Issue/Title: Pilgrim Nuclear Power Station (PNPS): Tritium in Groundwater Monitoring Wells

Topic: PNPS Updates as of June 13, 2012

Previous Plans: Results from groundwater monitoring well samples collected during the weeks of May 15th and May 29th, 2012 were reported by Entergy. Split sample results for the weeks of May 15th and May 29th, 2012 were also reported by MERL.

Current Status:

Table 1[1]: May 15th

Location	Date	MERL pCi/L	GEL pCi/L
MW 201	05/15/2012	482	592
MW 202	05/15/2012	-	-
MW 202 I	05/15/2012	-	-
MW 203	05/15/2012	-	-
MW 204	05/15/2012	-	-
MW 205	05/15/2012	1,533	1,820
MW 206	05/15/2012	***	***
MW 207	05/15/2012	-	-
MW 208-S	05/15/2012	-	-
MW 208-I	05/15/2012	-	-
MW 209	05/15/2012	927	985
MW 210	05/15/2012	-	-
MW 211	05/15/2012	1,186	1,140
MW 212	05/15/2012	-	-
MW 213	05/15/2012	-	-
MW 214	05/15/2012	-	-
MW 215 new	05/15/2012	1,187	1,200
MW 217 new	05/15/2012	556	666
MW 3	05/15/2012	-	-
MW 4	05/15/2012	-	-
SW-boat ramp	05/15/2012	-	-
SW-intake	05/15/2012	NDA	NDA

Table 2: May 29th

Location	Date	MERL pCi/L	GEL pCi/L
MW 201	05/29/2012	479	629
MW 202	05/29/2012	-	-
MW 202 I	05/29/2012	-	-
MW 203	05/29/2012	-	-
MW 204	05/29/2012	-	-
MW 205	05/29/2012	5,735	5,760
MW 206	05/29/2012	1,807	1,550
MW 207	05/29/2012	-	-
MW 208-S	05/29/2012	-	-
MW 208-I	05/29/2012	-	-
MW 209	05/29/2012	927	887
MW 210	05/29/2012	-	-
MW 211	05/29/2012	1,172	1,190
MW 212	05/29/2012	-	-
MW 213	05/29/2012	-	-
MW 214	05/29/2012	-	-
MW 215 new	05/29/2012	1,210	1,470
MW 217 new	05/29/2012	520	462
MW 3	05/29/2012	-	-
MW 4	05/29/2012	-	-
SW-boat ramp	05/29/2012	-	-
SW-intake	05/29/2012	NDA	NDA

*** NDA = not detected at less than activity value listed**
**** results pending**
***** well inaccessible**
- not analyzed this week

[1] PNPS screening level for tritium in groundwater monitoring wells is 3,000 pCi/L, which is 1/10th of the NRC-approved Pilgrim Offsite Dose Calculation Manual standard for tritium in non-drinking water sources. The EPA drinking water standard is 20,000 pCi/L. The nearest drinking water wells are approximately 2.5 miles from the plant.

The groundwater monitoring results reported by Entergy show MW205 decreased to a level of 1,820 pCi/L of tritium detected on May 15th and increased to 5,760 pCi/L of tritium detected on May 29th (the previous result on May 2nd was 5,440 pCi/L). Sample collection for MW206 was not possible during the sample collections on May 2nd and May 15th because the contractor reportedly failed to notify Entergy that moveable equipment was blocking access to the well. The equipment was moved and Entergy results show that MW206 decreased to 1,550 pCi/L of tritium detected on May 29th (compared to 1,930 pCi/L of tritium detected in MW206 on April 17th). Results for the other priority wells were within typical ranges detected since the groundwater monitoring for tritium began (i.e. approximately 600 pCi/L to approximately 1,500 pCi/L of tritium detected) for the weeks of May 15th and May 29th. Split sample results from MERL for the weeks of May 15th and May 29th were generally consistent with Entergy results (see table above).

Entergy results for surface water from the intake canal downstream of MW205 indicated no detectable tritium for the weeks of May 15th and May 29th. Split surface water sample results from MERL for the weeks of May 15th and May 29th also indicated no detectable tritium (see table above).

