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March 29, 2012

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555
ATTN: David B. Matthews, Director
Division of New Reactor Licensing

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT, UNITS 3 AND 4
DOCKET NUMBERS 52-034 AND 52-035
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION NO. 6158
(SECTION 6.4)

Dear Sir:

Luminant Generation Company LLC (Luminant) submits herein the response to Request for Additional Information (RAI) No. 6158 (CP RAI #240) for the Combined License Application for Comanche Peak Nuclear Power Plant Units 3 and 4. The RAI response addresses main control room heating, ventilation, and air conditioning.

Should you have any questions regarding this response, please contact Don Woodlan (254-897-6887, Donald.Woodlan@luminant.com) or me.

There are no commitments in this letter.

I state under penalty of perjury that the foregoing is true and correct.

Executed on March 29, 2012.

Sincerely,

Luminant Generation Company LLC

Rafael Flores

Rafael Flores

Attachment: Response to Request for Additional Information No. 6158 (CP RAI #240)

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NRO

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RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak, Units 3 and 4

Luminant Generation Company LLC

Docket Nos. 52-034 and 52-035

RAI NO.: 6158 (CP RAI #240)

SRP SECTION: 06.04 - Control Room Habitability System

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

DATE OF RAI ISSUE: 11/15/2011

QUESTION NO.: 06.04-14

The staff notes that CP COL 6.4(2) and STD COL 6.4(2) first appeared in Revision 2 of RCOLA Part 2 FSAR Section 6.4.7 next to Combined License Information item 6.4(2), "Automatic and manual action for the MCR HVAC system that are required in the event of postulated toxic gas release." COLA Revision 1 FSAR had only labeled item 6.4(2) as CP COL 6.4(2). The staff believes that US-APWR DCD subsection 6.4.3 contains wording that is only application specific. In particular, the RCOLA applicant cannot apply the conclusions of US-APWR DCD subsection 6.4.3 to each subsequent SCOLA applicant.

The staff requests additional information/justification as to why the applicant elected to assign the label "STD COL 6.4(2)" to the information contained in FSAR subsection 6.4.3.

ANSWER:

The left margin notation in FSAR Subsections 6.4.3 and 6.4.7 has been changed from "STD COL 6.4(2)" to "CP COL 6.4(2)".

Impact on R-COLA

See attached marked-up FSAR Revision 2 pages 6.4-1 and 6.4-4.

Impact on S-COLA

None; this response is site-specific.

Impact on DCD

None.

6.4 HABITABILITY SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

6.4.3 System Operational Procedures

STDCP COL 6.4(2) Replace the third paragraph in DCD Subsection 6.4.3 with the following. RCOL2_06.04-14

The analyses of control room habitability during postulated release of toxic chemicals described in Subsection 6.4.4.2 identify no hazardous chemical that exceeds the IDLH criteria of RG 1.78, so that no specific automatic action of MCR HVAC system is required to protect operators within the CRE against toxic gas release event. The emergency isolation mode may be initiated by manual action as described in Subsection 6.4.4.2.

6.4.4.1 Radiological Protection

CP SUP 6.4(1) Add the following text after the paragraph in DCD Subsection 6.4.4.1:

The impact of a post-accident release on the maximum control room dose for the same US-APW-R unit at Comanche Peak has been evaluated and addressed in the DCD. The DCD analysis credits operation of the main control room HVAC system in the pressurization mode. The dose to the control room operation at an adjacent US-APWR unit due to a radiological release from the other US-APWR unit is bounded by the dose to control room operators in the affected unit. While it is possible that the other US-APWR unit may be downwind in an unfavorable location, the dose at the downwind unit would be bounded by what has already been evaluated for a single US-APWR unit in the DCD. In addition, because the shortest distance between existing Comanche Peak Unit 1 or Unit 2 and US-APWR Unit 3 or Unit 4 is several times the separation between Unit 3 and Unit 4, the dose to either US-APWR unit control room from either existing operating unit would be bounded by a release at the same US-APWR Unit. Simultaneous post-accident radiological releases from multiple units at a single site are not considered to be credible. CTS-01395

6.4.4.2 Toxic Gas Protection

CP COL 6.4(1)
CP COL 6.4(2) Replace the second paragraph in DCD Subsection 6.4.4.2 with the following.

