PMComanchePeakPEm Resource

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Cc: ComanchePeakCOL Resource; Raione, Richard; Hamzehee, Hossein
Subject: Comanche Peak COL application Section 2.4 - Hydrology Issues
Attachments: CPNPP Groundwater Accidental Release Issues Public.docx

Don,

I am sending you the staff's position paper on the hydrology groundwater issues for Comanche Peak Nuclear Power Plant COL. We would like to schedule a conference call with you sometime next week, although we realize there is an ACRS meeting set for October 20, 2011. Please send us your availability for such a call.

Thanks,

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Comanche Peak Nuclear Power Plant
Status of Flooding, Groundwater, and Accidental Release Issues
(FSAR Sections 2.4.2, 2.4.12, and 2.4.13)

October 12, 2011

1.0 Introduction

The NRC staff is providing this information to Luminant to support a conference call to discuss the issues regarding Section 2.4 of the COLA.

The FSAR is now in Revision 2, and numerous updated tracking reports (UTRs) have also been issued by the Applicant. The most recent RAI responses show many improvements over previous submissions, particularly in providing better conceptual models of the groundwater system and its relation to surface water. They are, however, still lacking in key areas, such as quantitative analyses of groundwater levels, usable engineering assumptions about the engineered fill to be placed around structures and its low-permeability cover, and data and analysis methods used to estimate radionuclide dilution in the Squaw Creek Reservoir (SCR).

2.0 General Appraisal of RAIs

The specific RAIs are:

- RAI 4314 (CP RAI #147) Question 02.04.12-8 S01 and Question 02.04.12-9 S02
- RAI 4315 (CP RAI #145) Question 02.04.13-5 S01, Question 02.04.13-6 S01, and Question 02.04.13-7 S01

The responses and modifications to the FSAR do not adequately address the supplemental RAIs and Open Items issued in the areas of onsite flooding, post-construction maximum groundwater level, and accidental release of radioactive liquid effluents. Two general issues are that the Applicant (1) continues to make simplifying assumptions that are not supported by data or analysis, and are not shown to be conservative; and (2) has not provided sufficient detailed design information in certain areas to allow Staff to complete its independent analysis.

Of particular concern for both groundwater and surface water are the Applicant's "conservative" assumptions on the magnitude of dilution, which are not supported by data or technically defensible modeling. Based on information provided by the Applicant, the Staff believes that independent conservative analysis performed by the Staff would likely continue to show possible exceedances of effluent concentration limits (ECLs) as the result of an accidental tank release.

Similarly, unconservative assumptions about groundwater conditions make it possible that, based on existing information, post-construction maximum groundwater level could exceed the DCD limit of 821 ft MSL.

3.0 Detailed Review Comments

3.1 Design Changes

Based on the latest submittal from the Applicant, the following modifications, relevant to both Sections 2.4.12 and 2.4.13, were made to the surface drainage plan:

- The maximum invert elevation of the trench drain at the base of the cut bank on the south side of the site was reduced to 813.5 ft msl from the previous 820 ft msl). This has implications for maximum groundwater level, as discussed below in Section 3.3, Water Levels.
- Additional retaining walls are proposed, with maximum elevation of 817 ft msl
- Overflow elevation of the eastern stormwater retention basin is reduced to less than 812 ft msl
- Overflow elevation of the western stormwater retention basin is reduced to less than 810 ft msl

New engineered fill areas will be capped. No information was provided on the design of the caps (materials, extent, etc.) or whether it includes the circulating water system (CWS) piping fill that goes up the hill to the cooling towers, where groundwater elevations are much higher than the 821 ft msl DCD parameter. The fact that the caps are only over the fill may limit their effectiveness, especially in upland areas where the more permeable regolith is not being removed and will be in contact with the new fill, and where groundwater levels will equilibrate quickly between regolith and fill.

