BellBendCOLPEm Resource

From: Tesfaye, Getachew
Sent: Wednesday, July 08, 2009 11:34 AM
To: Canova, Michael
Subject: FW: NUMARK Documents for the NRC Hearing File for TO # 56, Bell Bend Chapter #2
Attachments: pTER_BB_groundwater_rbc_52009.doc

From: Hearing File [mailto:HearingFile@numarkassoc.com]
Sent: Wednesday, July 08, 2009 10:32 AM
To: Cook, Christopher
Cc: Tesfaye, Getachew; Adams, Sally
Subject: NUMARK Documents for the NRC Hearing File for TO # 56, Bell Bend Chapter #2

The attached information is being provided to you from Numark Associates, Inc pursuant to 10 CFR 2.1203(b) for inclusion in the NRC Hearing File.

Please contact Ms Karen Hall if you have any questions.

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From: Richard Codell [mailto:richardcodell@yahoo.com]
Sent: Thursday, May 21, 2009 3:41 PM
To: Marty Bowling
Cc: Terry Johnson; Hearing File
Subject: Latest version pTER 2.4.12

Marty:
Here is the latest version of the groundwater section. I have tried to take all of your advise from 2.4.13.
Dick

Hearing Identifier: BellBend_COL_Public
Email Number: 113

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Subject: FW: NUMARK Documents for the NRC Hearing File for TO # 56, Bell Bend Chapter #2
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From: Tesfaye, Getachew

Created By: Getachew.Tesfaye@nrc.gov

Recipients:
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2.4.12 GROUND WATER

2.4.12.1 Introduction

This section of the Bell Bend Nuclear Power Plant Final Safety Analysis Report (FSAR) provides information on the sub-surface water at the site, its effect on hydrostatic loading of safety related structures, and its potential pathway for released radionuclides from accidents to consumers of surface water or groundwater.

The specific areas of review are as follows: (1) identification of the aquifers, sources of recharge, present withdrawals and known and likely future withdrawals, flow rates, travel time, gradients, and other properties that affect movement of accidental contaminants in groundwater, groundwater levels beneath the site, seasonal and climatic fluctuations, monitoring and protection requirements, and man-made changes that have the potential to cause long-term changes in local groundwater regime, (2) effects of groundwater levels and other hydrodynamic effects of groundwater on design bases of plant foundations and those of other SSC important to safety, (3) potential effects of seismic and non-seismic information on the postulated worst-case groundwater conditions for the proposed plant site, and (4) any additional information requirements prescribed within the “Contents of Application” sections of the applicable Subparts to 10 CFR Part 52.

2.4.12.2 Summary of Application

In the BBNPP COL FSAR Section 2.4, the applicant addresses the groundwater in terms of impacts on structures and pathways of radionuclide release to users of potable water. The plant will use no groundwater during operation.

Section 2.4.12 of the BBNPP COL FSAR incorporates by reference Section 2.4.12 of the U.S. EPR FSAR, Revision 0.

In addition, in FSAR Section 2.4.12, the applicant provided the following:

Combined License Information Item

The applicant provided additional information in Section 2.4.12 to address COL Information Item 2.4-13 from U.S. EPR FSAR Tier 2, Table 1.8-2 as follows:

> Groundwater - A COL applicant that references the U.S. EPR design certification will provide site-specific information to identify local and regional groundwater reservoirs, subsurface pathways, onsite use, monitoring or safeguard measures, and to establish the effects of groundwater on plant structures.

In response to this Combined License Information Item, the COL applicant provided supplemental information in FSAR Sections 2.4.12.1 to 2.4.12.6. This information provided includes a summary of the following:

- The regional and local groundwater aquifers, formations, sources, and sinks.
- The present and projected future regional water use.
- A conservative analysis of critical groundwater pathways for a liquid effluent release at the site and evaluated the dispersion, retardation, and dilution capability of the groundwater and surface water environments with respect to present and projected users.
- Plans, procedures, safeguards, and monitoring programs to be used to protect present and projected groundwater users.
- Site characteristics, including the maximum operational groundwater level, for ground-water-induced hydrostatic loadings on subsurface portions of safety-related SSC without the use of permanent dewatering systems.

