**Tennessee Valley Authority**, 1101 Market Street, LP 5A, Chattanooga, Tennessee 37402-2801

June 29, 2009

10 CFR 52.79

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

In the Matter of )
Tennessee Valley Authority )

Docket No. 52-014 and 52-015

BELLEFONTE COMBINED LICENSE APPLICATION – RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION - CONTROL ROOM HABITABILITY SYSTEMS

References: 1) Letter from Ravindra G. Joshi (NRC) to Andrea L. Sterdis (TVA), Request for Additional Information Letter No. 159 Related to SRP Section 06.04 for the Bellefonte Units 3 and 4 Combined License Application, dated May 27, 2009.

2) Letter from Andrea L. Sterdis (TVA) to Document Control Desk (NRC), Request for Additional Information Letter No. 132 Supplement 1 Related to EVALUATION OF POTENTIAL HAZARDS – IDLH CONCENTRATIONS for the Bellefonte Units 3 and 4 Combined License Application, dated February 13, 2009.

This letter provides the Tennessee Valley Authority's (TVA's) response to the Nuclear Regulatory Commission's (NRC) request for additional information (RAI) included in Reference 1.

A response to the RAI is addressed in the enclosure which also identifies associated changes to be made in a future revision of the BLN application

The analyses performed in preparation of this RAI response identified changes required in a future revision of the BLN application to COLA changes previously identified in Reference 2. These COLA changes are provided in this response.

If you should have any questions, please contact Tom Spink at 1101 Market Street, LP5A, Chattanooga, Tennessee 37402-2801, by telephone at (423) 751-7062, or via email at tespink@tva.gov.

D085
A102
NRO

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

Executed on this 29th day of June, 2009.

Andrea L. Sterdis
Manager, New Nuclear Licensing and Industry Affairs
Nuclear Generation Development & Construction

Enclosure
cc: See Page 3

cc: (w/Enclosure)
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Enclosure
TVA letter dated June 29, 2009
RAI Response

Responses to NRC Request for Additional Information letter No. 159 dated May 27, 2009
(7 pages, including this list)

Subject: Control Room Habitability Systems detailed in the Final Safety Analysis Report

| **RAI Number** | **Date of TVA Response** |
|---|---|
| 06.04-06 | This letter – see following pages |

| **Associated Additional Attachments / Enclosures** | **Pages Included** |
|---|---|
| None | None |

Enclosure
TVA letter dated June 29, 2009
RAI Response

**NRC Letter Dated: May 27, 2009**

**NRC Review of Final Safety Analysis Report**

**NRC RAI NUMBER: 06.04-06**

Bellefonte Nuclear Plant, Units 3 & 4 COL Application FSAR 6.4.4.2 "Toxic Chemical Habitability Analysis"

Utilizing the method provided in Regulatory Guide 1.78 Appendix A, FSAR Figure 6.4-201 indicates the presence of chlorine in the atmosphere (human detection threshold is 3.5 ppm; at approximately 12 minutes on Figure 6.4-201). As indicated in Regulatory Guide 1.78, it is expected that a control room operator will take protective measures within two minutes after detection. Procedures require that control room personnel manually activate VES in the event of a chlorine gas release that affects the control room environment.

Figure 6.4-201 only simulates VBS operation for more than 20 minutes. Control room chlorine concentration after the switching from VBS to VES is missing. Please provide the computer simulation that should continue to cover the VES portion of operation to demonstrate chlorine concentration in the control room does not exceed the limit.

Also, the control room inleakage rates are not considered for the VBS simulation. The VBS inleakage is higher than the leakage rate during VES operation per DCD. Westinghouse is revising (Westinghouse letter dated May 4, 2009) its design to allow 15 cfm control room unfiltered inleakage (10 cfm through control room envelope plus 5 cfm through vestibule doors ingress/egress) during VES operation. Any revised VBS and VES control room inleakage should be considered in the computer simulations.

**BLN RAI ID: 3406**

**BLN RESPONSE:**

This response provides supplemental information to the analysis provided in response to the NRC request for additional information item 02.02.03-08 in letter BLN-RAI-LTR-132, Supplement 1.