New areas of engineered fill for grade buildup (as distinguished for filling excavations around structures) are shown on FSAR Revision 2 figure 2.4.12-212. This fill for grade buildup is not shown on any of the figures provided with this August 29, 2011 submittal (including figure 2.4.12-212). Fill is being added to create slopes and grade to move surface water to the storm water storage basins. Some of this new fill overlaps with the engineered fill in the essential service water (ESW) pipe tunnel that is adjacent to and in contact with the nuclear facilities, in particular near the Ultimate Heat Sinks (UHSs) near the northeast corner of Unit 3. This creates a potential direct path through new engineered fill from the nuclear facilities to the SCR. The retaining walls in this area will be drained directly to the SCR.

The Applicant states that there will be metal particulates in the boric acid tank (BAT). Staff did not consider the presence of particulates in our previous evaluations (because Staff were not made aware of it). The Applicant has not provided details, for example, of the composition of the metal particles in the BAT.

3.2 Conceptual Model

The conceptual model discussion relevant to Section 2.4.12 is now better, and at least includes more description of potential water balance inputs and outputs. However, the discussion is not quantitative, and the water balance inputs are dismissed by the Applicant as not important without supporting data or calculations. The Applicant assumes that any excess water entering the engineered fill (which might cause groundwater levels to exceed 821 ft msl) can drain out through the existing fill in the areas where existing fill is in contact with the engineered fill. However, in some areas groundwater would have to flow more than 1,000 ft, following a circuitous path through the engineered fill near the structures, before it reaches the existing fill and discharges to the SCR. Additional sources of uncertainty are that no estimates have been provided of the hydraulic conductivity of the engineered fill, or of the proposed low-permeability cover over the fill.

The Applicant states that groundwater exists in two zones: 1) a shallow regolith and shallow Glen Rose Formation bedrock zone, and 2) the underlying Twin Mountains Formation. It is assumed that no "permanent" groundwater occurs in the deeper part of the Glen Rose Formation that lies between these zones. It is assumed that all shallow regolith and shallow bedrock groundwater is "perched," is transient (because it is supplied by intermittent recharge), and will be removed during construction. Site data do not support this conceptualization. Existence of deeper Glen Rose groundwater is dismissed by the Applicant as not "permanent," despite long-term increasing trends in many of the deep C-zone wells. Slowly increasing water levels in wells in the deeper Glen Rose are, however, more sensibly interpreted as the result of groundwater inflow into the wells from a saturated, low-permeability formation. This conceptual model appears more likely than one in which groundwater in the deeper Glen Rose is not "permanent," (and it is not clear what "permanent" would mean in this case).

The Applicant eliminates the accidental release pathway to the storm flow basins from consideration under Section 2.4.13 by saying the storm flow inverts are at too high an elevation. This rationale is questionable, because the basin inverts are lower than the 813.5 ft msl cut bank drain invert elevation (which the Applicant states will limit the maximum groundwater level), and because the head in the basins will be lower than the invert when not full. It is easy to conceptualize scenarios where groundwater could flow into the storm basins, since they are not lined.

3.3 Water Levels

The Applicant uses the reduced elevation of the trench drain to argue that groundwater elevations at the site will not exceed an elevation of 813.5 ft msl, as considered in Section 2.4.12. Groundwater levels in the engineered fill adjacent to safety-related structures are of primary concern. The Applicant's argument ignores many factors significant for controlling the maximum groundwater level, in particular the rate of infiltration into the engineered fill surrounding the structures, and the rate of drainage from the fill toward the SCR. Because of the low permeability of bedrock lying between the trench drain and the structures, these factors will probably govern groundwater levels in the fill more the level of the trench drain. The trench drain crosses the engineered fill at a number of locations, but how this connection may affect groundwater levels has not been analyzed.

The properties and geometry of the fill and its cover will largely determine groundwater levels adjacent to the structures. The resulting groundwater levels may be analyzed using what we consider to be standard, readily available modeling methods.

Also in relation to groundwater levels, previous versions of FSAR Section 2.5 assumed that the groundwater level would be around 760 ft msl, much below the DCD parameter of 821 ft msl for maximum groundwater level. The Applicant now assumes the maximum level to be 813.5 ft msl, as discussed above. This change could impact slope stability calculations.

