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Braidwood Station Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Subject: Control Room Envelope Unfiltered Air Inleakage Test Results in Response to NRC 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, "Exelon/AmerGen 60-Day Response To NRC Generic Letter 2003-01, 'Control Room Habitability'," dated August 11, 2003

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

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

This letter provides the results of the integrated Control Room Envelope (CRE) inleakage testing performed at Braidwood Station during November 3-7, 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.

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References 2 and 3 provided the Exelon/AmerGen 60-day and 180-day responses to NRC Generic Letter 2003-01, "Control Room Habitability." These responses included the commitment for Braidwood Station to perform integrated CRE 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 Braidwood 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 unfiltered 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 Braidwood Station. The testing was performed in accordance with NCS/LAT Procedure 1204A, Revision 5, "Constant Injection Tracer Ventilation Test," which is based on the ASTM E741-00 methodology. The tracer gas test was completed on November 7, 2004.

Test Configurations

The CRE is comprised of the Main Control Room (MCR), Auxiliary Electric Equipment Rooms (AEER), the Control Room Ventilation (VC) System Heating, Ventilating, and Air Conditioning (HVAC) Equipment Rooms, Security Control Center (SCC), Upper Cable Spreading Rooms (UCSR), kitchen, toilets, other miscellaneous rooms, and the associated VC System Air Handling Units (AHU) and ductwork. The UCSR and two vestibules have only filtered supply air from the VC system with no return.

The Braidwood Station VC system consists of two independent 100% capacity 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 makeup air filter unit, makeup air fan, supply fan, return fan, supply air filter unit, recirculation charcoal adsorber, comfort heating coils, chiller, chilled water pump, cooling coils, and associated ductwork and dampers. 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 HVAC 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 recirculation filter unit that contains a medium efficiency filter and a normally bypassed charcoal filter. The emergency makeup 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, "Control Room Ventilation (VC) Filtration System." 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 Division 11/21 Miscellaneous Electrical Equipment Rooms (MEER).

Radiation detectors monitor the normal VC system outside makeup air intakes. Radiation detectors monitor the outlets of the emergency makeup 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 the emergency mode of VC system operation. The Shift Office Ventilation (VV) System, Laboratory Ventilation (VL) System and Radwaste Ventilation (VW) System, which have ductwork passing through the UCSR area of the CRE, are 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, VL and VW Systems, which have ductwork passing through the UCSR area of the CRE, are manually shutdown per procedure.

The system lineup used for the Control Room Envelope Tracer Gas Test is based upon a lineup that encompasses the design basis radiological analyses. Since Braidwood 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.

A Loss of Offsite Power (LOOP) was not considered the most conservative lineup for the test. On a LOOP, the kitchen and toilet exhaust fans would trip off. However, these fans do not trip during accident conditions. The fans exhaust air from areas in the CRE; thereby, reducing CRE differential pressure. Therefore, for conservatism, the kitchen and toilet exhaust fans were verified in operation for the test.

The VC system was run in the emergency makeup mode during the test since the operating VC system train will automatically shift into the emergency makeup mode if a safety injection or a high radiation signal is present.

The emergency makeup flow was set at the nominal value of 6000 actual CFM (ACFM), which is the setpoint of the installed emergency makeup flow controller. This is the design basis flow value and is verified in accordance with Technical Specification 3.7.10. The flow control damper was locked in a single position to reduce any inaccuracies in measurement of the airflow due to fluctuations caused by the feedback signal of the flow controller.

The Auxiliary Building Ventilation (VA) System was adjusted to obtain approximately –0.5 inches water gauge building differential pressure during the test, which encompassed the differential pressures obtained by various VA fan combinations. Although the negative pressure will increase the differential pressure between the CRE and Auxiliary Building, this has a more conservative impact on the test by reducing CRE differential pressures with respect to other adjacent areas, which can affect the inleakage adversely.

The Miscellaneous Electric Equipment Room Ventilation (VE/VX) System was not placed into any specified lineup since this system has minimal impact on the CRE differential pressures.

The Turbine Building Ventilation (VT) System was not placed into any specified lineup based on engineering judgment that the Turbine Building would not pressurize significantly enough in a design basis event to adversely affect the CRE to Turbine Building differential pressure. Although there are no administrative controls to maintain the Turbine Building louvers and windows open, there are typically enough windows/louvers open and various other openings to prevent adverse pressurization of the Turbine Building.

The Diesel Generator Ventilation (VD) System fans, which could reduce the MEER pressure, were verified to be not drawing air from the plenum, since the VD and VE/VX Systems share the same intake plenum.

The VL, VV and VW Systems, which have ductwork passing through the UCSR area of the CRE, were shut down to simulate the system lineup in the event of an outside air high radiation or a safety injection signal.

The toilet recirculation filter unit and security control center air conditioning unit were verified operating for the sole purpose of assisting in mixing. These units are completely contained within their respective rooms and, therefore, have no affect on the inleakage. The use of mixing fans is recommended by ASTM E741-00 to assist in creating a uniform tracer gas concentration and has no impact on inleakage.

Technical Specification Bases B3.7.10 discusses that the normally open outside air intake dampers (one bubble tight damper and one low leakage damper) are arranged in series so that failure of one damper to shut will not result in a breach of isolation. Therefore, to simulate single failure, one of the outside air dampers was maintained open. For conservatism, the low leakage damper was shut while the bubble-tight damper on the operating train was maintained open, since inleakage through the low leakage damper would be higher than the bubble tight damper.

