CITIZEN POWER

Public Policy Research Education and Advocacy

August 27,2009

Edwin M. Hackett
Executive Director
Advisory Committee on Reactor Safeguards
United States Nuclear Regulatory'Commission
Washington, DC 20555-0111

Dear Mr. Hackett:

Thank you for following up on our July 7, 2009 letter regarding concerns with the containment liners at Beaver Valley Power Station, Units 1 and 2. Citizen Power has been following the situation closely and would like to expand upon the reasons we believe that the proposed inspection techniques are insufficient given the discovery of corrosion that went through-wall at Beaver Valley 1 and the fact that half of the three-loop sub-atmospheric plants have experienced significant liner degradation. We respectfully request that this letter be make available to the Advisory Committee on Reactor Safeguards ("ACRS) Committee Members prior to the next meeting in September.

On April 23, 2009, FirstEnergy Nuclear Operating Company ("FENOC) notified the Nuclear Regulatory Commission ("IVRC) concerning the detection of a through-wall hole, approximately 1" by 3/8", during the performance of the ASME XI, Subsection IWE interior visual examination. This discovery followed the detection of three locations of corrosion during a steam generator replacement in 2006. FENOC responded to a request by license renewal staff to explain how it will incorporate the plant-specific operating experience into its ASME Section XI, Subsection IWE aging management program by letter dated June 1, 2009 (ADAMS Accession No. ML091540012). FENOC outlined two new actions that it will take before entering the period of extended operation. In the letter, FENOC committed to perform ultrasonic testing of the repaired hole during the next refueling outage for Unit 1. In addition, FENOC obligated itself to perform supplemental volumetric examinations of seventy-five (one square foot) sample locations of the containment liners of both Unit 1 and Unit 2 prior to the period of extended operation. According to the letter, this testing will provide a 95% confidence that 95% of the liner is not degraded (using the methodology in chapter 4 of EPRI TR-107514) if no degradation is found.

The contents of the June 1st letter were clarified in a July 24th conference call between FENOC and the NRC (ADAMS Accession No. ML092180557). In that discussion, the NRC stressed the fact that the sampling procedure must be random. FENOC responded with the letter Supplemental Information for the Review of License Renewal Application and License Renewal Application Amendment No. 39 on July 28th (ADAMS Accession No. ML092110117), which clarified that the supplemental volumetric examinations would be composed of 75 random samples and 8 non-random samples. A follow-up conference call between FENOC and the NRC on July 30th (ADAMS Accession No. ML092180605) further explained how the samples would be chosen,.

Citizen Power still has questions regarding the ability of the FENOC inspection program to identify corrosion of the containment liner that originates from the outside. The updated inspection program primarily consists of visual inspections, integrated leak rate tests ("IRLT"), supplemental volumetric examinations of 75 random locations per plant, and supplemental volumetric examinations of 8 non-random locations per plant. This inspection regime fails to adequately protect public health and safety for the following reasons:

1. The visual inspections are unlikely to detect significant amounts of corrosion originating from the outside of the containment liner until the corrosion goes through-wall. In addition, the scheduling of the IWE visual inspection (three times over a ten year period) does not guarantee that the hole will be small when discovered. Specifically, once the corrosion goes through-wall, the corrosion location may then have access to additional moisture and oxygen, which could speed up the progress of the corrosion. Furthermore, the shape of the initial corrosion pocket may be important. If a broad area of the liner is corroded, then a greater amount of corrosion can possibly occur before going through-wall, resulting in a larger extent of thinning liner surrounding the through-wall location.

2. The IRLT also suffers from not being designed to detect corrosion until it goes through-wall. In addition, the containment concrete inhibits airflow, making the IRLT highly inaccurate for measuring the leak-tightness of the steel liner without compensating for the concrete. Any analysis of whether the liner satisfies the 10 CFR 100 requirements may similarly be inaccurate if it is based solely on an IRLT. It was, in our opinion, unclear whether extrapolating the North Anna localized pressure tests to determine the estimated leakage at Beaver Valley 1 was appropriate. It should also be noted that the 2006 IRLT did not detect the hole discovered on April 23,2009.

