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Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Control Room Envelope Unfiltered Air Inleakage Test Results in Response to Generic Letter 2003-01, "Control Room Habitability"

References:

(1) NRC Generic Letter 2003-01, "Control Room Habitability," dated June 12, 2003

(2) Letter from Michael P. Gallagher (Exelon/AmerGen) to NRC, dated August 11, 2003, "Exelon/AmerGen 60-Day Response To NRC Generic Letter 2003-01, "Control Room Habitability"

(3) Letter from Michael P. Gallagher (Exelon/AmerGen) to NRC, dated December 9, 2003, "Exelon/AmerGen 180-Day Response To NRC Generic Letter 2003-01, "Control Room Habitability"

(4) Letter from Michael P. Gallagher (Exelon/AmerGen) to NRC, dated March 19, 2004, Generic Letter 2003-01, "Control Room Habitability, Integrated Control Room Envelope Unfiltered Inleakage Test Schedules"

This letter provides the results of the integrated Control Room Envelope (CRE) inleakage testing performed at Byron Station, Units 1 and 2 during October 2004.

Generic Letter 2003-01, "Control Room Habitability," (Reference 1) requested that licensees provide confirmation that: 1) the control room meets the applicable habitability regulatory requirements (i.e., GDC 1, 3, 4, 5, and 19), and 2) the Control Room Habitability Systems (CRHSs) are designed, constructed, configured, operated, and maintained in accordance with the design and licensing bases.

References 2 and 3 provided the Exelon/AmerGen 60-day and 180-day responses to NRC Generic Letter 2003-01, “Control Room Habitability,” dated June 12, 2003. These responses included the commitment for Byron Station to perform integrated CRE inleakage testing utilizing the American Society for Testing and Materials (ASTM) standard E741-00, “Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution.” Reference 4 provided the planned schedule for performance of the testing at Byron Station, and committed to provide a complete response to the Generic Letter requested information, based on test results, within 90 days of completion of the test.

The measured unfiltered inleakage test values are bounded by the value assumed in the design basis accident radiological analyses for control room habitability. The following provides a description of the testing performed and the results.

CRE Inleakage Testing

Reference 1 requested that licensees confirm the most limiting inleakage into the CRE is less than the values assumed for design basis radiological and hazardous chemical analyses. Reference 1 refers to ASTM E741-00, “Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution,” as an example of an acceptable test methodology.

Lagus Applied Technologies performed the CRE inleakage testing at Byron Station. This testing, based on the ASTM E741-00 methodology, was completed on November 1, 2004.

Test Configurations

The CRE is comprised of the Main Control Room (MCR), Auxiliary Electric Equipment Rooms (AEER), Control Room Ventilation (VC) System Heating, Ventilating, and Air Conditioning (HVAC) Equipment Rooms, Upper Cable Spreading Rooms (UCSR), Security Control Center (SCC), toilets, and other miscellaneous rooms.

The Byron Station Habitability Area Systems consist of two independent 100% capacity VC system equipment trains, except for the common supply and return ductwork. The VC system is common to Units 1 and 2. Each VC train consists of a supply air fan, cooling coils, heating coils, return air fan, refrigeration unit, chilled water pump, associated piping, valves, ductwork, and filters. The system is safety related and active components are designed with redundancy to meet single active failure criteria. The VC system equipment is located within the Seismic Category I Auxiliary Building structure. All VC system components are located within the CRE.

The VC system is designed to maintain a habitable environment and to ensure the operability of all the components in the MCR. Each VC equipment train has a supply air filter unit that contains a medium efficiency filter and a normally bypassed charcoal filter, called the recirculation filter. The emergency make up filter unit (EMU) for each VC train consists of a demister, heater, prefilter, high efficiency particulate air (HEPA) filter, charcoal adsorber, downstream HEPA filter, and a fan. The VC system is provided with redundant equipment to meet single failure criteria. The redundant equipment is supplied with separate essential power sources during a loss of offsite power. The VC system HVAC equipment is designed for Seismic Category I, except for the duct mounted comfort heating coils, humidification equipment, security computer air conditioning unit, and toilet/locker room exhaust fans which are seismically supported to prevent damage to safety related equipment.

In the emergency mode, the VC system maintains the MCR at a positive pressure of ≥ 0.125 inches water gauge, and the UCSR at a positive pressure of ≥ 0.02 inches water gauge, relative to areas adjacent to the CRE, as required by Technical Specification 3.7.10. Differential pressure indicators with an alarm are provided in the MCR and on local HVAC panels to monitor the differential pressure between the MCR and areas adjacent to the CRE. Differential pressure indication and alarm are also provided between the VC HVAC equipment rooms and the adjacent Miscellaneous Electrical Equipment Rooms (MEER).

