Citizens Exhibits 29

RAS 14342

U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of AmerGen Energy Co, LLC
Docket No. 50-0219-LR Official Exhibit No. Citizens Exh. 29
OFFERED by: Applicant/Licensee Intervenor
NRC Staff Other
IDENTIFIED on 9/24/07 Witness/Panel N/A
Action Taken: ADMITTED REJECTED WITHDRAWN
Reporter/Clerk DW

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

DOCKETED
USNRC

October 1, 2007 (10:45am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

In the Matter of:	
AmerGen Energy Company, LLC	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	

AFFIDAVIT OF BARRY GORDON

City of San Jose)
)
State of California)

Barry Gordon, being duly sworn, states as follows:

INTRODUCTION

1. This Affidavit is submitted to support AmerGen Energy Company, LLC's Motion for Summary Disposition on the contention filed by environmental and citizen groups ("Citizens") opposed to the renewal of the Oyster Creek Nuclear Generating Station ("OCNGS") operating license, and admitted by the Licensing Board on October 10, 2006. That contention challenges the frequency of AmerGen's UT measurements of the drywell shell in the sand bed region. In part of their contention, Citizens speculate that significant corrosion of the exterior of the OCNGS drywell shell in the sand bed region could occur through tiny defects (called "pinholes" or holidays") in

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the three-layer epoxy coating system: "corrosion may occur under the epoxy coating in the absence of visible deterioration due to non-visable holidays, or pinholes."

2. As I discuss below, it is my expert opinion that these allegations have no technical merit because: (a) significant corrosion is not possible with an epoxy-coated drywell shell; and (b) even if such a corrosion rate was possible, AmerGen's committed frequency of UT measurements is more than adequate to detect such corrosion (even under unrealistic assumptions), before the ASME Code-specified margins are exceeded. Accordingly, Citizens' argument is not only factually irrelevant but simply immaterial to the integrity of the drywell shell during the proposed period of extended operation.

EDUCATION AND EXPERIENCE

3. For the past 38 years, I have been an engineer focusing on corrosion and material issues in light-water reactors, with special emphasis on stress corrosion cracking (SCC). I have addressed numerous materials and corrosion issues in the nuclear industry in a wide range of contexts including reactor internals, piping, fuel hardware, water chemistry transient and core flow issues, weld overlays and repairs, crack growth rate modeling, alloy selection, failure analysis, license renewal, NRC inspection relief, dry fuel storage, and decontamination.

4. I received my B.S. and M.S. degrees in Metallurgy and Material Science from Carnegie Mellon University in 1969 and 1971, respectively. Since then, I have completed additional courses from M.I.T., the University of Pittsburgh and the National Association of Corrosion Engineers (NACE) in Corrosion Science.

5. I am a Registered Professional Engineer in Corrosion Engineering in the State of California (#208), a Registered Corrosion Specialist with NACE International (#1986) and a Member of the International Cooperative Group on Environmentally Assisted Cracking (ICG-EAC).
6. I was certified as an Instructor for the International Atomic Energy Agency (IAEA) on February 2001 and am an Adjunct Professor at the Colorado School of Mines, in Golden, Colorado where I currently supervise one Ph.D candidate. I teach the following course: "Corrosion and Corrosion Control in LWRs" for Structural Integrity Associates, Inc. and have taught "Corrosion and Corrosion Control in BWRs" for GE Nuclear Energy (GENE). I have held instructor credentials for Engineering in California Community Colleges since 1986.
7. From 1969 to 1975, I was employed as a materials engineer by Westinghouse Electric at the Bettis Atomic Power Laboratory, located in West Mifflin, Pennsylvania.
8. From 1975 to 1998, I was employed by GE Nuclear Energy, located in San José, California. While at GE Nuclear Energy, I was a technical expert in corrosion engineering, a project manager in corrosion technology, and a program manager in stress corrosion cracking.
9. Since 1998, I have been employed by Structural Integrity Associates, Inc., also located in San José, California, as an Associate.
10. I am familiar with the historical corrosion of the OCNGS drywell shell because I started working on that issue in 1986 as the OCNGS drywell project manager when I was employed by GENE.