The analysis provided in response to RAI 02.02.03-08 in BLN-RAI-LTR-132 Supplement 1 provided hazardous chemical concentrations at the Main Control Room (MCR) HVAC intake and hazardous chemical concentrations in the MCR in the event of a chemical release, without any operator action taken to isolate the control room. The analysis was modeled with the nuclear island nonradioactive ventilation system (VBS) in normal mode of operation throughout the toxic gas release scenario. This response to RAI 06.04-06 considers control room personnel actuation of the Control Room Emergency Habitability System (VES) within 2 minutes once the human detection odor threshold is reached.

To determine the interior MCR chemical concentration once VES is activated and to prevent exceedance of the chemical Immediately Dangerous to Life or Health (IDLH) peak concentration criteria after odor detection, additional analysis was preformed using the same methodologies described in RAI 02.02.03-08. The data provided in DCD Table 15.6.5-2 and the design changes identified in the Westinghouse letter of May 4, 2009 (NRC/DCP2457, Docket No. 52-006), were also considered in this analysis.

Per DCD Table 15.6.5-2, the following assumptions and parameters were used to model MCR normal VBS mode:

Main control room model:

– Main control room volume equal to 35,700 ($ft^3$) or 1011 ($m^3$)

– Volume of HVAC, including main control room and control support area equal to 105,500 ($ft^3$) or 2987 ($m^3$)

– Normal HVAC operation (prior to switchover to an emergency mode)

- Air intake flow equal to 1925 (cfm) or 0.91 ($m^3/s$)
- Filter efficiency is not applicable to analysis

The following assumptions and parameters were also used to model the chlorine and hydrogen fluoride release impact to the MCR operator:

– Only those meteorological conditions used to determine exterior chemical concentrations which are most time limiting in terms of operator to take actions to isolate MCR and actuate VES are analyzed (same as provided in response to RAI 02.02.03-08, BLN-RAI-LTR-132, Supplement 1);

– Analysis allowed to run with assumptions and parameters used to model MCR in normal VBS mode up to 2 minutes after the MCR interior chemical concentrations reach the chemical odor detection threshold;

– After the MCR interior chemical concentrations reach chemical odor detection threshold two minutes are allowed for manually actuating VES by the MCR operator. The assumptions and parameters used for MCR crediting VES applied are;

- No credit is taken for clean air flow from compressed air bottles of the emergency habitability system 60 (cfm);
- Unfiltered inleakage via ingress/egress 5 (cfm);
- Unfiltered inleakage from other sources 10 (cfm);
- No credit is taken for recirculation flow through filters 600 (cfm).

With MCR VBS in normal mode of operation the inflow from the exterior is 0.31 $m^3/s$ as provided in FSAR Table 6.4-201.

With VES in operation, VBS isolates and the only inflow is the inleakage of 15 cfm per the design changes identified in the Westinghouse letter of May 4, 2009 (NRC/DCP2457, Docket No. 52-006). This 15 cfm inleakage converts to:

$$15 \text{ cfm} * 1 \text{ min}/60\text{s} * (0.3048)^3 \text{ m}^3/\text{ft}^3 = 0.007079 \text{ m}^3/\text{s}$$

The value of 0.007079 $m^3/s$ is 2% of the normal MCR HVAC flow rate of 0.31 $m^3/s$, so the additional MCR concentration rise after VES initiation is small.

Another scenario was evaluated in the analysis for chlorine and hydrogen fluoride. In this scenario the MCR operator takes action by actuating VES just prior to chemical IDLH levels being reached in the MCR considering in leakage. The results of this analysis illustrate that IDLH levels will not be exceeded in the MCR (see Figures 1 and 2 of this response). This scenario provides a new measure of allowable operator action time. Although this time may be less than indicated in the response to RAI 02.02.03-08, it does <u>not</u> invalidate the conclusion that greater than 2 minutes is available for operator action to activate the VES, and therefore does not invalidate the conclusion that the BLN location satisfies Regulatory Guide (RG) 1.78 guidance for protecting the control room operator from toxic gas releases.