Tritium levels in groundwater have been monitored closely over the past two years since elevated tritium was first detected in groundwater above 20,000 pCi/L, but below the NRC reporting limit of 30,000 pCi/L, in monitoring well 205 in summer 2010. Since that time, eight additional groundwater monitoring wells have been installed at PNPS to help better characterize groundwater contamination, and help determine the source of tritium. For the most part, fluctuating tritium levels have been observed in MW205 (e.g., between approximately 1,000 and 25,000 pCi/L) and MW206 (e.g., between no detectable tritium and approximately 15,000 pCi/L). Lower tritium levels (e.g., ranging from no detectable tritium up to approximately 1,800 pCi/L) have been detected at MW201, MW209, MW211, and MW215, which are in the vicinity of MW205 and MW206. The rest of the 18 groundwater monitoring wells have typically had non-

detectable or levels of tritium just above detection (e.g., 500 to 700 pCi/L) throughout this two year period.

Tritium levels in MW205 and MW206 have continued to fluctuate over time. In 2010, MW205 results ranged from 1,760 pCi/L to 25,552 pCi/L with an average of 9,549 pCi/L of tritium detected (number of samples = 28) and MW206 results ranged from 1,380 pCi/L to 13,600 pCi/L with an average of 6,256 pCi/L of tritium detected (number of samples = 24). In 2011, MW205 results ranged from 921 pCi/L to 13,400 pCi/L with an average of 4,207 pCi/L of tritium detected (number of samples = 52) and MW206 results ranged from no detectable tritium to 5,050 pCi/L with an average of 2,196 pCi/L of tritium detected (number of samples = 50). In 2012 to date, MW205 results ranged from 1,820 pCi/L to 8,400 pCi/L with an average of 4,984 pCi/L of tritium detected (number of samples = 13) and MW206 results ranged from 1,440 pCi/L to 3,250 pCi/L with an average of 2,384 pCi/L of tritium detected (number of samples = 11). Thus, 2011 and 2012 data continue to show levels of tritium in MW205 and MW206 above background (defined as between approximately 400 pCi/L and 1,000 pCi/L of tritium based upon results at facilities nationally), though the levels appear to be lower than those observed in 2010.

Because the data continue to show tritium concentrations above typical background (MW205 and MW206 in particular) they indicate the presence of an ongoing tritium source (or sources) yet to be definitively identified as discussed in previous reports. Investigational activities undertaken to identify a tritium source have been complicated by the presence of subsurface materials (e.g., fill material consisting of construction debris, concrete slabs, conduits, and piping) as well as the deep reactor building foundation. The subsurface materials and structures also affect groundwater flow patterns at the plant posing challenges in understanding subsurface migration of tritium in groundwater. Investigational activities conducted to date to try to identify source(s) of tritium have included dye testing, soil sampling, installation of new groundwater monitoring wells along the reactor building foundation to investigate a preferential

pathway around the foundation, and inspections of piping and conduits, particularly those that may impact MW205 and MW206.

The following is a list of potential tritium in groundwater sources that have been identified to date with the status of investigations related to the possible sources.

- Potential sources of tritium less likely to explain levels in groundwater:
    - AOG (Augmented Off-Gas) System Lines:
        - These lines leave the turbine building just up gradient of MW217 MW207 and the reactor building just up gradient of MW215 and MW209, and run up to the main stack for permitted tritium vapor air releases. Investigation activities that have been undertaken to assess the potential of these lines being possible sources include the installation of MW215 and MW217, which are both down gradient of the AOG lines. Results of MW217 testing have generally been below 700 pCi/L of tritium detected, while MW215 has shown levels that generally range from 1,200 to 1,800 pCi/L. Because some downgradient wells (i.e., MW209, MW211 and MW215) continue to show tritium levels above 1,000 pCi/L, the AOG System Lines have not yet been ruled out as possible sources.
    - Atmospheric Precipitation Deposition:
        - Entergy routinely measured tritium in precipitation samples collected at the plant to explore the possible contribution that permitted air emissions of tritium may impact groundwater levels. To date, results of precipitation samples ranged from no detectable tritium to 849 pCi/L of tritium detected. These data suggest that atmospheric deposition does not play a primary role in elevated tritium levels detected in monitoring wells and hence it seems unlikely to be a significant source of tritium in groundwater.
    - Atmospheric Precipitation via Roof Drains Pathway:

        - Over 95% of the tritium emissions from the plant are released from a roof vent on the reactor building. Thus, samples of precipitation from the reactor building roof have been collected and analyzed for tritium. Levels ranged from non-detect to 849 pCi/L. Water samples from manholes where the roof drains lead to showed no detectible tritium. Also, results of dye testing efforts did not indicate roof drainage lines to be a source of tritium in groundwater. Dyes introduced to underground junction boxes for roof drain lines (i.e. junction box 1 on January 18th, 2011, where the reactor building roof drain enters and junction box 3 where the radwaste building truck look roof drain enters on January 19, 2011) were not detected in downgradient groundwater monitoring wells after a year of sampling. Despite these results, this is still being actively considered as a possible contributing source.
    - Possible Historical Spill in the Area of MW205:
        - Although Entergy has reported no records of a previous spill in the vicinity of MW205, they have conducted soil sampling in this area of the plant to investigate the possibility that a historical spill could be contributing to fluctuating tritium levels detected in groundwater in this well. Based on the soil sampling results for this area of the plant, which found no detectable tritium, Entergy has ruled this out as a potential tritium source at this time.

- Potential sources of tritium warranting greater focus in the groundwater monitoring investigation:
    - Condensate Storage Tanks:
        - These tanks are located on the north side of the building and are used to store water used to cool the reactor. Based on a guided wave study conducted by Entergy in July 2010, the piping associated with these tanks is intact and is currently considered an unlikely source of tritium in groundwater. MW210 is the monitoring

well located closest to these tanks, and MW202 and MW202I are located downgradient of the tanks. Levels in MW210 have ranged from no detectable tritium to 1,280 pCi/L. The most recent tritium concentration from this well was 1,080 pCi/L on March 6, 2012. Levels in MW202 have ranged from no detectable tritium to 1,040 pCi/L. Results of the most recent sample were 942 pCi/L tritium on March 6, 2012. Levels in MW202I have ranged from no detectable tritium to 930 pCi/L. The most recent sample had no detectable tritium on March 6, 2012. Because these tanks contain 8 to 10 million pCi/L of tritium, a significant leak would be expected to result in much higher tritium concentrations in nearby wells. Recently, as part of Entergy's buried pipe and tank program as well as a license renewal commitment, divers will be performing ultrasonic testing (UT) of the two tanks to inspect the integrity of the tank floors. This activity has been ongoing in May and June 2012. To date, the diver inspections of the 'B" tank indicate that the tank is in good shape and the wall thicknesses of the tank bottoms have not degraded significantly since their original installation. Investigations have not ruled out the possibility of a very small leak in the tanks and associated piping, and hence the Condensate Storage Tanks have not been completely eliminated as a potential contributing source at this time.

- Main Stack Drain Line:
  - This line runs from the main stack to the reactor building and carries tritiated water from condensed vapor at the main stack. Initial pressure testing results indicated that the line appeared to be intact. However, this line is planned to be re-examined via excavation and camera at three locations. This follow-up investigation is being planned because the line had been subject to some blockage in the past, and the line is known to contain tritium levels at approximately 50,000 pCi/L. A sample of drain line water

indicated 52,500 pCi/L of tritium detected in August of 2010. The three line locations that will be investigated include 90 degree bends in the line located near the underground diesel fuel tanks, MW211, and MW215. MW205 is down gradient of this line and it also passes in close proximity to MW203, MW209 and MW211 (see map below).

- Neutralization Sump Discharge Line:
  - This line is located up gradient of MW211, and MW212 (see map below). It is a newer line and Entergy does not believe it is likely to leak. However, MW211 and MW212 were installed partly to evaluate this line. MW212 typically shows no detectible tritium or tritium levels just above detection, while MW211 typically shows tritium levels above 1,000 pCi/L. Thus, the Neutralization Sump Discharge Line has not been completely eliminated as a possible contributing source.
- Radwaste Discharge Line:
  - The Radwaste Discharge Line exits the rear of the turbine building near MW-4, loops around the back of the turbine building, and bends toward the discharge canal up gradient of MW207 and MW217 (see map below). It is typically used once a year or less for permitted batched discharges that contain tritium. Dye introduced to the Radwaste Discharge Line did not show any detection of dye in wells located down gradient of this line (e.g., MW-4, MW206, MW201, MW207, MW217, MW211, MW209, and MW205). Dye was visible in the discharge canal during a subsequent scheduled permitted discharge 4 months after the dye was introduced to this line, thereby indicating the dye travelled the length of the Radwaste Discharge Line. Ozark's dye testing report indicated that because dye was not detected in down gradient wells the line is most likely intact. But, Ozark did not rule out the possibility of a small leak in this line which would not be detected through dye testing. If a small