3. The methodology of the random sample supplemental volumetric examination (based on chapter 4 of EPRI TR-107514) is not applicable to BV1. The purpose of that report was to develop age related degradation inspection requirements for five piping systems at the Calvert Cliffs Nuclear Power Plant ("CCNPP). FENOC inappropriately lifted the sampling mechanism of that report without applying the surrounding framework. Specifically, the program methodology requires that plausible age related degradation mechanisms ("ARDM) be determined and sorted according to whether they were "probable (expected to occur), possible (not expected to occur) or impossible (cannot occur)".' Probable ARDMs with significant impacts on the safety function require a formal response resolution. Only when the mechanism is not expected to occur, would the chapter 4 sampling mechanism apply.[2] This mirrors the language in chapter 4 stating that "one key feature of this [sampling] approach is the assumption that none of the inspected items will contain significant levels of a degradation mechanism (X=0)" and "...the underlying assumption used throughout this report is that the degradation mechanism in question does not exist for the systemlcomponent being investigated..."[3] In short, in order to use this statistical method, the null hypothesis is assumed to be that there is no degradation of the containment liner. When degradation of the containment liner has already been discovered, as in the current case, we believe that an alternative statistical model must be used that is based on a null hypothesis that there is already degradation.

   In the case of BV1, two separate events of significant degradation have occurred, with two different mechanisms explaining them (in one case a piece of wood and the other case water and oxygen accumulation during the construction of the concrete shell.)[4] According to evidence presented by the NRC staff during the Transcript of the 564th ACRS Meeting on July 8, 2009 (ADAMS Accession No. ML092290693), two other sub-atmospheric plants have experienced significant liner corrosion originating from the outside.[5] Both North Anna 2 and Surry 2 have had a two by four piece of wood found between the liner and the concrete causing corrosion. Since half of the three-loop sub-atmospheric plants have experienced significant liner degradation due to foreign materials located in the concrete, it is reasonable to state that this is a probable ARDM for these types of plants. This is especially true given that only 2 out of 97 plants that have not utilized a three-loop

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[1] EPRI TR-107514, Pg. 2-1.
[2] See EPRI TR-107514, Figure 2-1 on Pg. 2-4.
[3] EPRI TR-107514, Pg. 4-3.
[4] June 2009 SER, Pgs. 3-106 to 3-108.
[5] Transcript of 564th ACRS Meeting on July 8,2009 and Related Document, Pgs. 72-73, 81.

sub-atmospheric design have experienced similar problems. Therefore, the use of the chapter 4 sampling program is inappropriate for this ARDW.

In addition, if FENOC wishes to rely on the guidance of TR-107514, other plausible ARDMs should be identified and categorized as probable, possible or impossible. If any of these ARDMs are possible, a sampling framework should be set up for each individual ARDM identifying areas that are more likely to have corrosion. Samples would then be taken to meet the 95/95 standard for each of the possible ARDMs.

4. Citizen Power does not believe the proposed sampling regime is appropriate. However, if the EPRI TR-107514 sampling method is used as proposed by FENOC, it will not provide a 95% confidence that 95% of the liner is not degraded. One reason is that not all of the liner is accessible. If the corrosion mechanism results in the distribution of corrosion not occurring randomly across the liner, then a sample of only the accessible areas of the liner may result in an understatement or overstatement of an attribute. The key factor in predicting whether the corrosion would be random across the liner is an understanding of the differing potential mechanisms of corrosion. If any locations are more likely to have corrosion based on any possible ARDM, then these areas (at least the accessible ones) should be sampled independently using a method designed to meet the 95/95 standard. This is exactly what is proposed in EPRI TR-107514.[6]

   In addition, the timing of the samples, according to Amendment No. 39 to the BVPS License Renewal Application, can take place over a period of years. It is clear that the 95/95 standard will not be reached until the last sample is investigated because the required sample size will not be met until then. For BV 1, this can be as late as January 26, 2016 and for BV 2 it can be as late as May 27, 2027. This also parallels another problem with the proposed sampling. If the sampling is not accomplished within as short of a time frame as possible, the results may be skewed. For example, a sample that has just less than 10% corrosion depth when being sampled in the first year may have greater than 10% corrosion depth at the time of the last sample, years later. This phenomenon should be adjusted for by conservatively estimating (in this case the fastest probable corrosion rate) future increases in corrosion depth for these locations from the time they are sampled to the time that the sampling is completed.