Radiation and ionization detectors monitor the normal VC system outside make up air intakes. Ionization detectors continuously monitor the VC system Turbine Building make up air intakes. Radiation detectors monitor the outlets of the emergency make up filter units. Area radiation monitors are provided in the MCR. Detection of high radiation is alarmed in the MCR.

Upon high outside air radiation detection, the following automatic actions occur: the normal outside air intake is isolated, air is drawn in from the Turbine Building intake through the EMU, the recirculation charcoal filter bypass damper closes, and the recirculation filter inlet/outlet dampers open. This is called the emergency mode of VC system operation. The Shift Office Ventilation (VV) System, which has ductwork passing through the UCSR area of the CRE, is also automatically shutdown.

Upon initiation of a safety injection signal, the following automatic actions occur: the normal outside air intake is isolated, air is drawn in from the Turbine Building intake through the EMU, the recirculation charcoal filter bypass damper closes, and the recirculation filter inlet/outlet dampers open. The VV System, which has ductwork passing through the UCSR area of the CRE, is manually shutdown per procedure.

The system line-up used for the CRE Tracer Gas Test is based upon a line-up that encompasses the design basis radiological analyses. Since Byron Station does not have a hazardous chemical concern, there is no toxic gas mode of operation required for the CRE. Therefore, the CRE was not tested in that configuration.

To provide the most conservative test results, each VC train (A & B) was tested in the emergency mode of operation. In addition, the Shift Office Ventilation System was shutdown for each train’s test. The normal outside air intakes consist of one bubble tight damper and one low leakage damper in series. When the VC System is operated in the emergency mode, both normal outside air intake dampers are closed. To account for a single active failure, the tracer gas test was conducted with the normal outside air intake bubble tight damper in a failed open position, since inleakage through the low leakage damper would be higher than the bubble tight damper.

The Auxiliary Building Ventilation (VA) System maintains the Auxiliary Building at a negative pressure relative to the outside atmosphere, and therefore the CRE. Since air flows from areas of high pressure to low pressure, changes to the Auxiliary Building pressure that are within the plant design do not directly result in CRE inleakage. A major out leakage path for the CRE is design leakage from the Upper Cable Spreading Room to the Auxiliary building. A more negative Auxiliary Building pressure will cause increased out leakage to the Auxiliary Building since it is an adjacent area to the CRE. This results in lower CRE pressures. Therefore, the VA System was operated with a fan combination that provides the most negative Auxiliary Building pressure during the tracer gas test, since it tends to lower the CRE pressure, which can affect inleakage adversely.

The Miscellaneous Electric Equipment Room Ventilation (VE/VX) System and the Turbine Building Ventilation (VT) System were not placed into any specified lineup since these systems have minimal impact on the CRE differential pressures.

Ductwork from the Laboratory (VL) HVAC System and Radwaste (VW) HVAC System pass through the UCSR area of the CRE. Duct pressure is maximized in these systems when they are operating and could potentially cause unfiltered inleakage. Therefore, the VL and VW systems were operating during each VC train's tracer gas test since these systems are not tripped during high radiation signal or safety injection signal. The VV System, which also has duct passing through the UCSR area of the CRE, was shutdown during the tracer gas test since this system is tripped on a high radiation or safety injection signal as noted above.

The Byron Station control room habitability analysis was re-evaluated during the power uprate project in 2000 for design basis radiological accidents. The unfiltered inleakage value used in the control room habitability radiological dose analysis is 100 cfm.

Test Methods

Exelon Generation Company contracted NCS and Lagus Applied Technologies (LAT) to perform the CRE inleakage testing at Byron Station. Testing was performed with the system aligned as described above using NCS/LAT procedures that were written in accordance with ASTM E741-00, "Standard Test Method for Determining Air Change Rate in a Single Zone by Means of a Tracer Gas Dilution" using sulfur hexafluoride (SF6) as the tracer gas.

Each VC train's test was performed similarly using the Concentration Buildup/Steady State test method. The tracer gas was continuously injected into the VC system emergency makeup air stream at a constant rate and dispersed throughout the CRE. After waiting a sufficient period of time for concentration equilibrium to occur, measurement of the tracer concentration at the most downstream point (in a static pressure sense) of the CRE allows inference of the total inleakage to the CRE.