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2.4.12.3 Regulatory Basis

The applicable regulatory requirements for groundwater are:

1. 10 CFR Part 100, as it relates to identifying and evaluating hydrological features of the site. The requirement to consider physical site characteristics in site evaluations is specified in 10 CFR 100.20(c).
2. 10 CFR 100.23(d) sets forth the criteria to determine the siting factors for plant design bases with respect to seismically induced floods and water waves at the site.
3. 10 CFR 52.79(a)(1)(iii), as it relates to identifying hydrologic site characteristics with appropriate consideration of the most severe of the natural phenomena that have been historically reported for the site and surrounding area and with sufficient margin for the limited accuracy, quantity, and period of time in which the historical data have been accumulated.

The related acceptance criteria are summarized from SRP Section 2.4.12:

1. Local and Regional Groundwater Characteristics and Use: To meet the requirements of 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), a complete description of regional and local groundwater aquifers, sources, and sinks, local and regional groundwater use, present and known and likely future withdrawals, regional flow rates, travel time, gradients, and velocities, subsurface properties that affect movement of contaminants in the groundwater, groundwater levels including their seasonal and climatic fluctuations, groundwater monitoring and protection requirements, and any man-made changes with a

potential to affect regional groundwater characteristics over a long period of time is needed.

2. Effects on Plant Foundations and other Safety-Related Structures, Systems, and Components: To meet the requirements of 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), a complete description of the effects of groundwater levels and other hydrodynamic effects on the design bases of plant foundations and other SSC important to safety is needed.

3. Consideration of Other Site-Related Evaluation Criteria: To meet the requirements of 10 CFR 50.55a, 10 CFR 100.20(c)(3), 10 CFR 100.23(d), and 10 CFR 100.20(c), the applicant's assessment of the potential effects of site-related proximity, seismic, and non-seismic information on the postulated worst-case scenario related to groundwater effects for the proposed plant site is needed.

   In addition, the hydrologic characteristics should be consistent with appropriate sections from Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants" (although there are no safety related uses of groundwater for the Ultimate Heat Sink, other than hydrostatic effects on foundations that is covered in item 2 above).

2.4.12.4 Technical Evaluation

The NRC staff reviewed Section 2.4.12 of the BBNPP COL FSAR, and checked the referenced DC FSAR to ensure that the combination of the DC and the information in the COL represent the complete scope of information relating to this review topic. The NRC staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. Section 2.4.12 of the U.S. EPR FSAR is being reviewed by the staff under docket number 52-020. The NRC staff's technical evaluation of the information incorporated by reference related to groundwater will be documented in the staff safety evaluation report on the design certification application for the U.S. EPR.

Combined License Information Item

The NRC staff reviewed COL Information Item No. 2.4-13 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under Section 2.4.12 of the BBNPP COL FSAR. This Information Item states that a COL applicant referencing the U.S. EPR design certification will provide site-specific information on local and regional groundwater reservoirs, subsurface pathways, onsite use, monitoring or safeguard measures, and the effects of groundwater on plant structures.

In response to this information item, the applicant described the regional and local hydrogeology in FSAR Section 2.4.12.1. The applicant also described regional and local groundwater use in FSAR section 2.4.12.2. No groundwater will be used for operation of the BBNPP and construction impacts will be limited to dewatering operations.

The site is in northeastern Pennsylvania near the northeastern end of the Ridge and Valley Province, and close to the south of the Appalachian Plateaus Province. The site is underlain by thick sequences of Paleozoic sedimentary rock overlying Precambrian crystalline basement rock. The sedimentary rock includes sandstone, siltstone, shale, limestone and some coal and conglomerates. The sedimentary rock is highly faulted and folded, and does not appear to include any aquicludes.

Groundwater in the bedrock is contained mainly in secondary openings, with solutioning of calcareous rock. Porosity, permeability and yield of unweathered bedrock are very low. However, the upper, weathered portion of the sedimentary rock has productive wells. Glacial till, outwash, colluviums, kame and kame terrace were deposited from the last major glacial advance of 17,000 to 22,000 years ago. Outwash sand and gravel deposited in major stream valleys from glacial advance and retreat form some of the most productive aquifers in the region.

Water stored in the glacial outwash aquifer is primary (intergranular) rather than secondary as in the case of the bedrock aquifers. Groundwater on site in the glacial overburden aquifer is coupled closely to surface water in nearby streams and ponds. The FSAR section 2.5.4 describes the overburden on the site as varying from 3.8m (12 ft) to 18.9 m (62 ft) in thickness, and consisting of brown silty sand or sand containing gravel and large rounded cobbles and boulders with some loose sand pockets.

Much of the glacial overburden soils will be removed in the power block area in order to provide a better foundation for structures on bedrock or engineered fill.