5. The 8 non-random sample locations should be selected based upon possible corrosion mechanisms, as described in EPRI TR-107514. Some mechanisms, such as foreign matter, will most likely not exhibit any spatial bias. However, some possible mechanisms may result in corrosion in some locations more often then others. These potential mechanisms should be identified and more-likely corrosion locations based on these mechanisms should be the sample from which the non-random locations are chosen.

6. In Citizen Power's opinion, at this point in time, FENOC cannot know the actual condition of the liner because the visual IWE inspections and the IRLT are ill-suited to detect corrosion originating from outside the liner. Therefore, it is impossible to know whether the design limits for the containment liner are being exceeded without a proper investigation of the liner for corrosion. Given that there is a possibility that the containment liner currently would not perform its intended function in the event of an accident, Citizen Power believes

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[6] EPRI TR-107514, Pg. 2-3, "Possible mechanism / component pairs will be evaluated to determine potential locations where the degradation is expected to occur, if at all. It is possible that there may be more than mechanism/component pair per component. These locations were further divided into 'more likely' and 'less likely' groupings. The 'more likely' locations were used to determine a population size." It should be noted, if you assume EPRI TR-107514 sampling is appropriate in the first place, that for a possible mechanism based on foreign objects the proper population to sample from would be the entire liner because there are no "more likely" locations.

that the only way to provide assurance that corrosion of the liner is not a safety issue is to immediately conduct an adequate UT examination of the containment liner.

7. Finally, in the July 24th conference call, FENOC suggested the following wording for their clarification letter to their RAI response letter L-09-139, "These random inspections will commence in the 2010 refueling outage at unit #1 and the 2011 refueling outage at unit #2. The additional informed sampling of Unit 1 will commence on-line, within the bounds of the current fuel cycle. All inspections will [sic] completed by December 31, 2012." However, in the Amendment No. 39 to the BVPS License Renewal Application, the updated LRA sections indicate that random examinations of Unit 1 are to be completed by January 2016, the random examinations of Unit 2 are to be completed by May 2027, and the implementation schedule for non-random examination of Unit 2 is "May 27, 2027". Citizen Power believes that inspection schedules that stretch out this long imperil public safety because there is no guarantee that corrosion of the liner will be detected before breach of the containment occurs.

In conclusion, our opinion is that the current inspection plans, as outlined in the LRA, are inadequate to protect the public safety. We strongly recommend that Advisory Committee on Reactor Safeguards find that UT testing should commence immediately and that either 100% of Unit 1's containment liner be tested or that FENOC modify the testing methodology to reflect the prior existence of corrosion. If you have any questions, please contact me at robinson@citizenpower.com.

Sincerely,

Theodore S. Robinson, Esquire
Staff Attorney
Citizen Power
2121 Murray Avenue
Pittsburgh, PA 15217

cc: Alan L. Hiser

Enclosure

DOCKET NOS. 50-334 and 50-412
CITIZEN POWER
EXHIBIT ONE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the *matter* of		
FirstEnergy Nuclear Operating Co.	)	May 25,2009
Beaver Valley Power Station Unit 1	)	Docket No. 50-334 and 50-412
License Renewal for Beaver Valley Units 1 and 2	)	

DECLARATION OF ARNOLD GUNDERSEN
SUPPORTING CITIZEN POWER'S PETITION

I, Arnold Gundersen, declare as follows:

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

2. Citizen Power has retained me as an expert witness in the above captioned matter, and my declaration is intended to support the Petition of Citizen Power.

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

4. I began my career as a reactor operator and instructor in 1971 and progressed to the position of Senior Vice President for a nuclear licensee. A copy of my Curriculum Vitae is attached. (Exhibit 3)

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

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

7. I have more than 35-years of professional nuclear experience including and 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, Consumptive Water Loss, Nuclear Fuel Rack Design and Manufacturing, Nuclear Equipment Design and Manufacturing, Prudency Defense, Employee Awareness Programs, Public Relations, Contract Administration, Technical Patents, Archival Storage and Document Control, Source Term Reconstruction, Dose Assessment, Quality Assurance and Records, Configuration Management, Whistleblower Protection, and NRC Regulations and Enforcement.

8. My declaration is intended to support the Petition by Citizen Power and is specific to issues regarding FirstEnergy Nuclear Operating Company's application to extend Beaver Valley Unit 1 Power Station's operating license for an additional 20 years.