11. More recently, I prepared an evaluation report on the corrosion of steel embedded in concrete on the exterior of the drywell (June 5, 2006) and on effects of water on corrosion propensities of concrete embedded steel identified in the interior of the drywell (November 3, 2006). I also testified before the Advisory Committee on Reactor Safeguards (ACRS) on both subjects on January 18, 2007.

OPINIONS OF BARRY GORDON

12. In his June 23, 2006, memorandum, Dr. Rudolf Hausler suggests that a future corrosion rate of 0.017" per year is possible for the external surface of the drywell shell in the sand bed region at OCNGS. He correctly asserts that this corrosion rate was observed by the former owner of the OCNGS in certain areas of the sand bed region prior to 1992 (after which the external surface of the drywell shell was protected from further corrosion by a sand bed removal and the installation of a multi-layer epoxy coating system). As I demonstrate below, however, this corrosion rate is not possible with an epoxy-coated drywell shell. Moreover, even if this or a significantly higher corrosion rate was possible, AmerGen's committed frequency of UT measurements is more than adequate to detect such corrosion before the ASME Code-specified margins are exceeded.

13. Part of the reason why the corrosion rate was historically as high as 0.017" per year in certain bays of the drywell shell sand bed region is because there was a medium (*i.e.*, sand) to physically hold water against the drywell shell. Specifically, the sand bed region got its name from the sand that was placed there as part of the original design. Once water entered this area, the sand physically held the water against the shell, ensuring a constant source of water to facilitate corrosion of the metal drywell shell.

This sand, however, was removed as part of the corrective actions completed in 1992 to prevent additional corrosion in the sand bed region. So there is no water-retaining media to facilitate future corrosion.

14. Of course, such a corrosion rate of 0.017" per year is unrealistic because the drywell shell is protected from further corrosion by a multi-layer epoxy coating system. AmerGen has demonstrated that corrosion of the external surface of the drywell shell has been arrested, and no additional corrosion is possible unless there is a defect in the coating and water is able to come into contact with the metal drywell shell through that defect. Accordingly, it is my opinion that no corrosion is possible beneath an intact epoxy coating system, such as the one applied on the exterior of the OCNGS. This is because corrosion of a kind significant enough to affect the integrity of the drywell shell requires the presence of water and oxygen, and there is no water or oxygen adjacent to the metal surface of the drywell shell to initiate, let alone sustain, the corrosion process.

15. Dr. Hausler, however, has speculated that there could be tiny defects in the coating, referred to as "pinholes" or "holidays." He essentially argues that water could get to the metal surface of the underlying drywell shell through these hypothetical, tiny defects. It is my opinion that even if there were such defects, they would not allow sufficient oxygenated water to reach the underlying drywell shell for corrosion to exceed ASME Code-specified margins before AmerGen would detect it through its committed inspections (*i.e.*, every four years). Accordingly, this argument is simply not relevant to the long-term integrity of the drywell shell. The support for my opinion is presented in the next paragraphs.

16. We know that the maximum measured historical corrosion rate was not 0.017" per year, but was more than twice that at 0.039" per year (in location Bay 13A).[1] So we know that with the presence of water, wetted sand holding that water adjacent to the uncoated shell, blocked drains preventing that water from being drained out of the sand bed region, and the temperature specific to the exterior of the drywell shell in the sand bed region during operations, that loss of metal at a rate of 0.039" per year is possible.