Test Methods

Exelon Corporation contracted NCS Corporation and Lagus Applied Technologies (LAT) to perform the CRE inleakage testing at Braidwood Station. The inleakage testing was performed in accordance with NCS/LAT Procedure 1204A, Revision 5, "Constant Injection Tracer Ventilation Test," which is based on the ASTM E741-00 methodology.

On site calibration of the two AUTOTRAC™ Automated Gas Chromatographs using certified calibration standards was performed daily prior to the initiation of each test to ensure that instrument drift and any sensitivity variations would be minimized. Calibrations were performed in accordance with NCS/LAT Procedure 1308, Revision 2, "Field Calibration of AUTOTRAC™ Automated SF6 Gas Chromatograph."

Makeup flow rates from the EMU filter unit were measured by a tracer gas dilution technique using NCS/LAT Procedure 1215, Revision 5, "Tracer Gas Flowrate Determination Test." Measurement of the filtered makeup flow rate in combination with a measured tracer gas concentration value allows calculation of the amount of air inleakage to the CRE.

Four mixing fans were used in the CRE during the test to assist in providing adequate mixing.

Differential pressures between the MCR and various surrounding areas were measured in accordance with NCS/LAT Procedure 1302, Revision 2, "Measurement of Control Room Differential Pressures," using two calibrated 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 differences between the responses of the two units. Differential pressure calculations included corrections for differences in instruments and elevations.

Each VC train test was performed similarly using a Concentration Buildup/Steady State tracer gas test method in accordance with NCS/LAT Procedure 1204A, Revision 5, "Constant Injection Tracer Ventilation Test." The tracer gas was continuously injected into the VC System emergency makeup air stream at a constant rate and dispersed throughout the CRE. After allowing a sufficient period of time for concentration equilibrium to occur, in accordance with ASTM E741-00 requirements, tracer gas samples were obtained for analysis.

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)*	Design Basis Assumption for Maximum Unfiltered CRE Inleakage (CFM)	Measured Test Filtered Inleakage (SCFM)	Maximum Unfiltered Inleakage (SCFM)
1	Radiation/ Pressurization	A	5004** ± 159	100	196 ± 83	29.3
2	Radiation/ Pressurization	B	4914** ± 163	100	97*** ± 73	17.9

* Standard CFM (SCFM) referenced to 70 degrees F and 14.7 psia.

** Makeup Air Train A = 5576 ACFM at 0.0673 lb/ft^3 actual condition
Makeup Air Train B = 5404 ACFM at 0.0682 lb/ft^3 actual condition

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

The inleakage tracer gas test provides the total inleakage, which includes "filtered inleakage" (occurring upstream of the recirculation filter) and "unfiltered inleakage" (occurring downstream of the recirculation filter). The inleakage measured by this test at Braidwood Station is all occurring upstream of the recirculation filter unit, since the duct and components downstream of the recirculation filter unit are located inside the pressurized CRE and any inleakage occurring downstream of the recirculation filter unit would be clean air from the CRE itself. Outside systems that interface with the CRE (VV, VW, VL) were isolated during the test, service air lines that enter the CRE have been capped permanently, and the filter unit drain isolation globe valve is kept closed. The only other possible location for unfiltered inleakage is the CRE boundary, which is confirmed to be pressurized. Therefore, the measured inleakage given above is "filtered inleakage" since it is filtered by the recirculation filter unit before entering the CRE.

The equivalent "unfiltered inleakage" was determined from the measured inleakage by calculating the amount not filtered by the recirculation filter unit to be able to compare with the 100 SCFM unfiltered inleakage value used in the design basis dose analysis. The recirculation filter unit consists of a medium efficiency (80%) particulate filter and a charcoal adsorber (90% efficiency, which includes the filter bypass leakage). The habitability calculations are based on the assumption that 95-100% of the iodine is gaseous and 0-5% of the iodine is particulate. The "unfiltered inleakage" based on the test results, that penetrates the recirculation filter is as follows:

A train = 29.3 SCFM
B train = 17.9 SCFM

Therefore, the 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 100 SCFM unfiltered inleakage value assumed in the Braidwood Station design basis accident analyses.

Measurement of the differential pressure verified that the MCR is maintained at a positive pressure of at least 0.125 inch water gauge relative to areas adjacent to the CRE during emergency mode of VC System operation at a makeup flow rate greater than or equal to 5400 ACFM and less than or equal to 6600 ACFM in accordance with Technical Specification 3.7.10

Operability of the CRE

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

The Braidwood Station limiting design basis accident analysis control room operator dose, based on an assumed CRE unfiltered inleakage rate of 100 SCFM, bounds the dose that would result from the most limiting measured unfiltered inleakage rate of 29.3 SCFM, and remains within the 10 CFR 50, Appendix A, GDC 19 limits of five rem whole body and 30 rem thyroid. Therefore, Braidwood Station has demonstrated that the most limiting unfiltered inleakage into the CRE is bounded by the value assumed in the design basis accident radiological analyses for control room habitability. Additionally, Braidwood Station plans to submit a License Amendment Request (LAR) to incorporate Alternative Source Term (AST) methodology into the Braidwood 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 SCFM 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 Braidwood 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,

Keith J. Polson
Site Vice President
Braidwood Station

cc: Regional Administrator, NRC Region III
NRC Senior Resident Inspector – Braidwood Station