9. Beaver Valley Unit 1 is a Westinghouse three loop Nuclear Steam Supply System with a Stone & Webster designed "sub-atmospheric containment." It received its operating license to generate electricity on July 2, 1976.[1]

10. According to NUREG/CR 5640, the ***Nuclear Power Plant System Sourcebook***:

> "Sub-atmospheric containments are only found at seven Westinghouse PWR plants, six 3-loop plants, and one 4-loop plant."

11. Stone & Webster Engineering Corporation designed all sub-atmospheric containment systems. The six three-loop sub-atmospheric units are Beaver Valley 1 and 2, North Anna 1 and 2, and Surry 1 and 2. Stone & Webster's last sub-atmospheric containment is at Millstone Unit 3, a Westinghouse four-loop unit.

12. As a former Northeast Utilities employee who worked on the Millstone Unit 3 engineering, design, and construction, I have personal knowledge of Stone &

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[1] http://www.nrc.gov/info-finder/reactor/bv1.html

Webster's sub-atmospheric design. Moreover, in 2008, I provided written testimony to the NRC regarding Millstone Unit 3 sub-atmospheric containment. **(Exhibit 2)**

13. Furthermore, I briefed the NRC ACRS on the problems and contradictions associated with the NRC's analysis of sub-atmospheric containments.

14. As the lead licensing engineer for Northeast Utilities' Millstone Power Station Unit 3 during the 1970's, I was responsible for coordinating the analysis for the PSAR (Preliminary Safety Analysis Report), which formed the original design basis of the Millstone Power Station Unit 3 including its Containment. This interface was among Millstone's structural mechanical, electrical, construction, and operations personnel as well as the architect Stone & Webster and the NSSS vendor Westinghouse. Millstone Power Station Unit 3 was originally designed to be a "Sub-Atmospheric Containment." [In this instance my testimony is that of a fact witness[2] in addition to my overall testimony as an expert witness in my Millstone Unit 3 Declaration (Exhibit 2).]

15. In my 2008 expert witness report to the NRC ACRS, I identified generic issues with sub-atmospheric containments. The issues of critical concern to both the engineering and operations staff regarding the Sub-Atmospheric Containment were:

15.1. Members of the operations staff, who worked within the Containment, were repeatedly subjected to the adverse effects of high temperature and low oxygen.

15.2. The small size of the Containment Building.severely limited space for equipment and also complicated accident analysis.

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[2] According to the Department of Justice United States Attorneys' Manual Title 3, Chapter 3-19.111 An expert witness qualifies as an expert by knowledge, skill, experience, training or education, and may testify in the form of an opinion or otherwise. (See Federal Rules of Evidence, Rules 702 and 703). The testimony must cover more than a mere recitation of facts. It should involve opinions on hypothetical situations, diagnoses, analyses of facts, drawing of conclusions, etc., all which involve technical thought or effort independent of mere facts. And according to Chapter 3-19.112 Fact Witness A fact witness is a person whose testimony consists of the recitation of facts and/or events, as opposed to an expert witness, whose testimony consists of the presentation of an opinion, a diagnosis, etc
http://www.usdoj.gov/usao/eousa/foia_reading_room/usam/title3/19musa.htm#3-19.111

15.3. Significant construction problems relating to the placement of concrete and rebar were caused by the Containment's small size.

15.4. Minimal analytical data regarding the long-term strength of the building's concrete and its continual exposure to the combination of high temperatures, low pressure, and low specific humidity within its sub-atmospheric Containment as it has aged has led to doubts and questions regarding the strength of this critical safety-related structure in the event of a nuclear accident.

16. Following my ACRS testimony, the ACRS questioned a containment specialist staff member of NRC as to whether the NRC even has the capability to analyze a sub-atmospheric containment. According to the NRC containment specialist, the NRC cannot accurately analyze Containment systems.