Current ground surface elevations at the BBNPP site range from 198 m (650 ft) msl along Walker Run to about 244 m (800 ft) msl north of the power block (FSAR 2.4.12.1.3). To the north, the ground elevation rises up to 350 m (1,150 ft) msl.

The site has been investigated by a total of 73 borings and monitoring wells, as described in Section 2.5 of the FSAR. Of these borings, 41 were, or became upon completion of geophysical evaluations, monitoring wells. Of the wells, 14 are screened in the glacial overburden aquifer, 19 in the shallow bedrock, and 8 in the deeper bedrock. The first 10 monitoring wells are clusters (i.e., multiple wells closed off at different depths). These well clusters are used mainly to determine vertical pressure gradients. Most of the wells were installed in October 2007, and one was installed in May 2008. FSAR Figure 2.4-62 shows locations of monitoring wells on the BBNPP site. Surface water locations such as ponds are assumed to be in close contact with groundwater in the glacial overburden aquifer and their water levels are assumed to coincide with groundwater levels. FSAR Figure 2.4.64 shows the location of two hydrogeologic cross sections on the site. FSAR Figures 2.4-65 and 2.4-66 show the geologic cross-sectional view of boreholes and wells along these cross-sections.

Water levels were recorded monthly from October 2007 to September 2008. Monthly groundwater elevation measurements are presented From October 31, 2007 to September 4, 2008 in Table 2.4-45 of the FSAR along with ground surface and top of casing elevations.

The monitoring wells were used to determine groundwater pressures or elevations in the various aquifers on the site, hydrologic gradients both horizontally and vertically, subsurface flow directions, and hydraulic properties of the aquifer materials through slug, pumping and packer tests. There were 14 slug tests in the glacial overburden aquifer and 11 in bedrock wells. In addition, there were pumping tests with observation wells in the glacial overburden aquifer and the bedrock aquifer. Packer tests were also performed on up to 56 intervals in five of the geological boreholes in bedrock prior to conversion of those boreholes to monitoring wells. In addition to the monitoring wells, water levels in ponds on and adjacent to the site were assumed to be closely coupled to groundwater levels and were used to estimate water table elevations in the glacial overburden aquifer.

The applicant states that there will be eight groundwater sampling locations in the power block area to monitor for potential liquid leaks from the BBNPP for the site's REMP program. The location of these wells, WG1 though WG8, is shown in ER figure 6.2-13, "BBNPP Ground Water Sampling Locations that are within the Protected Area Boundary". These wells will be sampled quarterly.

The applicant describes in FSAR section 2.4.12.5.2 the state of hydrostatic loading on safety related structures during operation in terms of groundwater level below plant grade. The applicant projects that the minimum depth of the water table at the nuclear island basemat will be 193 m (633 ft) msl. Plant grade has been established at 205.4 m (674 ft) msl. The water table elevations in the glacial overburden aquifer will range from 199 to 201 m (653 to 661 ft) msl near the power block. This would place the maximum groundwater level approximately 4 m (13 ft) below plant grade in the power block area, well below the maximum groundwater level of 1 m (3.3 ft) below plant grade specified in the U.S. EPR FSAR. However, the applicant reported that the safety related Essential Service Water Emergency Makeup System (ESWEMS) pumphouse would have a maximum groundwater level 0.9 m (3 ft) below grade. The applicant describes in Section 1.1.1.4 (COLA Part 7: Departures and Exemption Requests) the calculations they used to justify the departure from the U.S. EPR FSAR requirements, and concludes that the departure has no safety significance. Based on their calculations, the applicant requests in Section 1.2.1 (COLA Part 7) an exemption from compliance with the U.S. EPR FSAR Tier 1 and 2 requirements for maximum groundwater level. Given that the groundwater level beneath the ESWEMS pumphouse is so close to the maximum groundwater level specified in the U.S. EPR FSAR, the staff would like an opportunity to examine the details of the applicant's calculation package for determining the groundwater level and safety impacts on the structure.
[RAI 2.4.12-1].

Pressure measurements from the cluster wells indicate that there is an upward gradient in several areas of the site, likely leading to groundwater discharge at the top of the weathered bedrock into the glacial overburden. The staff evaluated whether safety related structures in the discharge areas would experience higher hydrostatic pressure than evident from the water table elevations in the glacial overburden. In this regard, monitoring well 310B near the northwest corner of the power block (finished in the weathered shale) had a maximum measured groundwater elevation of 203.1 m msl

(666.33 ft msl) (FSAR Table 2.4-45). This water level is still about 2.3 m (7.5 ft) below plant grade. Furthermore, it is highly likely that elevated pressure measured in the weathered shale would dissipate in the glacial overburden or engineered fill and not be experienced by any safety related structures.