Makeup flow rates from the EMU filter unit were measured by a tracer gas dilution technique. Measurement of the filtered makeup flow rate in combination with a measured total inleakage value allows calculation of the amount of air inleakage to the CRE that is not provided by makeup flow by differencing these two measured values. Considering that the ductwork and components downstream of the recirculation carbon filter are all located within the pressurized CRE, the inleakage measured in this test was most likely filtered inleakage. However, for conservatism the entire measured inleakage value is considered unfiltered inleakage.

Two mixing fans were used in the CRE during these tests to provide adequate mixing. One fan was used for the toilet adjacent to the MCR and one fan was used for the Janitor's closet.

During each tracer gas air inleakage test, differential pressures between the MCR and various surrounding areas were measured using two highly accurate digital barometers. Initially, both barometers were placed next to each other in the MCR and the units were "zeroed." One unit was then moved to the various locations and the pressure values noted at timed intervals. The indicated pressure values of the unit that remained in the MCR were also recorded at the same timed intervals. The mobile unit was then returned to the MCR and both readings were recorded. This allowed a correction to be made for drift between the responses of the two units.

Differential pressures were then calculated between the various locations by differencing the drift corrected values of the two digital barometers. Elevation corrections were made to the readings of the mobile barometer to ensure that the appropriate differential pressure was determined. To facilitate this correction, a local pressure gradient was calculated using the barometric equation assuming a temperature of 70 degrees F.

Results

The following tabulates the results of the above testing and associated acceptance criteria:

Test	VC System Mode	Train In Service	Outside Air Makeup Flow (SCFM)*	Existing Design Basis Assumption for Maximum Unfiltered CRE Inleakage (CFM)	Unfiltered Inleakage Test - Measured Inleakage (SCFM)*
1	Radiation/ Pressurization	A	5681** ± 197	100	55*** + 104/- 55
2	Radiation/ Pressurization	B	5600** ± 171	100	68*** + 71/- 68

* Referenced to 70 degrees F and 14.7 psia.

** Mean of nine measurements

*** Per Regulatory Guide 1.197 Section 1.4, Inleakage rates below 100 cfm do not require an uncertainty value to be added.

Based on the above, results of the tracer gas test for each VC train operating in the emergency mode indicate that the unfiltered inleakage into the CRE is less than the value assumed in the control room habitability radiological dose analyses of 100 cfm.

Measurement of the differential pressure verified that the MCR is maintained at a positive pressure of at least 0.125 inches water gauge relative to adjacent areas during emergency mode of VC operation at a makeup flow rate greater than or equal to 5400 cfm and less than or equal to 6600 cfm.

Operability of the CRE

The Byron Station VC System is designed to ensure habitability after any of the design basis radiological accidents, assuming unfiltered inleakage rate of 100 cfm. Based on the test results described above, the total unfiltered inleakage value into the Byron Station CRE is less than the value assumed in the existing control room habitability radiological dose analysis. These test results show that Byron Station control room integrity is within the current design assumptions.

The existing Byron Station limiting design basis accident analysis control room operator dose, based on an assumed CRE unfiltered inleakage rate of 100 cfm, bounds the dose that would result from the most limiting measured unfiltered inleakage rate of 68 scfm, and remains within the 10 CFR 50, Appendix A, GDC 19 limits of 5 rem whole body and 30 rem thyroid. Therefore, Byron Station has demonstrated that the most limiting unfiltered inleakage into the CRE is bounded by the value assumed in the design basis radiological analyses for control room habitability. Additionally, Byron Station plans to submit a License Amendment Request (LAR) to incorporate Alternative Source Term (AST) methodology into the Byron Station design and licensing basis in accordance with 10 CFR 50.67. The design basis radiological analyses supporting this LAR demonstrate that an assumed unfiltered inleakage rate of 1,000 cfm results in control room operator dose within regulatory limits. Therefore, the test results described above demonstrate significant margin between measured CRE unfiltered inleakage and the existing design basis accident analysis assumed unfiltered inleakage and for the proposed design basis accident analyses incorporating AST methodology.

The above information completes the Byron Station response to Generic Letter 2003-01, “Control Room Habitability,” requested information Item 1(a).

No new regulatory commitments are established by this submittal. If you have any questions or require additional information, please contact Mr. David J. Distel at (610) 765-5517.

Sincerely,

Original signed by
Stephen E. Kuczynski
Site Vice President
Byron Station

cc: Regional Administrator, NRC Region III
NRC Project Manager, NRR – Byron Station
NRC Senior Resident Inspector – Byron Station
Illinois Emergency Management Agency – Division of Nuclear Safety