The NRC staff member containment specialist said,

> "It's sort of difficult for us to do an independent analysis. It takes time. We're not really set up to do it. The other thing you have to realize, too, for containment, which isn't as true in the reactor systems area, is that **we don't have the capability.**" (Page 88, ACRS Transcript, July 9,2008, lines 6-11.) [Emphasis added]

17. From 1976 until 2002, Beaver Valley Unit 1 (BV1) was operated with a sub-atmospheric containment building. In my opinion, Stone & Webster's similar patents[3] provide two important considerations that apply directly to Beaver Valley's design. Those two considerations are that concrete is considered

[3] According to one of S&W's patents, "A Sub-atmospheric double containment system is a reinforced concrete double wall nuclear containment structure with each wall including an essentially impervious membrane or liner and porous concrete filling the annulus between the two walls. The interior of the structure is maintained at sub-atmospheric pressure, and the annulus between the two walls is maintained at a sub-atmospheric pressure intermediate between that of the interior and the surrounding atmospheric pressure, during normal operation. In the event of an accident within the containment structure the interior pressure may exceed atmospheric pressure, but leakage from the interior to the annulus between the double walls will not result in the pressure of the annulus exceeding atmospheric pressure so that there is no net outleakage from the containment structure. US Patent 4081323 Issued on March 28, 1978 to Stone & Webster Engineering Corp.

porous and all boundaries leak to some extent. On page 1 of the footnoted patent, Stone & Webster considers the concrete to be "***porous***", and on page 8 of the cited patent, Stone and Webster stated, "...***all*** boundaries leak to some extent...".

18. In a sub-atmospheric containment, the air pressure in the containment is approximately 4 psi[4] below the pressure outside the containment liner.

19. During the past four years the evidence I reviewed shows that several age related corrosion problems have impacted BV1's containment system.

20. According to Beaver Valley Senior Resident Inspector David Werkheiser[5], May 19, 2009, the first documented containment liner problem at BV1 was uncovered during the BV1 2006 steam generator replacement outage.

    20.1. Specifically, NRC Senior Resident Inspector Werkheiser said that when the containment liner was cut and removed to allow the steam generator replacement, Beaver Valley personnel noticed three locations or pockets on the "outside" of the cut portion of the liner where significant corrosion was present.

    20.2. According to Werkheiser, FirstEnergy's BV1 attributed these "pockets" to construction problems dating back to the early 1970's. Werkheiser also noted that in FirstEnergy's analysis, the "pockets" or voids appear to have been caused by improper vibration of the concrete as it was being poured.

    20.3. Furthermore, Werkheiser noted that FirstEnergy's analysis showed that over time these "pockets" had allowed moisture to accumulate and gradually corrode. the "outside" of the liner.

    20.4. Finally, Werkheiser confirmed that the three corrosion locations were analyzed and repaired prior to start-up in 2006 in accordance with:

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[4] pounds per square inch

[5] Telephone conversation between Beaver Valley Senior Site Resident Inspector David Werkheiser and Arnold Gundersen, expert witness nuclear engineer, May 19, 2009 12:33 pm.

- o Duquesne Light Company Calculation 8700-DSC-156W, 2/26/91;
- o Liner Minimum Wall Thickness S&W Calculation 11700-EA-41, 11/3/71;
- o Duquesne - Beaver Valley Unit 1 – Reactor Containment Liner Stress Analysis and repaired before the Unit started up in 2006.

21. In my opinion, the data I reviewed from the FirstEnergy BV1 SER and outage report indicates problems with the BV1 inspection techniques. For more than 30-years, BV1's visual, ultrasonic and integrated leak-rate inspection techniques were unable to detect these three voids and their associated corrosion until 2006, though the voids and corrosion clearly existed well before then.

22. When the steam generator was replaced in 2006, the 17' x 21' piece of liner which was removed represents, according to my calculations, approximately three percent of the total containment liner.

22.1. Given that the voids are randomly positioned, when I applied a ratio of the containment surface area to the piece removed, a basic statistical analysis showed that if three voids were found behind a 17'x 21' section, there may be as many as 99 (ninety-nine) more voids that are similarly impacted by corrosion, but remain hidden behind the residual containment liner.

22.2. By failing to reexamine the full liner in 2006 after detecting three corrosion sites, I believe that FirstEnergy and the NRC made analytical errors by not analyzing whether the sampling density is sufficient to make a reasonably valid conclusion. By not inspecting for more corrosion, in other words, not looking for evidence of the corrosion problem does not prove that corrosion does not exist and that the containment system is sound.