The control room habitability analyses consider postulated releases of toxic chemicals from mobile and stationary sources in accordance with the habitability system material condition, configuration controls, safety analyses and operating and maintenance procedures in accordance with the guidance in RG 1.196.

6.4.6 Instrumentation Requirement

STD COL 6.4(5) Replace the last paragraph in DCD Subsection 6.4.6 with the following.

Instrumentation to detect and alarm a hazardous chemical release in the vicinity, and to automatically isolate the control room envelope (CRE) from such releases is not required based on analyses described in Subsection 6.4.4.2. No hazardous chemicals concentrations in the MCR exceeded the IDLH criteria of RG 1.78.

6.4.7 Combined License Information

Replace the content of DCD Subsection 6.4.7 with the following.

CP COL 6.4(1) ***6.4(1)*** *Toxic chemicals of mobile and stationary sources and evaluation of the control room habitability*

This COL item is addressed in Subsection 6.4.4.2.

CP COL 6.4(2) ~~STD COL 6.4(2)~~ ***6.4(2)*** *Automatic and manual action for the MCR HVAC system that are required in the event of postulated toxic gas release* RCOL2_06.04-14

This COL item is addressed in Subsection 6.4.3 and Subsection 6.4.4.2.

6.4(3) *Deleted from the DCD.*

6.4(4) *Deleted from the DCD.*

STD COL 6.4(5) ***6.4(5)*** *Toxic gas detection requirements necessary to protect the CRE*

This COL item is addressed in Subsection 6.4.6.

6.4.8 References

Add the following reference after the last reference in DCD Subsection 6.4.8.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Comanche Peak, Units 3 and 4

Luminant Generation Company LLC

Docket Nos. 52-034 and 52-035

RAI NO.: 6158 (CP RAI #240)

SRP SECTION: 06.04 - Control Room Habitability System

QUESTIONS for Containment and Ventilation Branch 1 (AP1000/EPR Projects) (SPCV)

DATE OF RAI ISSUE: 11/15/2011

QUESTION NO.: 06.04-15

This is follow-up RAI to RAI Letter No. 172 (4678) Question 06.04-9.

In Question 06.04-9, the staff asked a four part question that prompted the applicant to perform a sensitivity analysis to justify and show the effects of changes to the original analysis described in FSAR subsection 6.4.4.2 (i.e. the bounding case above). The applicant responded on October 6, 2010 (ADAMS Accession ML102810224) with the outcomes of changing the inputs of (1) control room intake height; (2) solar radiation and maximum ambient dry bulb temperature; and (3) stability class and wind speed. The staff verified that Revision 2 of RCOLA FSAR subsection 6.4.4.2 contained the outcomes of these sensitivity analyses. The staff performed confirmatory modeling for all the applicant's findings of FSAR Table 2.2-214 and replicated the sensitivity analysis described above.

In addition, the staff performed HABIT modeling for extended runs beyond the applicant's HABIT models which were programmatically limited by timing out (e.g. 12.5 minutes for chlorine). The results of the staff's HABIT modeling of the chlorine accident yielded a MCR concentration still below the IDHL limits but not substantially below. In particular, for the extended run modeling of the chlorine event the staff used an elevated MCR intake of 14.3 meters and a 5% exceedance temperature [i.e. 36.11°C (97°F)]. This model resulted in a maximum peak MCR concentration equal to 8.8 ppm which occurred at 28.25 minutes into the event. This lack of significant margin prompted further investigation by the staff. The staff notes that the ALOHA manual defines a heavy gas as *"A gas that has a molecular weight greater than that of air (the average molecular weight of air is about 29 kilograms per kilomole) will form a heavy gas cloud if enough gas is released."* Chlorine with a molecular weight of 70.9 grams/mole fits the definition of a heavy gas. Based on this, the staff modeled in ALOHA the chlorine event as a heavy gas based on a 5% exceedance temperature and other parameters similar to the HABIT modeling. The staff notes that there is one limitation of the ALOHA model in that MCR intake elevations cannot be factored into the model. The ALOHA heavy gas model for the chlorine event yielded a peak internal building concentration of 46.5 ppm occurring at approximately 25 minutes into the event. Internal building concentration for this chlorine model exceeded the IDHL limit of 10 ppm at approximately 18 minutes into the event.