Potential impacts of higher heads in upland areas on the Units 3 & 4 site are insufficiently considered. These upland areas receive recharge, and groundwater could flow downslope through the fill in pipe trenches into the engineered fill. This possibility has not been analyzed in detail. It is unknown whether the pipe trenches will be covered with a low-permeability cap as is proposed for the engineered fill near the reactor and associated structures. At the most recent site audit, the Applicant suggested that subsurface dams and drainage structures could be installed to prevent downslope flow; however, no specific proposed designs have been received.

3.4 Vertical Pathway Analysis

It was assumed for the accidental release analysis of Section 2.4.13 that only 105 gallons of the 58,000 gallon tank spill migrates vertically. This is based on the difference between the lateral and vertical permeabilities.

A travel time of 18.8 years for vertical radionuclide migration downward from the release point to the Twin Mountains Formation was calculated using Darcy's law, and decay for that period is evaluated. No detailed modeling (e.g. considering dispersion) was conducted. ECLs are exceeded at the top of the Twin Mountains Formation. An effective porosity of 0.12 is assumed which is actually the total porosity (probably this estimate is high even for the total porosity). An effective porosity of 0.05 was used in the Staff's independent analysis. Also, the Applicant assumes a distance of 193 ft for the release to travel to reach the Twin Mountains Formation, but the FSAR states that the thickness of the Glen Rose is 150 ft below the base of the foundation. This 193 ft assumption is not conservative.

Once the release reaches the Twin Mountains it is assumed to move laterally under a very low assumed hydraulic gradient of 0.0052 for 0.75 miles to the site boundary in 62.8 years. The travel time was calculated using Darcy's law, and decay was considered. The permeability assumed is 9 ft/day, based on a USGS value which is less than the value of 12 ft/day measured in onsite wells as described in the Units 1

& 2 FSAR. Effective porosity was assumed to be 0.27, which is probably too high (not conservative), and is probably closer to a total porosity value.

No dilution was assumed in the Glen Rose Formation for this calculation, but dilution in the Twin Mountains Formation was assumed by the Applicant to be equal to the volume of groundwater found in a 5 ft x 5 ft x 0.75 mile aquifer volume (adjusted for porosity). This is not a conservative assumption, nor does it have any good physical basis. The assumption is not clearly based the scientific theory of flow and transport in an aquifer or on site-specific hydrogeological conditions. This is particularly unacceptable because a number of widely accepted, but more physically based, analytical models are readily available for groundwater contaminant transport analysis.

3.5 Horizontal Pathways to the SCR

Basically, the evaluation in the RAI response about horizontal pathways (discussed under Section 2.4.12, but more directly relevant to Section 2.4.13) is the same as in FSAR Revision 2, with the Applicant making the same assumptions about dilution volumes. Therefore, Staff's previous RAIs and supplemental RAIs remain unresolved.

Applicant assumed a lower permeability for the existing fill along Path 2 than Path 1, which is not justified.

The pathway lengths Staff measured are considerably shorter than what the Applicant used.

In the response to RAI 4314, Question 02.04.12-9 S02, the Applicant hypothetically calculates the rate at which groundwater would flow from fully saturated engineered fill into adjacent existing fill through a surface ("contact wall") between them in an area on the east side of the site. The calculation is presented as

Flow rate = (Depth of surface)(Width of surface)(Hydraulic conductivity)

or using the values presented, and introducing a units conversion factor

$$424 \text{ gpm} = (23.5 \text{ ft})(350 \text{ ft})(74.2 \text{ gpd/ft}^2)(1/1{,}440 \text{ day/min})$$