23. BV1 documented a second containment liner problem on April 23, 2009, when the 'company filed event report 45015 with the NRC. According to BVI event report 45015 ***Damaged Area In Containment Liner:***

"On April 21,2009 during the Beaver Valley Power Station Unit No.1

(BEAVER VALLEY PS-1) refueling outage, an ASME XI Section IWE General Visual examination was performed on the interior containment liner. A suspect area was identified at the 738 foot elevation level of containment. This area was approximately 3 inches in diameter and exhibited blistered paint and a protruding rust product. At approximately 1015 hours on April 23,2009 after cleaning the area and removal of the corrosion products, a rectangular area approximately 1 inch (horizontal) by 3/8 inch (vertical) was discovered that penetrated through the containment steel liner plate (nominal .375 inch thickness). The BEAVER VALLEY PS-1 containment design consists of an internal steel liner that is surrounded by reinforced concrete."

"With the plant currently shutdown and in Mode 6, the containment as specified in Technical Specification 3.6.1 is not required to be operable. The cause of this discrepancy is currently being evaluated.

"This is reportable pursuant to 10 CFR 50.72(b)(3)(ii)(A) as a condition of the principal safety barrier (i.e., containment) being seriously degraded."

23.1. In my opinion, it is important to note once again that all visual, ultrasonic and integrated leak-rate inspection techniques at BV1 ***failed*** to ***detect the incipient passive failure of a key safety structure before the full perforation of the steel liner.***

24. FirstEnergy claims that the "root cause" of both the BV1 2006 containment liner corrosion and the 2009 gross containment liner failure may be related to construction problems that occurred more than 33-years ago. However, the evidence I examined shows that this purported ***root cause*** analysis is simplistic for several reasons:

24.1. In the National Association of Corrosion Engineers (NACE) book[6] ***Corrosion Basics,*** Pierre R. Roberge defines the electrochemistry of corrosion as resulting "from the overwhelming tendency of metals to react electrochemically with oxygen, water, and other substances in the aqueous environment".

[6] ***Corrosion Basics: An Introduction,*** 2nd Edition, by Pierre R. Roberge, 2006 by NACE Press Book, 364 pages, 77 tables, 292 figures hardbound, ISBN: 1-57590-198-0

24.2. Therefore, in order for any corrosion to occur, there must be both moisture and oxygen present during which the corrosion reaction would occur. In my expert opinion, if this corrosion issue were solely due to construction problems that occurred more than 33-years ago, there would not have been enough oxygen to cause the identified corrosion. Thus, there must be a secondary source of oxygen.

24.3. Neither the construction voids between the liner and the concrete, which was the purported BV1 **2006** reason for containment corrosion, nor BV1's **2009** claim, that a block of wood left from construction, is the cause of this recent gross containment failure, because neither accounts for the significant oxygen and moisture buildup that must have occurred. I believe that both FirstEnergy and the NRC have failed to address the underlying issue, which is how did the accumulated moisture and oxygen infiltrate the containment system for such an extensive period of time as to perpetuate a serious corrosion reaction.

25. No root cause analysis to date has addressed moisture and oxygen buildup behind the liner, or why such a buildup occurred at only four very specific locations. The failure to conduct a root cause analysis implies that the four sites of corrosion identified during the past three years may be an anomaly. Rather, I believe that a root cause analysis must investigate in an in-depth fashion the possibility of systemic corrosion issues which may be even greater than 99 corrosion "pockets" on the "outside" of the containment liner rather than limited to these four recently discovered random sites.

26. As discussed above, BV1's sub-atmospheric containment design is unique. In my opinion, it is possible that the pressure differential between the outside moist air and the sub-atmospheric conditions within the containment could act as the driving force to draw moisture and oxygen through the porous concrete into construction voids and wood adjacent to the liner. Therefore, I believe this sub-atmospheric design may be the *root cause* of the oxygen and moisture buildup behind the liner. *A* thorough *root cause analysis* must consider what impact the sub-atmospheric containment had upon the accumulation of oxygen and moisture between the liner and the porous concrete.

27. In summation, I found the incomplete analytical evidence in the FirstEnergy BV1 and the NRC assessments of BV1's containment failures to be simplistic and believe such incomplete analysis puts an undue risk on public health and safety. In my opinion, an in-depth analysis of the corrosion problems that exists between the liner and the porous concrete may uncoversystemic failure mechanisms.

28. Moreover, I believe the breach of this containment liner with no prior warning following repeated and various types of containment inspections which occurred for more than 33-years has broad nuclear policy and safety ramifications, for BV1, Beaver Valley Unit 2 and the other sub-atmospheric containments nationwide.