In light of the comparative results of the HABIT versus ALOHA modeling for chlorine, the staff produced a ALOHA heavy gas model for a 93% by weight sulfuric acid solution. The molecular weight of a sulfuric acid solution equals 98.1 grams/mole with an IDHL of 15 mg/m^3.

The ALOHA heavy gas model for sulfuric acid assumed a continuous release over 60 minutes and used a 5% exceedance temperature and a stability class consistent with Regulatory Guide 1.78 guidance. The results of the ALOHA heavy gas analysis for sulfuric acid yielded an indoor concentration of 8,090 mg/m^3 at 60 minutes with an onward (beyond the graph) slope of 10-15° rising. It appears that the IDLH within the building at ground level (i.e. not representative of an elevated MCR) could be exceeded at about 5 minutes after the event (i.e. sulfuric tank rupture). As a point of comparison, the staff ran a HABIT model adhering to the temperature and stability class guidance of RG 1.78. A non-elevated MCR intake and a "Liquid Tank Burst" were also assumed. The staff's Habit run, timed out at 18.9 min with both the external and internal concentrations still slowing rising. At 18.9 min the CRE concentration was up to 5.082E-2 mg/m^3. The IDHL is 15 mg/m^3.

The staff also notes that both the applicant's and the staff's HABIT modeling illustrate the sensitivity of the EXTRAN results to the parameter of MCR intake height. The staff believes that the MCR HVAC intake height used in the habitability analyses needs to be captured as a plant attribute in FSAR 6.4.4.2 "Toxic Gas Protection". The staff requests that the applicant revise FSAR 6.4.4.2 accordingly.

In summation, the staff posits that since chlorine and sulfuric acid clearly fit the definition of a heavy gas that ALOHA modeling is the more appropriate program (i.e. as opposed to HABIT) to use for determining MCR habitability. More specifically, the use of the HABIT Gaussian model may be producing non-conservative results for these two heavy gases. The staff requests that the applicant re-evaluate their findings of FSAR 6.4.4.2 and address the fact that chlorine and sulfuric acid are heavy gases and provide a comprehensive justification for why the results are appropriate and conservative.

ANSWER:

Chlorine IDLH

The IDLH limit for chlorine is 10 ppm and is inherently conservative since it provides significant margin for the safety of the operators. For example, the NIOSH (National Institute for Occupational Safety Health) "Documentation for Immediately Dangerous To Life or Health Concentrations (IDLHs)" for chlorine indicates an original IDLH of 30 ppm based on "exposure to 30 ppm will cause intense coughing fits, and exposure to 40 to 60 ppm for 30 to 60 minutes or more may cause serious damage".

However, RG 1.78, Rev. 1, states:

> The IDLH value or limit, based on a 30-minute exposure level, is defined as one that is likely to cause death or immediate or delayed permanent adverse health effects if no protection is afforded within 30 minutes. For each chemical considered, the IDLH limit can be tolerated for 2 minutes without physical incapacitation (for example, severe coughing, eye burn, or severe skin irritation) of an average human. Thus, a 2-minute exposure to the IDLH limits provides an adequate margin of safety in protecting control room operators, and these limits are recommended.

Accordingly, the NIOSH original IDLH limit of 30 ppm appears to be more consistent with the RG intent and can be used to illustrate significant margins.

Perhaps most importantly, RG 1.78 states:

> It is expected that a control room operator will take protective measures within 2 minutes (adequate time to don a respirator and protective clothing) after the detection and, therefore, will not be subjected to prolonged exposure at the IDLH concentration levels.

> If toxicity limits of released chemicals are not available and no detection instruments are available in the control room for the hazardous chemicals under consideration, the human detection threshold, such as the odor threshold, may be used.