An additional analysis was performed for chlorine with an assumed odor detection threshold at 3.5 ppm. There is a considerable range of published chlorine odor detection thresholds. The value of 0.31 ppm used in response to RAI 02.02.03-08 is taken from an EPA source. Other sources, such as the "Handbook of Industrial Toxicology and Hazardous Materials" (by Nicholas P. Cheremisinoff, published by CRC Press, 1999) list 3.5 ppm. NUREG/CR-6624 (Recommendations for Revision of Regulatory Guide 1.78) lists AIHA odor detection threshold of 0.08 ppm for chlorine. Considering the lower NUREG/CR-6624 odor detection threshold value, the values selected for this analysis are more conservative. A web search identified the reasons for this variability as differences between individuals, and, alternatively, as the impact of a tolerance effect "tuning out" the odor (olfactory fatigue). The odor detection threshold value of 3.5 ppm for chlorine is between the value of 0.31 ppm and the maximum operator action time event investigated. Both 0.31 ppm and 3.5 ppm odor detection thresholds are used in the analysis with results provided in Figure 1.

To determine the worst-case meteorological conditions applicable to the toxic chemical release scenarios the process depicted in response to RAI 02.02.03-08 was utilized. The results presented in RAI 02.02.03-08 derive the exterior and interior concentrations for multiple meteorological conditions using the EXTRAN module and CHEM module of the HABIT code (or the JAVA extended HABIT code).

As indicated in response to RAI 02.02.03-08 there are two chemicals that did not screen out based on the screening criterion described in Regulatory Guide 1.78 that require operator actions. Those chemicals are chlorine and hydrogen fluoride.

There are two meteorological conditions in the chlorine release event that are equally time-limiting for an operator to take actions:

1. Stability Class E with a wind speed of 5 m/s; and
2. Stability Class E with a wind speed of 6 m/s.

The worst case in terms of operator action time and meteorological conditions frequency of occurrence is when the wind speed is 5 m/s, stability class E with a ground temperature of 39.61 degrees C and an air temperature of 37.61 degrees C.

In addition there are two meteorological conditions in the hydrogen fluoride release event that are equally time limiting for an operator to take actions:

1. Stability Class E with a wind speed of 4 m/s; and
2. Stability Class E with a wind speed of 8 m/s.

The worst case in terms of operator action time and meteorological conditions frequency of occurrence is when the wind speed is 4 m/s, stability class E with a ground temperature of 39.61 degrees C and an air temperature of 37.61 degrees C.

As shown in Figures 1 and 2 below, the MCR concentration stays well below IDLH if the VES is activated two minutes after MCR interior chemical concentrations reach the chemical odor detection threshold. This is true for the hydrogen fluoride odor detection threshold of 0.04 ppm and for chlorine whether the EPA-generated 0.31 ppm odor detection threshold is used, or the more conservative 3.5 ppm threshold is used.

The following figures include output from both HABIT and the extended JAVA language form of HABIT. As described in the response to BLN-RAI-LTR-132 Supplement 1, these Figures provide a benchmark for the extended HABIT code for as long as the HABIT code runs. The extended version is necessary to see the control room peak concentrations. In every case, there is agreement between the JAVA extended code and HABIT, and in cases where the extended code is needed to show the

peak CR concentration, the extended JAVA code is more conservative (a higher peak) than the HABIT code. Note that the data points are generated by HABIT and the lines are generated by the extended JAVA code.