Fluctuation of groundwater on site

Groundwater elevations fluctuate mainly as a function of recharge at the surface, although there are also effects of vertically upward flow from the underlying shale in some areas. Groundwater elevations are generally lower in summer and fall when precipitation is lowest and evapotranspiration is greatest. The highest groundwater levels generally occur in the winter and spring.

The applicant reports infiltration rates for three drainage basins in the NBSR basin in the Appalachian Plateaus Province and the Ridge and Valley Province. They noted that groundwater recharge approximately equals surface water discharge rates in these basins. The average rate of groundwater recharge for the Wapwallopen Creek Basin, the closest to the BBNPP site, is approximately 36 cm/yr (14.2 inches/yr), or about 32% of the average annual precipitation.

Transport of radioactively contaminated groundwater

The glacial deposits at the location of the BBNPP after site grading will be approximately 0 to 18 m (0 to 60 ft) thick. The thickest overburden occurs along Beach Grove Road. A trough of thick glacial sand and gravel runs from Confers Lane Road and passes through the southern edge of the power block area. The glacial deposits are penetrated by impervious shale that alters the groundwater hydrology in the area. In addition, an impermeable slurry wall will surround the power block area and the ESWEMS pumphouse to facilitate construction dewatering and to protect adjacent wetlands. The southern trough is a potential groundwater pathway for releases of radioactive water from the hypothetical tank spill covered in Section 2.4.13. Groundwater in the southern trough appears to flow into Walker Run.

The operation of the plant should have practically no influence on local or regional groundwater users. The applicant takes potential groundwater users into account in the tank spill analysis presented in Section 2.4.13, but discounts the possibility of a direct groundwater pathway to any of these wells because of the predominant direction of groundwater flow. The applicant's pathway involves groundwater discharge into Walker Run, and then a surface water pathway through the discharge of Walker Run to the North Branch of the Susquehanna River (NBSR). A possible groundwater pathway exists indirectly by way of potential leakage of NBSR water into large water supply wells in Berwick PA, about 8 km (5 miles) downstream of the BBNPP. The staff has requested additional information on the presumed groundwater and surface water pathways in Section 2.4.13. **[RAIs 2.4.13-1 and 2.4.13-3]**.

Hydrogeologic Properties

Hydrogeologic properties of the aquifer materials beneath the site were determined from hydraulic tests conducted on the site and laboratory samples collected from boreholes:

Glacial overburden aquifer - Slug tests in the wells in the glacial overburden aquifer on site predicted horizontal hydraulic conductivity (Kh) values ranging from 1.2 x 10^{-5} cm/s (.0338 ft/day) to 0.034 cm/s (96.3 ft/day). Values of Kh were higher, ranging from 0.0084 to 0.034 cm/s (23.8 to 96.3 ft/day) in the southern trough, which is the postulated path for contaminant transport from the tank spill. Values of Kh for all aquifers beneath the site are presented in FSAR Table 2.4-54. Slug tests measure hydrogeologic properties within a short distance of the wells. The geometric mean of the values from slug tests in the glacial overburden was calculated to be 3.63 x 10^{-3} cm/s (10.3 ft/day)

There were several laboratory measurements of Kh in glacial overburden from core samples presented in Table 2.5-39 of the FSAR. Results from these small-scale tests reported Kh varying from 3.0 x 10^{-5} to 2.1 x 10^{-4} cm/s (0.085 to 0.6 ft/day).

Kh values from a long-term pumping test at monitoring well MW302 gave a value of 5.93 x 10^{-2} cm/s (168 ft/day). Pumping tests at the SSES site for 6 locations in the glacial overburden aquifer yielded Kh values of between 1.16 x 10^{-3} to 7.06 x 10^{-2} cm/s (3.3 and 200 ft/day). Pumping tests generally measure hydrogeologic properties averaged over a much greater distance than slug tests. The applicant chose to use the Kh value of 5.93 x 10^{-2} cm/s (168 ft/day) in the tank spill analysis because it conservatively bounds all measured and average values from other tests on site.

The pumping test in monitoring well MW302 also yield estimates of specific yield (or effective porosity) in the glacial overburden ranging from 0.253 to 0.5, with a median value of 0.322. The median value was used in the tank spill analysis in FSAR Section 2.4.13.