In addition to the above conservatism in using an IDLH limit of 10 ppm, the modeling of the event also utilizes significant conservatisms, including:

- Postulation of a full chlorine release from a maximum capacity truck accident at the highway location of closest approach to the control room intake
- Postulation of meteorological characteristics representative of the worst five percent (per RG 1.78) or of even lower probability conditions (for example, worst lower percentage temperatures, utilization of zero cloud cover conditions, etc.)
- Control room intake conditions representative of worst-case intake flow combined with worst-case postulated infiltration, with no operator action assumed to reduce these.
- No control room operator notification of the initiation of the event prior to event determination by the odor detection threshold.
- No credit for the significant dispersion effects of building wakes in the vicinity of the control room intake.

Accordingly, the critical parameter for operator safety is not the peak MCR concentration, but whether the time between the odor detection threshold and the IDLH limit exceeds 2 minutes (0.08 ppm for chlorine per NUREG/CR-6624, as noted in the referenced applicant response to RAI 4678). The analyses described below were performed to show that sufficient time is available for the operators to take protective measures to avoid prolonged exposure per RG 1.78.

Heavy Gas Dispersion Methodology

Based on the definition of a "heavy gas" in the ALOHA User's Manual (The CAMEO Software System – ALOHA User's Manual, dated February 2007), the postulated release of chlorine gas fits the definition of a heavy gas. However, the ALOHA model has the limitation that MCR intake elevations cannot be factored into the model because ALOHA calculations are based on a "flat-earth" model.

In addition, per the ALOHA manual, the diffusion behavior of a dense gas becomes neutrally buoyant (i.e., Gaussian) after the diffused gas concentration reaches 1%. From the ALOHA manual:

> When a gas that is heavier than air is released, it initially behaves very differently from a neutrally buoyant gas. The heavy gas will first "slump," or sink, because it is heavier than the surrounding air. As the gas cloud moves downwind, gravity makes it spread; this can cause some of the vapor to travel upwind of its release point. Farther downwind, as the cloud becomes more diluted and its density approaches that of air, it begins behaving like a neutrally buoyant gas. This takes place when the concentration of heavy gas in the surrounding air drops below about 1 percent (10,000 parts per million).

Given this fact and the limitation of ALOHA noted above, a combined "virtual source" approach was performed to utilize the combined features of ALOHA and HABIT.

For the virtual source approach, the heavy gas dispersion model in ALOHA was initially used to determine the distance ($D_{1\%HG}$) from the postulated chlorine source to the nearest location where a 1% resulting heavy gas chlorine concentration was reached. This acknowledges the heavy gas behavior for concentrations above 1%. Next, a similar distance ($D_{1\%NB}$) to 1% concentration for a neutrally buoyant gas was evaluated with HABIT and subtracted from the previous distance. This acknowledges the transition between the two behaviors as concentration approaches 1% (i.e., the heavy gas does not spontaneously transition to neutrally buoyant). Finally, a full neutrally buoyant chlorine release was then assumed to occur at a virtual source location closer to the control room than the actual postulated chlorine source. This virtual source was moved closer by an amount equal to the difference in the two distances ($D_{1\%HG}$ - $D_{1\%NB}$) calculated above and the virtual source was evaluated using HABIT. This virtual source evaluation in HABIT acknowledges neutrally buoyant behavior for low concentrations and its effect for an elevated control room intake.

As an additional note, the calculations below were performed with ALOHA v5.4.2. Per discussions with the software developer (National Oceanic and Atmospheric Administration), this version modified the reference height for the wind speed profiles in the code calculation. This change was found to produce conservatively higher concentration results compared to the previous version (v5.4.1.2).

Virtual Source Calculation

The heavy gas dispersion model in ALOHA was used to determine the distance from the postulated chlorine source to the nearest location where a 1% resulting heavy gas chlorine concentration was reached under the worst-case conditions stated in the RAI. This evaluation used Pasquill Stability Class F, which is the worst-case Stability Class permitted by ALOHA. (Note that per the ALOHA manual, such stable atmosphere conditions are conservatively inconsistent with the strong solar heating conditions postulated at a 5% exceedance temperature of 36.11°C or 97°F). This distance ($D_{1\%HG}$) from the source was found to be 606 meters, while the total horizontal distance from the postulated chlorine source to the nearest control room intake is 2253 meters.