This calculation, however, neglects the hydraulic gradient, which must be included as a factor because the definition of the "practical unit" of gpd/ft^2 contains the hidden assumption of a hydraulic gradient of 1.0. (The older use of "practical units" of gpd/ft^2 for hydraulic conductivity, gpd for flow rate, and the like has been largely abandoned in favor of consistent units such as ft/min or cm/sec.) The hydraulic gradient under the conditions used for the calculation would certainly be small. The current hydraulic gradient is unknown, but must be much less than 1.0. Its magnitude may be estimated using water levels in the existing fill and Squaw Creek Reservoir. Groundwater elevations measured in well MW1211A, which is completed in the existing fill, are a few tenths of a foot below the elevation of Squaw Creek Reservoir reported by the USGS for the same day. The apparent lower elevation is unlikely to be real, and may result from use of different vertical datums. The only conclusion that may be drawn is that the existing hydraulic gradient is small, probably less than 0.01. Thus, it is clear that the calculated flow rate is grossly overstated. Possibly the hydraulic conductivity was misinterpreted as representing a volumetric flux.

3.6 Mixing Within the SCR

Radionuclide releases may migrate to the SCR by way of groundwater. For purposes of analysis relevant to Section 2.4.13, the Applicant conservatively assumes that the entire release will be transported to the SCR will occur without loss of radionuclides, for example by adsorption onto fill material particles. The release will then be diluted within the SCR before it is discharged from the SCR at the Roto-Cone, an outlet structure that is the assumed receptor point. The Applicant's assumptions about dilution within the SCR are not supported by data or modeling results,

3.7 Onsite Flooding and Surface Water Drainage

A detailed site drainage plan is needed for analysis of local intense precipitation flooding under Section 2.4.2. Staff reiterated, through repeated interactions with the Applicant, the importance of having (1) detailed design information and (2) a comprehensive understanding of the impact that surface water and drainage analysis are likely to have on subsurface flow and transport.

During the most recent safety site audit conducted in June 2011, Staff raised the following major issues:

- The Applicant's existing site drainage plan with 5-ft interval contours is not detailed enough to satisfactorily support Staff's review.
- The Applicant's analysis of onsite flooding from local intense precipitation is not adequate. While the standard practice is to use readily available computer software, the Applicant relied on hand calculations that fail to address important hydraulic characteristics of overland and channel flow.
- Staff's independent analysis (based on the current inadequate site drainage plan and Staff's computer modeling) indicated that there is a potential for exceedance of the design basis flood stage resulting from probable maximum precipitation.
- The Applicant has not demonstrated whether there is a potential for initiation of scour and supercritical flows in certain critical sections of the drainage channel.
- The Applicant also needs to provide analysis that provides reasonable assurance that the existing units will not be impacted as a result of the construction and operation of the proposed new units.

At the end of the audit, the Applicant promised to develop a computer model that will address the issues described by Staff and resolve the overall inadequacy of the surface water analysis. The Applicant also was committed to provide a clearer presentation of the site drainage features and site drainage plan with usable contour resolution. The current schedule for submitting the surface water related response is October 21, 2011. There is a potential for results of the onsite flooding and drainage analysis to impact the recharge characteristics and subsequently the estimation of post-construction maximum groundwater level.

4.0 Summary

Review of the Comanche Peak COL FSAR, sections 2.4.12 and 2.4.13,has not resolved the number of open items. Repeated RAIs and site audits have yielded improvements, but deficiencies remain in the FSAR, currently in Revision 2. Problem areas include:

- Use of arbitrary assumptions that lack physical support and thus cannot be rigorously evaluated.
- Lack of quantitative analysis in areas where normal engineering and scientific practice would call for it.
- Lack of key engineering decisions, for example making reasonable assumptions about the hydraulic conductivity of the engineered fill and of the cover layer above it.
- Inadequate, and non-quantitative, analysis of maximum groundwater level in engineered fill, including reliance on trench drain elevations that are almost certainly irrelevant.
- A conceptualization of the occurrence of groundwater that conflicts with available monitoring well water levels.
- Analysis of radionuclide dilution in the Twin Mountains Formation that relies on arbitrary assumptions about the dilution volume that lack clear physical support.
- An obviously incorrect estimate of flow rate from the engineered fill into adjacent existing fill.
- Estimates of dilution within the SCR that are based on largely arbitrary, and physically unsupported, dilution volumes.