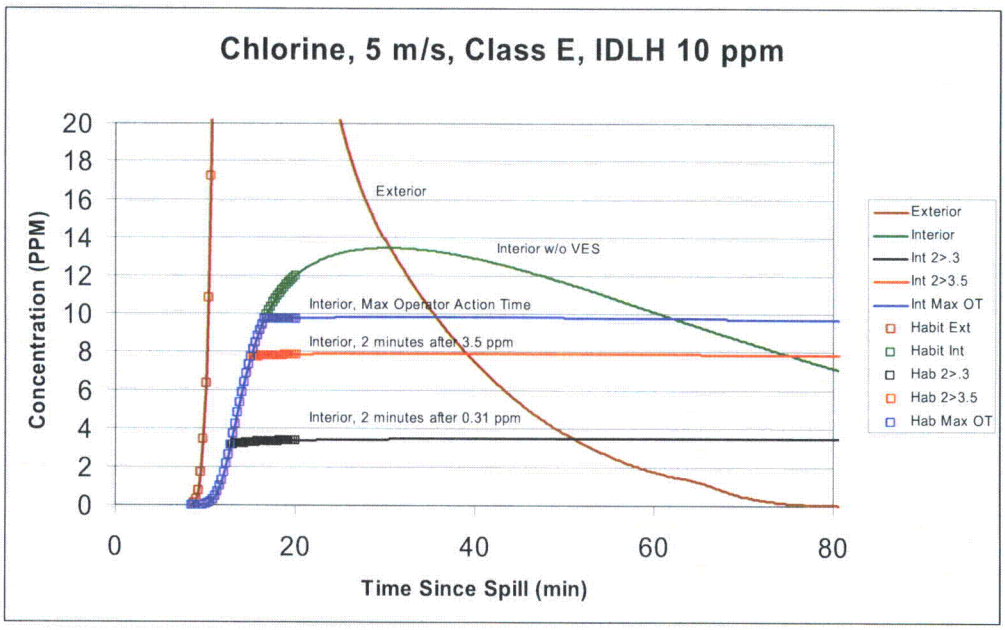


Figure 1: Chlorine, Stability Class E, 5 m/s Wind,
includes the 2 minute operator action time and the 15 cfm MCR inleakage

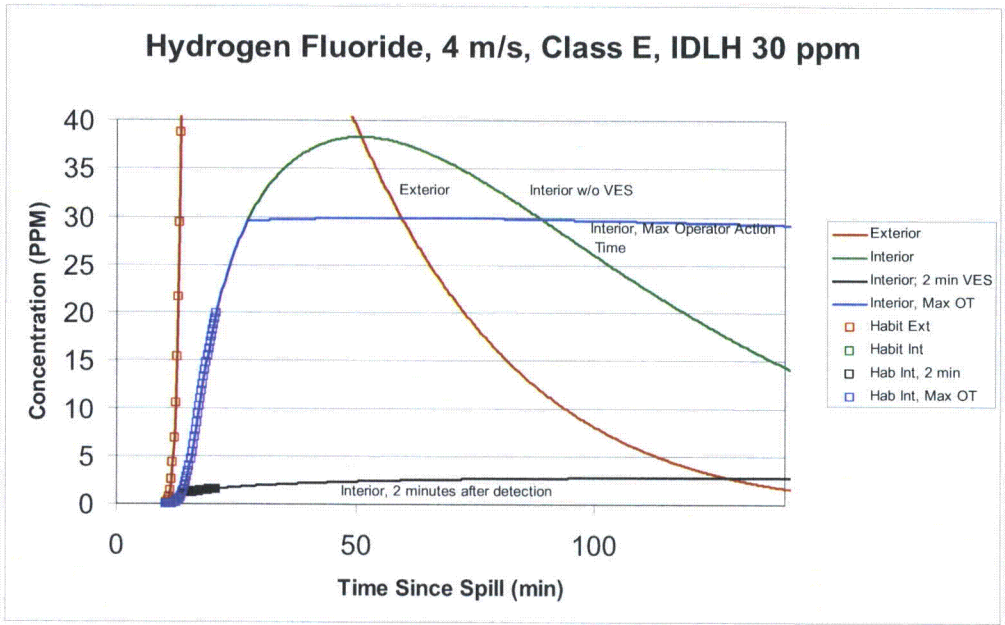


Figure 2: Hydrogen Fluoride, Stability Class E, 4 m/s Wind,
includes the 2 minute operator action time and the 15 cfm MCR inleakage

Table 1 below shows the revised allowable operator action including the MCR concentration overshoot.

Table 1: Results of MCR with VES in Operation

| Chemical | IDLH (ppm) | Stability Class/ Wind Speed | Detection (ppm) | Detection Time (min) | Operator Action Time (min) | VES Actuation Time | Peak CR Concentration (ppm) |
|---|---|---|---|---|---|---|---|
| Chlorine | 10 | E 5 m/s | 0.31 | 10.75 | 2 | 12.75 | 3.49 |
| Chlorine | 10 | E 5 m/s | 3.5 | 13 | 2 | 15 | 7.92 |
| Chlorine | 10 | E 5 m/s | 0.31 | 10.75 | **5.75** | 16.5 | 9.82 |
| Hydrogen Fluoride | 30 | E 4 m/s | 0.04 | 11.75 | 2 | 13.75 | 2.76 |
| Hydrogen Fluoride | 30 | E 4 m/s | 0.04 | 11.75 | **15.5** | 27.25 | 29.84 |

The bolded and underlined values show changes in allowed action time from the analysis performed in support of the RAI 02.02.03-08 response. For chlorine, the allowed operator action time decreases from approximately 6 minutes (RAI 02.03.02-08 response) to approximately 5.75 minutes assuming detection at 0.31 ppm. Evaluation of the table data shows that use of 3.5 ppm as an odor detection threshold reduces the maximum allowed operator action time from approximately 5.75 minutes to approximately 3.5 minutes (this is the difference between the 5 m/s action time of 16.5 minutes and the 3.5 ppm detection time of 13 minutes). For hydrogen fluoride, the allowed time changes from approximately 15.75 minutes (RAI 02.03.02-08 response) to approximately 15.5 minutes.