Next, HABIT runs were made at F stability and a range of wind speeds from 1 to 6 meters/second to find the worst-case distance where HABIT predicts this same 10,000 ppm concentration with its Gaussian model ($D_{1\%NB}$). This distance was calculated to be 178 meters, resulting in a final offset for the virtual source of 428 meters (606 – 178 meters). The HABIT analysis was then re-run for all wind speeds, including 2.5 meters/second, at this distance of 1825 meters (2253 – (606 – 178) meters) to the nearest control room intake with credit for the 14.3 meter control room elevation. The resulting true virtual source modeling gave MCR results as shown on the following Figure 1 plot. The plot shows the time available for a control room operator to detect a release at the odor threshold (0.08 ppm) and then take protective measures before the IDLH of a MCR concentration of 10 ppm is reached is always over 12 minutes. This is well over the 2 minutes considered by RG 1.78 as adequate time before the IDLH of a MCR concentration of 10 ppm is reached.

Accordingly, this analysis indicates the sufficiency of the previous evaluations. FSAR Section 6.4 has been revised to describe the above chlorine results. FSAR Subsection 6.4.4.2 has also been revised to add the MCR HVAC intake height (14.3 meters) that was used in the habitability analyses in order to recognize the importance of an elevated intake to provide protection for the operators.

Sulfuric Acid Modeling

Per RG 1.78, 10 torr is the vapor pressure threshold that determines the need for consideration of flashing and boil off in liquid spill release determinations; chemicals with such a low vapor pressure (<10 torr) are not considered to result in significant atmospheric gaseous releases. The vapor pressure of a sulfuric acid solution at normal temperatures is approximately 0.001 torr. Accordingly, with such a negligible vapor pressure, sulfuric acid solutions can be screened out from consideration for control room habitability evaluation.

Impact on R-COLA

See attached mark-up FSAR Revision 2 pages 6.4-2 and 6.4-3.

Impact on S-COLA

None.

Impact on DCD

None.

requirements of RG 1.78. Chemicals, including chemicals in Comanche Peak Nuclear Power Plant (CPNPP) Units 1 and 2, are identified and screened as described in Subsection 2.2.3.1.3.

Several hazardous chemicals exceed the screening criteria provided in RG 1.78 and an analysis is required to determine control room concentrations. Toxic chemicals that do not meet RG 1.78 screening criteria are identified in Table 2.2-214, and calculated maximum control room concentrations of each chemical are also described in Table 2.2-214. Using conservative assumptions and input data for chemical source term, CPNPP Units 3 and 4 control room parameters, site characteristics, and meteorology inputs, postulated chemical releases are analyzed for maximum value concentration to the MCR using the HABIT code, version 1.1. RG 1.78 specifies the use of HABIT ~~1.1~~ software for evaluating control room habitability. HABIT software includes modules that evaluate radiological and toxic chemical transport and exposure. For this analysis of chemical release concentrations, EXTRAN, and CHEM modules are utilized in the code. EXTRAN models toxic chemical transport from the selected release point to the ~~heating, ventilation, and air conditioning (~~HVAC~~)~~ intake for the MCR, considered at a bounding height of 14.3 meters above an assumed ground level release (i.e., conservatively lower than the bottom elevation of the fresh air intake missile shield). CHEM is then applied by HABIT to model chemical exposure to control room personnel, based on EXTRAN output and MCR design parameters. RCOL2_06.04-15 RCOL2_06.04-15

The meteorological conditions assumed for these cases were initially set at G stability and 2.5 m/s wind speed, which is more extreme than 95th percentile for the CPNPP site. The 2.5 m/s wind speed is higher than would be expected for G stability but is conservative in that it introduces the chemical gas into the intakes faster than at lower speeds. The analyses are thus bounding. Lower concentrations are calculated on average using F stability and results for a range of wind speeds and worst case conditions are also presented below as a sensitivity analysis.