17. To show how absurd Citizens' argument is—that corrosion significant enough to affect the integrity of the drywell shell could occur through a pinhole or holiday in the epoxy coating—I have made the following assumptions in my calculation, some of which are unrealistic and overly conservative:

- AmerGen performs the visual and UT inspections of the sand bed region in 2008 that it has already committed to;
- AmerGen does not perform inspections of the sand bed region in 2010, also consistent with its commitments (inspections are to be performed every four years after 2008);
- The drywell shell is exposed to water during the 2010 scheduled refueling outage. The source of the water is minor leakage from the refueling cavity, which only contains water during refueling outages, so the shell could not get wet prior to a refueling outage;

[1] Citizens' Petition states that a "reasonable estimate of the worst case potential corrosion rate that may occur could be obtained by analyzing the pre-1992 data [*i.e.*, before the sand was removed from the sand bed region].... Observed corrosion rates to 1990 ranged up to 0.035 inches per year and were very uncertain." While it is my understanding that AmerGen is not required to perform "worst case" analyses, the corrosion rates that occurred prior to removal of the sand from the sand bed region simply are not representative of the potential corrosion rates after removal of the sand. As I demonstrate in this Affidavit, even this order of magnitude corrosion does not challenge the integrity of the drywell shell.

- This water is not detected. This is conservative because AmerGen's commitments include monitoring the refueling cavity liner drain during outages, as well as the five sand bed region drains both quarterly and daily during outages;
- The water enters Dr. Hausler's hypothetical pinhole or holiday on the first day of the 2010 refueling outage. This is conservative because the refueling cavity is not even flooded on the first day of the outage;
- The pinhole or holiday is located within the region that has the least remaining margin (*i.e.*, Bay 13). This is conservative because it is statistically unlikely that the thinnest area of the shell also has the defect in the coating;
- Corrosion at the maximum historical rate of 0.039" per year instantly begins as water enters the pinhole or holiday;
- Oxygen's contact with the metal surface is not mitigated by the presence of corrosion products. This is conservative because corrosion tends to be self-limiting when corrosion films are produced on the metal surface and corrosion byproducts (*i.e.*, rust) create a diffusion barrier that reduces the amount of subsequent corrosion of the shell;
- The refueling outage takes four weeks to complete, and the cavity is filled with water during the entire refueling outage;
- The water stays in the pinhole during the entire four-week outage; and
- The water in the pinhole or holiday does not evaporate until a year after the refueling outage is over, and the 0.039" per year corrosion rate continues for the entire year after the outage, for a total of 56 weeks of new corrosion. This

is extremely conservative because the temperature in the sand bed region of the drywell is about 130°F during operations, which would result in the evaporation of the small amount of water in the pinhole or holiday in significantly less time. For example, at 130°F, a drying out rate of about 0.3 pounds per hour, per square foot, is reasonable for a sand bed region with no sand.[2] This would result in evaporation of water in the pinhole or holiday in less than one day. There are many factors involved in the calculation of water evaporation rates. One of the most important factors is the air or wind velocity across the water surface. I derived the 0.3 pounds per hour, per square foot value from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) equation for evaporation from ponds or pools: W = [A + (B)(V)](Pw - Pa)/Hv (where: W = water evaporation rate, (lb/hr) per sq.ft. of the water's surface area; A = a constant = 95; B = a constant = 37.4; V = air velocity over the pond surface, miles/hr (which I assumed was zero); Pw = vapor pressure of water at the water temperature, inches of Hg; Pa = vapor pressure of water at the air dewpoint temperature, inches of Hg; and Hv = heat of vaporization of water at the pond water temperature, Btu/lb).

18. In summary, therefore, I have assumed that the drywell shell behind the pinhole or holiday will experience the maximum historical corrosion rate of 0.039" per year, for 56 weeks. This results in a total loss of metal of about 0.042", which is well within: (a) the margin of 0.064" remaining in Bay 19 (thickness of 0.800"), when measured

[2] This is around 2.4 ounces per hour, per square foot.

against the general average thickness criterion of 0.736"; and (b) the margin of 0.128" remaining in Bay 13A, when measured against the very local area average thickness of 0.490".

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Barry Gordon
Structural Integrity Associates, Inc.
3315 Almaden Expressway, Suite 24
San Jose, CA 95118-1557

Subscribed and sworn before me this 26 day of March 2007.

PAULA RODGERS
Commission # 1540492
Notary Public - California
Santa Clara County
My Comm. Expires Jan 1, 2009

Paula Rodgers
Notary Public

My Commission Expires: Jan. 1, 2009