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U.S. NUCLEAR REGULATORY COMMISSION

In the Matter of Entergy (Pilgrim Nuclear Power Station)
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before The Atomic Safety And Licensing Board

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

Docket # 50-293-LR

January 28, 2008

Declaration of David P. Ahlfeld, PhD, PE
Regarding
Groundwater Monitoring Requirements for PNPS

I am presently a Professor in the Department of Civil and Environmental Engineering at the University of Massachusetts, Amherst. I have taught, conducted research and worked on projects in the area of groundwater flow and contaminant transport in the subsurface and related topics for over 20 years.

Decades of experience with subsurface facilities, much of it since Pilgrim was constructed, indicates that, even with the best-intentioned efforts of leak prevention, leaks of contaminants into the subsurface can and do occur. There are numerous instances of this across many industries and examples at nuclear power plants. Leakage can occur for a period and then stop or it can continue at a low flow rate for extended periods. These and other leakage modes produce subsurface contamination that is virtually impossible to detect without the use of direct sampling methods such as monitoring wells.

The Pilgrim facility has several components that are within scope from which detectable contaminants could leak into the subsurface. These include buried pipes and tanks servicing the condensate storage system, offgas system piping, salt service water system and fuel oil systems. Entergy describes several methods they use to prevent leaks from occurring, however, Entergy has not demonstrated that they have sufficient means of detecting leaks if they occur.

Groundwater monitoring networks are commonly used as a means of detecting leaks from a wide variety of facilities. To make the monitoring network an effective means of detecting leaks, the network should be designed so that a pollutant release under any plausible leak scenario will be detected, with high degree of certainty. The design of a monitoring network includes determination of plausible leak scenarios, determination of

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expected fate and transport of the leaking substances and then placement of the detection network so that these transporting substances will be detected.

This general guideline for monitoring network design is expanded upon below, with reference to specific features of the Pilgrim Nuclear Power Station (PNPS). These constitute the steps in monitoring network design which, with appropriate documentation, would constitute an adequate design. As noted below, many of these steps are similar to those recommended in the Nuclear Energy Institute (NEI) Industry Ground Water Protection Initiative – Final Guidance Document (NEI 07-07, August, 2007).

Steps in Monitoring Network Design

1) Determination of all plausible leak locations. This would include consideration of all piping segments and tanks that are placed below the ground surface and are part of system components that are within scope. For purposes of monitoring network design, leaks from any of the plausible locations would be presumed to release water contaminated with radionuclides or oil. This step is similar those recommended in the NEI Guidance Document (Objective 1.2 Site Risk Assessment) where buried piping is described as being a credible mechanism for leaking materials to reach groundwater.
2) Identification of the specific contaminant species that would be present in the leaking water or oil from each of the system components. A set of indicator contaminants should be selected for each system component that can, if detected in groundwater, uniquely identify the component. Particular emphasis should be on those contaminants that are least likely to sorb and thus be most rapidly transported.
3) Consideration of the fate and transport of each indicator contaminant from each of the plausible leak locations.
    a. This analysis would include prediction of subsurface transport pathways from all identified source locations. This prediction would consider vertical migration of leaking water through the unsaturated zone to the water table. It would also account for the direction and rate of groundwater flow. Such predictions must be based upon understanding of groundwater behavior at the site derived from a recently-conducted detailed site characterization as recommended in the NEI Guidance Document (Objective 1.1 Site Hydrology and Geology). This is particularly important at PNPS where building, paving and changes to storm drainage may significantly affect local flow behavior.
    b. Transport of a particular contaminant along identified transport pathways must be analyzed. For each contaminant it is necessary to account for the initial concentration of the contaminant in the leaking liquid and the effects of dispersion, sorption, radioactive decay or other processes that may affect concentrations of the contaminant at the monitoring well.
4) The NEI Guidance Document (Objective 1.3 On-Site Groundwater Monitoring) recommends a monitoring system that will "ensure timely detection" of leaks. This will be accomplished with placement of monitoring wells so that all predicted transport pathways are intercepted with a high degree of certainty. The

placement of monitoring wells should consider both the areal (plan view) location and also the vertical location of the well screens. A complete monitoring system will also include upgradient control wells which are intended to provide ambient groundwater conditions and help to confirm groundwater flow directions. The PNPS is a particularly challenging site for placement of monitoring wells. Because of the short distance between possible leak sites and the coast line (assuming that groundwater flow is generally towards the sea), the potential is high for a narrow transport pathway to convey contaminants between monitoring wells unless they are closely spaced. This suggests that a high density of monitoring wells will be needed to detect leaks with adequate assurance.