The HABIT-based analysis determines the peak concentration in the MCR and compares this level to the RG 1.78 criterion, the specific chemical listed immediately dangerous to life and health (IDLH). In the cases that were analyzed, all postulated releases led to concentrations that are ~~well~~ below the IDLH level. Values of IDLH for various chemicals are found in NUREG/CR-6624 (Reference 6.4-201). RCOL2_06.04-15

The most limiting case, or the one that leads to the highest control room concentration relative to the IDLH, is the tanker truck release of chlorine on Highway FM 56, at a distance of closest approach to CPNPP Units 3 and 4 MCR intake of 1.4 miles. Chlorine is used for this case because it is one of the most hazardous Department of Transportation approved chemicals, and bounds other chemicals by toxicity, dispersibility, and quantity that may use public transportation such as Highway FM 56. Using the methodology prescribed by RG 1.78, as well as the heavy gas modeling in ALOHA, the ~~HABIT initial~~ analysis ~~for G stability and 2.5 m/s wind speed~~ showed MCR concentration remains below ~~5.7~~10 ppm ~~at~~ RCOL2_06.04-15

~~equilibrium in the MCR~~throughout the evaluated transient under all conditions. ~~This concentration (5.7ppm) is less than t~~The IDLH concentration for chlorine ~~(~~is 10 ppm~~).~~ ~~The concentration at the MCR HVAC intakes, that is the concentration of outside, will exceed the IDLH (10 ppm) at about 2.5 minutes, remain elevated until approximately 7 minutes, and then start decreasing slowly on a scale based on the volume and ventilation rates in the MCR.~~ RCOL2_06.04-15

For Class F stability and the worst case sensitivity analysis conditions of an intake height of 0 m, solar radiation of 1150 W/m^2, a wind speed of 6 m/s, air and ground temperature of 115 °F, and cloud cover of 0 tenths, the concentration in the MCR reaches the human detection threshold for chlorine (0.08 ppm) at approximately 0.25 minutes and reaches the maximum concentration (8.0 ppm) in approximately 16 minutes. Additional sensitivity analyses were performed with the heavy gas model in ALOHA combined with HABIT to model a "virtual source" at the distance from the release location where the released gas behaves as a neutrally buoyant gas. The sensitivity results confirmed the previous analysis results. RCOL2_06.04-15

RG 1.78 states that it is expected that a control room operator will don a respirator and protective clothing, or take other mitigating action within two minutes after detection. Also during a toxic gas emergency, the control room operators have the option of manually actuating the emergency isolation mode of the MCR HVAC System.

All of the FSAR Table 2.2-214 assumed chemical releases were analyzed with the HABIT code, and produce maximum control room concentration values~~well~~ below the IDLH. Therefore, there will be no procedure requiring operator action, either donning respirators and protective clothing or manually isolating the control room HVAC System. Both of these response actions will be considered at the discretion of the operators in the event of a toxic gas release. The CPNPP Units 3 and 4 Emergency Plan includes provisions for maintaining self-contained breathing apparatuses (SCBAs) in the control room. A toxic gas release is within the scope of procedures addressed by FSAR Subsection 13.5.2. Training is addressed in the CPNPP Emergency Plan and in Subsection 13.2 of the FSAR. RCOL2_06.04-15

Periodic surveys are conducted for onsite chemicals annually and for offsite at least once every three years for stationary and mobile sources of hazardous chemicals within a five mile radius of the plant in accordance with Regulatory Guide 1.196 Regulatory Position 2.5. In addition, prior to use, chemicals and chemicals of potential impact (halogenated gas or liquid products to be purchased in quantities of 100 pounds or greater) require a Control Room Habitability assessment. Procedures to implement these periodic surveys and chemical evaluations are developed per Subsection 13.5.2.2.

ITAAC (Tier 1 Section 2.7.5.1.2) and pre-operational tests (Tier 2 Subsection 14.2.12.1.101) address CRE integrity and verify the functional arrangement of MCR HVAC equipment and systems in adjacent areas with the design description, in accordance with RG 1.196. Operating and maintenance procedures as mentioned in FSAR Section 13.5 address periodic assessment of the control room