leak in this line was located behind the turbine building it could potentially flow around the turbine and reactor building deep foundations along preferential pathways. To address this possibility, MW215 and MW217 were installed close to the deep foundation on the west side of the reactor building. The pending installation of MW216 on the east side of the reactor building, down gradient of this line and along the deep foundation, will also help to further evaluate the radwaste discharge line as a potential source. Since being installed in December 2011, MW215 has ranged from 1,170 pCi/L of tritium detect to 1,820 pCi/L with an average of 1,418 pCi/L of tritium detected (number of samples = 15); MW 217 has ranged from no detectable tritium to 901 pCi/L of tritium detected with an average of 547 pCi/L of tritium detected (number of samples = 15). Investigation of the Radwaste Discharge Line is continuing.

- Spent Fuel Pool:
  - The spent fuel pool itself is located at the upper level of the reactor building within secondary containment. Entergy considers the spent fuel pool structure unlikely to be a possible tritium source, since it is accessible from under it, and any leaks would be easily detected. Piping associated with the spent fuel pool may be an indirect source. There are sumps connected to drain lines that are next to and below the spent fuel pool structure that would collect any leaks from pipes that circulate and cool the spent fuel pool water within secondary containment. Any leaks in this piping would be collected by the drains and sumps and processed for recycling into cooling systems or stored in a tank for future permitted discharge via the Radwaste Discharge Line or Neutralization Sump Discharge Line. Thus if the Radwaste Discharge Line, for example, was determined to be a source, then leakage from piping related to

the Spent Fuel Pool could be a contributor. As noted earlier, the Radwaste Discharge Line is still under investigation.

- Other potential tritium sources under investigation:
    - Station Heating Line:
        - This line exits the reactor building and has the potential for tritiated moisture to condense within it. Entergy has plans to remove the plug where the line exits the reactor building, and if condensation is present in the line, they will test it for tritium. Also, Entergy is evaluating plans to excavate down to this line to examine it via camera at three locations, including where it exits the reactor building, at a bend near MW205, and at an elbow near the intake structure up gradient of MW205.
    - Utility Conduits:
        - These conduits exit the reactor building and have the potential for tritiated moisture to condense in them similar to the station heating line. Entergy will be examining the conduits by accessing manholes to look for any moisture or leaks. If any puddles exist in the manholes they will test the accumulated water for tritium, pump them out and see if the water returns. Entergy will share the exact locations of these conduits with MDPH.

Despite identifying and investigating the potential sources listed above, no one source or combination of sources have been identified as the definitive source(s) for the tritium detected in groundwater monitoring wells at PNPS. The Radwaste Discharge Line remains an important suspect source. Although seldom used (about once per year), its location could contribute to tritium levels seen in MW205 and MW206 if it were leaking. Any leakage could flow along the deep foundation of the reactor building on both sides, contributing to tritium levels detected in MW205 on the west side and MW206 on the east side. In addition, MDPH has observed what seems to be a possible time trend with permitted tritium releases through the Radwaste Discharge Line and tritium levels

detected in MW206 about seven months later. Specifically, tritium was released through the Radwaste Discharge Line in several batches (up to approximately 1.7 million pCi/L) concluding on April 6, 2010, and the level in MW206 peaked at 13,600 pCi/L on November 1, 2010. Tritium was again released through the Radwaste Discharge Line in several batches up to approximately 1.4 million pCi/L concluding on May 13, 2011, and the level in MW206 peaked at 5,050 pCi/L on December 13, 2011, also approximately 7 months later. This observation has been shared with Entergy, and they are currently investigating a potential connection. Although no dye was detected in monitoring wells down gradient of the radwaste discharge line, this does not completely rule out the possibility of this line being a source since the Ozark dye testing report stated small leaks may not be detectable with dye. MDPH also continues to be interested in the Main Stack Drain Line as a second possible source, which runs in very close proximity to MW209 and MW215 and is also up gradient of MW205 (see map below). This line is known to contain tritium at levels reaching approximately 50,000 pCi/L.

Looking Forward:

MDPH will continue to closely follow all investigational activities that are currently underway at PNPS (i.e. well placement, excavation activities, etc.).

Map of underground pipe lines that have the potential to be a source of tritium in groundwater (all locations approximate):