5) Understanding of the fate and transport of indicator contaminants can be used to determine the appropriate frequency of water sample collection at the monitoring wells and the required detection limits for analysis. In particular, the dilution of contaminated water as it mixes with ambient water during transport must be considered. Detection limits for contaminant analysis should be as low as practical so that dilution of contaminants does not mask the presence of leaks.

Recent Experience at PNPS

Recently, Entergy reported finding tritium at levels up to about 3000 pCi/L in monitoring wells on site. These initial monitoring results highlight flaws in the monitoring system at PNPS and provide a contrast to appropriate monitoring design.

Based on the map provided by Entergy in its recent filing, four monitoring wells have been placed at the site. These are generally located between the reactor and the shoreline. The wells are spaced approximately 200 feet apart. I am not aware of any recent hydrogeologic studies that have been conducted to determine current groundwater flow directions and rates. Hence, the suitability of these wells to actually intercept plausible leakage transport pathways is unknown.

Based on my estimation of the locations of pipe runs and plausible leak locations, this number of wells is entirely inadequate to provide the assurance of detection called for in the NEI guidance and in industry practice. Given the short distance from likely pipe locations and the shore, it is highly likely that a leak of radiological contaminants could migrate through the groundwater and pass between these widely-spaced wells or perhaps flow beneath them without detection. It is useful to contrast the PNPS plan with Entergy's Indian Point NPS which has many times more monitoring wells. Indeed, a 4-well monitoring system is more typical of that used for a retail gasoline station or a small municipal (non-hazardous) landfill. That it should be considered adequate for a large industrial facility such as PNPS is unrealistic.

The selection of tritium as the indicator contaminant raises a problem since tritium may be present in several of the potential leak sources that are within scope (e.g. condensate storage tank and salt service water systems). Hence, tritium does not provide a unique indicator of the component which is the source of the leak. A better designed monitoring system would seek a range of radionuclides that, taken together, serve as specific source indicators.

Presuming that the tritium detected originated at PNPS, the question arises as to the specific mechanism by which this tritium came to be at, for example, well MW 201. It has been suggested by PNPS personnel, as reported in the press, that this tritium is from rainfall sources. Presumably, the transport pathway for this would be airborne tritium captured by passing raindrops with rainfall subsequently infiltrating to the subsurface. But this transport pathway may be limited if, as is presumably the case, the monitoring wells are placed in a paved area of the site where rainfall can not infiltrate. There are alternative theories for the source of tritium. A small pipe leak producing a transported plume of tritium that happens to travel near to monitoring well MW 201 might account for the observed levels of tritium. Alternately, a larger pipe leak producing a large plume of tritium with concentrations much larger that 3000 pCi/L might exist in the subsurface between wells MW 201 and MW 202. In this scenario, the diluted edge of the plume happens to travel near to monitoring wells MW 201 and MW 202. These alternate hypotheses highlight the fact that with so few monitoring wells, it is impossible to determine with any degree of certainty what contaminants may exist in the subsurface.

In summary, groundwater monitoring networks can be used as part of a leak detection system and are widely used for this purpose. Well-established protocols exist for proper design of monitoring networks including well and screen placement, sampling frequency and selection of sampled contaminants. The 4-well monitoring system apparently used by Entergy does not meet reasonable standards for monitoring network design.

I declare that under penalty of perjury that the foregoing reflects my true opinion in these matters.

David P. Ahlfeld, PhD, PE

Biographical Sketch

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Education

Humboldt State Univ., Arcata, California	B.S. in Environmental Resources Engineering,	1983
Princeton University,	M.A. in Civil Engineering,	1985
Princeton University	Ph.D. in Civil Engr. and Oper. Research,	1983-1987

Academic Appointments

Professor, Department of Civil and Environmental Engineering, University of Massachusetts, September 2004 to present.
Associate Professor, Department of Civil and Environmental Engineering, University of Massachusetts, January 1998 to September 2004.
Associate Professor, Department of Civil and Environmental Engineering, University of Connecticut, September 1994 to January 1998.
Assistant Professor, Department of Civil Engineering, University of Connecticut, January 1988 to August 1994.
Lecturer, Department of Civil Engineering and Operations Research, Princeton University, Spring semester 1987 and Spring semester 1988

Selected Recent Publications

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