, so if one were inoperable, the second loop could be used to return the cooling water back to the bay. Each loop can transfer the full heat capacity required for its intended safety objective.

The NRC Staff Exhibit 17 says that,

> "... the system would retain the ability to remove heat from the RBCCW. The Staff does not believe that there is any credible mechanism for the discharge piping to become plugged. The discharge piping is constructed using carbon steel which is ductile and would deform before it would rupture. In addition, the pressure from the water inside the pipe would keep it from collapsing. But, even if it did become plugged, the second loop is still available to return the water to the bay"

Waiting for a leak to grow so big as to effect the intended function of the system would be unthinkable in an above ground portion of the same system. Single failure criteria do not apply when a system is known to be leaking significantly, in which case it should be considered inoperable already. Therefore, in my opinion, a second single failure should be postulated given that Entergy's Pilgrim Station plans to wait an excessive amount of time to repair any leaks.

In my opinion, the central question of identifying leaks, that is leaks of any size, is not addressed so that the responses and questions, although of general interest, do not answer the question at hand, which is the sufficiency of the AMPs to assure leaks will be detected and promptly repaired in order to comply with regulation and thereby protect the public health and safety.

Q21. On November 19, 2007, Entergy announced its initiation of a new program entitled: the *Buried Piping and Tanks Inspection Program and Monitoring Program*, Entergy's Prefiled Testimony, labeled as Exhibit 5. Please describe the program and evaluate its effectiveness.

A. The Program indicates that Entergy agrees with the Petitioners that the programs and procedures are currently in place that would determine whether or not the buried pipes containing radioactive fluids are leaking in such a manner as to be unable to satisfy their respective safety functions.

Section by Section Analysis [extracted from Gundersen Declaration at 12 minus Tables]

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."

Steps required in building a risk assessment tool are discussed in Section 5.0, subsection [2] on page 7. However the program fails in that it does not require a complete baseline review. There is no indication that the entire component is supposed to be examined; instead escape hatches 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." Any program worth its salt would require a thorough baseline inspection along the entire length of the pipe.

2. **Section 5.2, Scope Program** subsection [3] at page 8 acknowledges the validity of Pilgrim Watch's initial contention that, "The program shall include buried or partially buried piping and tanks that, if degraded, could provide a path for radioactive contamination of groundwater. Some examples are: Buried piping containing contaminated liquids." Entergy agrees that "radioactive contamination of groundwater" is an important issue and belongs in the Buried Piping and Tanks Inspection and Monitoring Program.

3. **Section 5.4 Identification of Buried Piping and Tanks to be Inspected and Prioritized**, page 9, Subsection [1] directs the licensee to develop a list of all systems containing buried piping and tanks and to identify those sections, collecting physical drawings, piping/tank installation specifications, piping design tables and other data needed to support inspection activities. Pilgrim Watch knows that 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; whether the component has substandard parts; the age of the components parts; cathodic protection; last inspection date and report number; and manufacturers warranty, if any. This information is the type of information that is needed when the NRC Staff conducts their safety evaluation so that the SER Report will be meaningful; unfortunately it was not available. The license application decision should be delayed until the information is available and critically reviewed.

Subsection [4] categorizes the piping into high, medium and low impact. High impact components require prompt attention. We agree that they should require prompt attention however Entergy's definition of "prompt" allows considerable delay –high impact buried sections shall be examined within 9 months of issuance of the procedure; and no date is given when the procedure shall be initiated. The impact assessment lists radioactive contamination as "High Risk" once again confirming the validity of Pilgrim Watch's initial contention that radioactive contamination belongs in this adjudication process...

4. Section 5.5, ..."Inspection Intervals vs. Inspection Priority" reflects the outcome from an assessment of the risks from buried piping and tanks.

For example:

(a) 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. The time interval is too long.

(b) It does not tell how much of the component will be inspected.

(c) There is no requirement to shorten a subsequent inspection based upon the degree of corrosion discovered at the time of the prior inspection.

(d) 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 in Table 4. For example, if a section of buried piping categorized as having "Low" inspection priority is excavated for other reasons, this excavation procedure should direct/require workers to take advantage of the opportunity and perform inspections- corrosion is neither linear nor constant across the component's length.