Shale bedrock aquifers – Values of Kh in the shallow weathered bedrock and deep bedrock are smaller than those estimated for the glacial overburden. Slug tests performed on the shallow bedrock yielded Kh values from 3.25 x 10^{-2} ft/day (3.7 x 10^{-4} cm/s) to 1.36 x 10^{-2} cm/s (38.5 ft/day), with a geometric mean Kh of 1.41 x 10^{-3} cm/s (4.01 ft/day). The long-term pumping test gave a Kh value of 1.62 x 10^{-4} cm/s (0.46 ft/day). The pumping test is more representative of the value averaged over a greater distance than the slug test.

Slug tests in the deep bedrock were about one order of magnitude smaller than those in the shallow bedrock. Packer tests in the deep bedrock yielded Kh values of zero (impermeable) to 3.00 x 10^{-4} cm/s (0.85 ft/day). The tests that showed non-zero permeability are probably indicating the presence of fractures in otherwise impermeable rock.

The effective porosities of the shale aquifers were not measured, but are probably smaller than that of the glacial overburden aquifer.

The applicant did not provide details of their field and laboratory analyses of hydrologic properties of aquifer materials on the site. Staff requests details of the handling, measurements and analyses of the applicant's determinations of hydrologic properties. **[RAI 2.4.12-2]**

Groundwater flow and transport

The transport of contaminants released from the BBNPP during accidents is covered in Section 2.4-13. Any accidental spills from the plant are likely to be confined to the glacial overburden aquifer or engineered backfill because of its high permeability and the fact that it is likely to be the first unit encountered beneath the spill. The applicant estimated the approximate travel time from the center of the power block to the expected discharge in Walker Run about 366 m (1200 ft) away would be 282 days, based estimated gradient of 0.0081, a permeability of 5.93 x 10^{-2} cm/s (168 ft/day), and an effective porosity of 0.322. In addition, measurements in cluster wells on the site indicate that there is an upward hydraulic gradient over part of the likely path of radionuclide travel that might further confine the released radionuclides to the glacial overburden aquifer.

2.4.12.5 Post Combined License Activities

There are no post-COL activities related to this section.

2.4.13.6 Conclusions

The NRC staff reviewed the application and checked the referenced U.S. EPR FSAR on Docket No. 52-020. The results of the NRC staff's technical evaluation of the information related to groundwater confirmed that there is no outstanding information expected to be addressed in the COL FSAR related to this section.

The results of the NRC staff's technical evaluation of the information related to groundwater incorporated by reference in the BBNPP COL FSAR will be documented in the staff safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete, and this is being tracked as part of Open Item [1-1]. The staff will update this SER to reflect the final disposition of the design certification application.

However, as a result of the open items **[RAIs 2.4.12-1 and 2.4.12-2]**, the staff is unable to finalize its conclusions on the applicant's submittal of an analysis of groundwater in accordance with the requirements of 10 CFR 50, 10 CFR 52, and 10 CFR 100.

2.4.12-7 REFERENCES

Bell Bend Nuclear Power Plant FSAR

Bell Bend Nuclear Power Plant ER

U.S. EPR FSAR

Bell Bend COLA Part 7

Requests for Additional Information

RAI 2.4.12-1

To meet the requirements of 10 CFR 50.55a, 10 CFR 100.20 and 10 CFR 100.23, a complete description is needed of the methods used for determining groundwater elevations for comparison with the plant design bases. Please describe the process of determining the safety of the pumphouse for the Essential Service Water Emergency Makeup System structure if the groundwater depth is 0.9 m (3.0 feet) below grade, versus the 1 m (3.3 feet) below grade specified in the U.S. EPR design certification.

Staff requests the calculation packages for (1) the applicant’s determination of the groundwater level and (2) the applicant's determination of the safety impacts to the pump house that would result from the groundwater level being closer to grade than the U.S. EPR design limits.

RAI 2.4.12-2

To meet the requirements of 10 CFR 50.55a and 10 CFR 100.20, please provide the following reports and any other information relating to field and laboratory tests for hydrologic properties such as permeability and porosity of on-site materials:

- Data and analyses for pumping tests conducted at the site, including those in Rizzo Project No. 07-3891, File No. F-13, 13i;
- Data and analyses for slug tests conducted at the site, including those in Rizzo Project No. 07-3891, File No. F-13, 13j; and
- A copy of the Ground Water Elevation Calculations 2.5.4-2, Rev 1,Rizzo Project No. 07-3891, File No. F-15.