29. The evidence I reviewed also shows significant problems, therefore, I believe that corrective actions are appropriate, including, but not limited to:

    29.1. The prompt 100% ultrasonic inspection of the entire liner at BV1 due to the fact that more than 33-years of visual inspection and fractional ultrasonic testing failed to detect the 2009 corrosion until the liner failed.

        29.1.1. In my opinion, the liner failure implies that visual and partial ultrasonic techniques are inappropriate for liner inspections under any conditions.

        29.1.2. In my assessment, the Beaver Valley liner degradation and/or failures of both 2006 and2009 indicate a gross breakdown in Quality Assurance (QA) procedures during the construction phase of BV1.

        29.1.3. Based upon my knowledge of the construction processes involved in pouring a sub-atmospheric containment, the QA process applied during the BV1 construction repeatedly missed opportunities for this piece of wood to have been discovered and removed.

        29.1.4. If the failure discovered in 2009 existed in 2006, an Integrated Leak rate Test'in 2006 failed to detect incipient failure implying that slow, controlled, pressurization of the containment in that test is inadequate to detect incipient

failure.

29.2. It is my position that the 20-year life extension of the Beaver Valley Units 1 and 2 should be put on hold until these significant programmatic Aging Management problems have been analyzed and resolved.

29.2.1. The visual, ultrasonic and integrated leak test inspection failures show programmatic weakness in the aging management systems upon which FirstEnergy has relied upon for its Beaver Valley Units' license extensions.

29.3. In my opinion, if the 100% UT inspection process discovers other construction voids, then the containment liner should be reanalyzed to determine the operability BV1 in order to ascertain any overall weakening of the liner.

29.3.1. An analysis of the Containment liner will ascertain its ability to withstand seismic stress and limit radiation releases, and the NRC has informed the ACRS of its inability to perform a containment analysis, I believe that an independent National Lab should perform this analysis.

29.4. Likewise, I believe that Beaver Valley Unit 2 (BV2) should also be inspected using 100% ultrasonic techniques, given that BV1 and BV2 have the same design, were built by the same contractor, have the same inspection program, and the same Aging Management Program.

30. Furthermore, it is my conclusion that these events at BV1 also have critical ramifications for the entire U.S. nuclear industry, but especially for PWRs.

30.1. In my opinion, the Containment Breach at BV1 in 2009 **was** the ***Passive Failure*** of one of the most important safety barriers in a nuclear power plant.

30.1.1. The nuclear industry has heretofore considered such containment liner failures virtually impossible.

30.1.2. NRC Risk Informed Decision Making does not take the likelihood of

Passive Failure of the Containment into consideration.

30.1.3. Given the generic nature and risk to public health and safety due to *containment breach*, I believe that the NRC should order 100% Ultrasonic Testing of all PWR containment liners.

31. In my opinion, FirstEnergy's inability to detect the most recent failure (2009) of the containment liner prior to perforation, as well as its inability to detect three other corrosion sites discovered in 2006, may indicate one of two possible failure scenarios.

31.1. If the 2006 and 2009 corrosion events grew slowly and began during construction, I believe this implies that during the 35-years since construction, neither the visual, ultrasonic, nor integrated leak rate testing have been adequate to detect incipient containment liner failure.

31.2. 'The second possibility is that visual, ultrasonic and integrated leak rate testing do indeed work, but that through wall liner failure can propagate much more quickly than anticipated between inspection intervals.

31.3. Both of these scenarios are equally troubling to me, as one indicates that ANY existing inspection regime has been inadequate, and the second indicates rapid failures are possible between inspections whose corrosion growth mechanisms have yet to be determined.

32. Given either scenario, it is my professional opinion that the NRC must modify the Beaver Valley SER and AMP to include a full ultrasonic inspection and root cause analysis prior to license extension.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed this day, May 25; 2009 at Burlington, Vermont.

Arnold Gundersen, MSNE

STATE OF VERMONT)
COUNTY OF CHITTENDEN) ss.

I HEREBY CERTIFY that on this 25th day of May 2009, personally appeared Arnold Gundersen resident of Burlington Vermont, who is personally known to me or who produced the following identification, and he swore, subscribed, and acknowledged before me that he executed the foregoing as his free act and deed as an expert witness of said case, for the uses and purposes therein mentioned, and that he did take an oath.

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

OFFICIAL NOTARY Lawrence E. Cole

NOTARY PUBLIC STATE OF VERMONT

MY COMMISSION EXPIRES: 2/2010