(e) In subsection [5], the determination of inspection locations may also consider the "ease of access to inspection point." However we know that ease of location and lack of corrosion do not necessarily go together. In fact the odds are that a component that is difficult to access has never been inspected – all the more reason to inspect it.

5. **Section 5.6, Parameters to be Inspected**, page 13, lists: external coatings and wrapping condition; pipe wall thickness degradation; tank plate thickness degradation; and cathodic protection system performance, if applicable. The attributes that must be considered in tabulating risk are too narrow. They include: (a) soil resistivity measurement; (b) drainage risk weight; (c) material risk weight; (d) cathodic protection/coating risk weight.

The list should be expanded to include, for example, the age of the component's parts; the number of high risk corrosion areas in component such as welds, dead spots etc; counterfeit or substandard part not replaced. The list is silent on internal corrosion and we know that corrosion from the inside can bring about a failure. The section is silent on the size of the sample required; its location; and the rational for the sampling protocol – if, in fact, a sample is taken and not an inspection of the entire component.

6. **Section 5.7,** on page 13, provides vague remarks about **acceptance criteria** for any degradation of external coating, wrapping and pipe wall or tank plate thickness. It says that they should be based on current plant procedures; and if not covered by plant procedures then new procedures need to be developed before the inspections. The pass/fail grade should be clearly defined. For example what precisely constitutes an "unacceptable" from an "acceptable" degraded external wrapping?

The LLTF was very specific that "significant" and other such descriptions need definition.

7. Section 5.8, Corrective Actions, page 14, says that "a condition report (CR) shall be written if acceptance criteria are not met. Pilgrim Watch knows that any and all inspections should generate a written 'condition report' regardless of what is or is not found to maintain a permanent paper trail of all inspections.

> The 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].

This provides no assurance to public safety for the following reasons:

a. The corrective actions *may* include engineering valuations, scheduled inspections, and change of coating or replacement of corrosion susceptible components; and they just "may not." There are no guarantees.

b. The licensee's own engineering department will deal with it; but there is no clear definition of how they will deal with it. 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 sees the 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? 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.

8. 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."

A review of steps (a) through (f) reveal a lack of objective, or even subjective, acceptance criteria that could trigger a condition report:

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

b. "Look for signs of damaged coatings or wrapping defects"-as long as workers look 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." The combination of "may" and "when appropriate" means the acceptance criterion is met when examinations are performed or not.

d. "Use holiday tester to check excavated areas of piping for coating defects." When coating defects are found for exposed area of piping using a holiday tester, the acceptance criteria is met and no condition report is written.

e. If visual inspection reveals coatings or wrappings not to be intact, further inspection of piping for signs of pitting, MIC, etc is required. If the additional inspection is performed, the acceptance criterion is satisfied and no condition report is warranted whether damage is found or not.

f. Inspect below grade concrete for indication of cracking and loss of material. As long as the inspection is performed, the acceptance criterion is satisfied whether damage is found or not.

9. Section 5.12 subsection [2] on page 16 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 is identified.

10. Section 5.9 Preventive Measures, at 14, "...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.

Q22. Entergy contends that the standard of reasonable assurance provided is based upon conformance to: NRC Guidance; the GALL Report; industry practices; PNPS operating experience; and the SER review, in your professional opinion do you agree with Entergy's assessment?

A. No, I do not agree at all.

In my opinion, the GALL Report simply represents general guidance and is not a mandate. The NRC has repeatedly stated that plant specific data such as operating experience must be considered. Furthermore, the GALL Report is changed periodically informing us that it is neither plant specific nor a regulatory mandate.

Conformance to NRC Guidance again is not convincing because guidance is simply "guidance not mandate" and like the GALL, NRC Guidance continues to evolve as industry-wide lessons are learned. In my opinion, the proliferation of leaks from buried pipes and tanks at nuclear power plants around the country is a good example of exactly why public health and safety standards are not met by nuclear power plants by simply referring these firms to either NRC Guidance or industry practices.