Procedures will require that control room personnel manually activate VES in the event of a hydrogen fluoride or chlorine gas release that affects the control room environment. A combined operator manual action and VES response time of two minutes is conservatively used for activation, isolation, and pressurization of the control room environment after detecting the presence of hydrogen fluoride or chlorine gas. This time allows the operators to activate VES and protect the operations staff from exceeding IDLH limits.

**Conclusion**

The analysis described above confirms the ability of the emergency habitability system (VES) to meet the Immediately Dangerous to Life or Health (IDLH) peak concentration criteria if operated within 2 minutes of toxic gas detection.

This response is PLANT-SPECIFIC.

**ASSOCIATED BLN COL APPLICATION REVISIONS:**

1. COLA Part 2, FSAR Chapter 6, Subsection 6.4.4.2, tenth paragraph (as revised in response to BLN-RAI-LTR-132, Supplement 1) will be revised from:

The analysis shows that for the case resulting in the most rapid rise in the chlorine concentration inside the control room, it takes approximately ten minutes after the event initiation before the chlorine concentration reaches the human detection threshold of 0.31 ppm. The chlorine concentration inside the control room would reach the IDLH value of 10 ppm 16 minutes after the event initiation, or 6 minutes after human detection.

To read:

The analysis shows that for the case resulting in the most rapid rise in the chlorine concentration inside the control room, it takes approximately ten minutes after the event initiation before the chlorine concentration reaches the human detection threshold of 0.31 ppm. The chlorine concentration inside the control room would reach the IDLH value of 10 ppm at approximately 16 minutes after the event initiation, or approximately 6 minutes after human detection.

2. COLA Part 2, FSAR Chapter 6, Subsection 6.4.4.2, 13th paragraph (as revised in response to BLN-RAI-LTR-132, Supplement 1) will be revised from:

The sensitivity study shows that for the most rapid hydrogen fluoride concentration build up inside the control room it takes approximately five to six minutes after the event takes place before hydrogen fluoride concentration at the control room HVAC intake reaches elevated levels. Approximately one additional minute or less passes before the hydrogen fluoride concentration inside the control room reaches the human detection threshold of 0.04 ppm. Hydrogen fluoride concentration inside the control room would reach the IDLH value of 30 PPM at about 27 minutes, or 15 minutes after human detection.

To read:

The sensitivity study shows that for the most rapid hydrogen fluoride concentration build up inside the control room it takes approximately five to six minutes after the event takes place before hydrogen fluoride concentration at the control room HVAC intake reaches elevated levels. Approximately one additional minute or less passes before the hydrogen fluoride concentration inside the control room reaches the human detection threshold of 0.04 ppm. Hydrogen fluoride concentration inside the control room would reach the IDLH value of 30 PPM at approximately 27 minutes, or approximately 15.75 minutes after human detection.

3. COLA Part 2, FSAR Chapter 6, Subsection 6.4.4.2, (as revised in response to BLN-RAI-LTR-132, Supplement 1) will be revised to include a new paragraph (following the 16$^{th}$ paragraph which begins "A combined operator manual action...") to read:

With VES in operation the only potential toxic inflow to the MCR envelope is the inleakage total of 15 cfm. This inleakage results in a slight increase in toxic gas concentration in the interior of the MCR, but remains below the chemical IDLH peak concentration criteria. For chlorine, the allowed operator action time decreases from approximately 6 minutes to approximately 5.75 minutes with odor detection of 0.31 ppm and for hydrogen fluoride, the allowed operator action time decreases from approximately 15.75 minutes to approximately 15.5 minutes. Allowed operator action time is greater than 2 minutes and therefore satisfies Regulatory Guide (RG) 1.78 guidance for protecting the control room operator from toxic gas releases.

**ASSOCIATED ATTACHMENTS/ENCLOSURES:**

None