As I have previously stated, a thorough baseline inspection has not been performed or required, so there is no baseline data by which to judge Pilgrim's past operating experience. Also, there is no industry-wide experience with which to compare corrosion and leakage in buried components at 40 to 60-year-old reactors. More regrettably the NRC did not perform a thorough "autopsy" of the parts from reactors which have been closed and dismantled, like Yankee Atomic and Maine Yankee. Such an analysis and study of the impact of aging on various materials and components would have enabled the entire industry to make predictions based upon sound data. Finally, there is no operating experience for the AMP and the UT examinations are completely untested.

The SER review was recently evaluated by the NRC Office of Inspector General. Since the NRC OIG found serious flaws with the review process, in my opinion, the SER review should not be applied to Pilgrim until the process has been corrected and once again reviewed by the NRC OIG.

Finally I believe, Entergy's own corporate program, the ***Buried Piping and Tanks***

Inspection Program and Monitoring Program (Entergy's Prefiled Testimony, Exhibit 5), which was introduced quite late during the discovery process on November 19, 2007, should be specifically applied to the Pilgrim site prior to anyone drawing any conclusion based upon the adequacy of Pilgrim's proposed solutions to inspecting underground systems. Absent specific implementing procedures to Entergy's elective corporate guidance, the ASLB and the Petitioners are forced to guess, rather than have the requisite 95% assurance in the adequacy of Pilgrim's program.

Q23. From your professional experience, please describe what the aging management program for buried pipes and tanks at Pilgrim Station must look like in order for the public and ASLB to have confidence that public health and safety will be protected during the license extension.

A. Yes, let me answer with Section 18 from my Declaration Supporting Pilgrim Watch's Contention 1, January 26, 2008. At the end of this discussion, I will also add some additional points.

> "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:

1. Establish critical Baseline Data;
2. Reduce the future corrosion rate;
3. Improve monitoring frequency and coverage.
4. 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. Therefore in my opinion, and given Pilgrim's proximity to the environmentally sensitive Bay and salt marshes, a rigorous and

> expanded Monitoring Well program should be ordered and immediately undertaken at and around the Pilgrim Nuclear Power Plant Site."

In closing, let me reiterate that in my opinion until Entergy Nuclear Pilgrim Station implements Entergy's corporate guidance concerning inspection of underground pipes and tanks, provides those implementing procedures to the Petitioners for complete review and assessment, and begins implementation of concrete procedures, these proceedings should be halted, and the license extension should not be granted.

CURRICULUM VITAE
ARNOLD GUNDERSEN

CURRICULUM VITAE

Arnold Gundersen
June 2007

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

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
Authorship solicited by DOE

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.

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.

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

<u>Critical Facility Reactor Operator, Instructor</u>

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

<u>Assistant Engineer</u>

Performed shielding design of radwaste and auxiliary buildings for Newbold Island Units 1 & 2, including development of computer codes.

<u>Vetted as expert witness in nuclear litigations, federal, international, and state hearings including but not limited to:</u> 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.

<u>Public Service, Cultural, and Community Activities</u>

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.

Fairewinds Associates, Inc
Arnold Gundersen

March 5, 2008

To: Mary Lampert, Pilgrim Watch

Please find attached my Declaration in Q&A format in the matter:

> Entergy Corporation Pilgrim Nuclear Power Station License Renewal Application, Docket # 50-293 before the Atomic Safety And Licensing Board of the United States Of America Nuclear Regulatory Commission.

My testimony is in support of Pilgrim Watch's Contention #1.

Sincerely, 3/5/08

Arnold Gundersen

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of — Docket # 50-293-LR

Entergy Corporation

Pilgrim Nuclear Power Station

License Renewal Application — March 6, 2008

CERTIFICATE OF SERVICE

I hereby certify that the following was served March 6, 2008 by electronic mail and by U.S. Mail, First Class to the Service List: Pilgrim Watch's Rebuttal Directed to Entergy's Initial Statement of Position On Pilgrim Watch Contention 1, January 8, 2008 and NRC Staff Initial Statement of Position, Contention 1, January 29, 2008; The Testimony of Arnold Gundersen Supporting Pilgrim Watch's Contention 1, March 6, 2008; Arnold Gundersen's CV and Cover Letter.

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