



Overview of NUCON Tracer Gas Testing Program For Protected Spaces Per ASTM E741

1 Background

- 1.1 Many civilian and military facilities incorporate “safe rooms” or “citidals” for protection of personnel during emergency conditions. In the event of chemical attack the “envelope” is sealed and special air filtration systems are activated to remove gaseous and particulate contaminants in order to maintain “habitability”.
- 1.2 To confirm “habitability” of these safe spaces integrity testing of the effective envelope is done using ASTM E741-2000; “Standard Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution.
- 1.3 This test determines if, and how much, “unfiltered inleakage” may occur during safe mode operation. The amount of “unfiltered inleakage” provides information the operators can use to determine the necessity of repairs or modifications.

2 Methodology

- 2.1 A walk-down of the candidate safe zone “envelope” may be performed prior to development of a test plan and site specific procedures. The purpose for this walk-down is to identify tracer gas injection and sample points for testing in different operational modes. The walk-down also helps ascertain if supplemental mixing fans will be needed in to insure uniformity of tracer gas concentration in the envelope. Any vulnerability found will also be noted and discussed with cognizant personnel.
- 2.2 The testing methodology of ASTM E741-2000, “Test Method for Determining Air Change in a Single Zone by Means of a Tracer Gas Dilution” is used to measure the control room air in-leakage.
- 2.3 The constant injection technique described in this method is used for the operational modes that use outside air to pressurize the envelope. In addition, the testing methodology of ASTM E2029-1999, “Volumetric and Mass Flow Rate Measurement in a Duct Using Tracer Gas Dilution” will be used to measure outside airflows. Sulfur hexafluoride (SF_6) will be used as the tracer gas.
- 2.4 NUCON test procedures 12-365 “Airflow Measurement Using Tracer Gas Technique” and 12-366 “Envelope Leakage Testing and Characterization Using the Constant Injection Test Method” show how NUCON implements these ASTM methods are attached. The first step in testing is to assure that the subject envelope can be treated as a single zone (so called spatial testing performed during envelope characterization tests).



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- 2.5 A constant injection leak test method is used in conjunction with the duct flow method to measure the total in-leakage to the subject envelope while measuring the outside airflow at the same time during testing in the pressurization modes. The difference between the total envelope leakage flow and the outside airflow is then a measure of the unknown in-leakage to the system. The main advantage of the constant injection method is that it provides a measure of the total in-leakage flow rate without having to know the control room volume. Its uncertainty can be reduced by injecting the tracer gas into the outside air pressurization flow and measuring it at the same time the total leak flow is measured in the control room return by measuring its concentration.
- 2.6 The E741 testing methodology provides a comprehensive measurement of the integrity of the control room envelope. Supplementing this information with the differential pressure of the control room with respect to adjacent areas along with static duct pressure measured during operation in the different modes along with a knowledge of the CR HVAC system and other HVAC systems adjacent or associated with the CR (gained from a review of plant drawings, a system walk-down and discussions with plant personnel) will allow any unknown in-leakage found to be noted as filtered or unfiltered in-leakage.

3 Set-up and Logistic Requirements

- 3.1 The equipment needed to perform the test is shipped to your site to arrive no later than the middle of the week before testing begins. Injection and sample points need to be identified during a pre-test walk-down (see 2.1). The information gathered during this walk-down will also provide the information needed for site-specific test procedures based on NUCON procedures.

4 Summary of Testing and Related Activities

- 4.1 A site briefing and walk-down may be necessary to develop site-specific tests procedures and to identify locations for tracer gas injection and sample points.
- 4.2 Prior to Testing:
- 4.2.1 Prepare site-specific test procedures.
 - 4.2.2 Provide a Quality Assurance Plan.
 - 4.2.3 Provide personnel Qualification, Security Data and Exposure History.
 - 4.2.4 Pre-test Plant Staff Briefing & "Walk-down" (Optional).



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4.3 Testing:

NUCON will send personnel and calibrated instrumentation to site to perform the subject testing. In general, Site Testing activities breakdown as follows:

4.3.1 Day One:

4.3.1.1 Equipment Set-up.

4.3.2 Day Two: (2nd Shift)

4.3.2.1 Characterize the “envelope” CRE and measure outside airflows.

4.3.2.2 Establishing “target” SF₆ concentration and taking multiple samples at various locations around the CRE to confirm spatial uniformity.

4.3.2.3 Measure outside airflows on Train A and Train B using tracer gas.

4.3.2.4 Confirm “positive pressure” of the CRE to adjacent areas.

4.3.3 Day Three:

4.3.3.1 Tracer Gas Test Alignment No. 1.

4.3.4 Day Four: (2nd Shift)

4.3.4.1 Tracer Gas Test Alignment No. 2.

4.3.5 Day Five: (2nd Shift)

4.3.5.1 Tracer Gas Test Alignment No. 3.

4.4 Post-Testing:

4.4.1 Produce a Certified Test Report.

4.4.1.1 Submit “Draft” report (draft report for client review).

4.4.1.2 Submit “Final” report.

5 Deliverable Reports and Documentation

5.1 Principal Deliverables:

5.1.1 Pre-test “walk-down” and Plant Staff briefing (Optional).

5.1.2 Site walk-down report (Optional).

5.1.3 Site Specific Testing Procedures.

5.1.4 Tracer Gas Testing, including Post-test data/briefing of site personnel.



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- 5.2 Certified Test Report
 - 5.2.1 Draft Report.
 - 5.2.2 Final Report.
- 5.3 Support Documentation:
 - 5.3.1 Calibration Certificates for all Test Equipment.
 - 5.3.2 Quality Assurance Program Manual.
 - 5.3.3 Quality Plan.
 - 5.3.4 Personnel Qualifications (Individual Qualifications, Security & HP Data).
 - 5.3.5 Charcoal Impact Statement; Effect of SF₆.
 - 5.3.6 Contact List.
 - 5.3.7 Miscellaneous project related documentation and correspondence.

6 Related Documents

- 6.1 NUCON Procedure 12-366 Rev. 2, "Envelope Leakage Testing Using the Constant Injection Method".
- 6.2 NUCON Procedure 12-365 Rev. 1, "Airflow Measurement Using Tracer Gas Technique".
- 6.3 NUCON Procedure 12-101 Rev. 6, "Airflow Capacity & Distribution Test".
- 6.4 NUCON Procedure 12-369 Rev. 0, "Mapping of Pressure Zones Using the NUCON Model PD-C Pressure Detector".
- 6.5 NUCON Procedure 12-356 Rev. 1, "Envelope Inleakage Testing Using the Concentration Decay Test Method".
- 6.6 Bulletin 12B18; General List of Instrumentation, Tools and Test Gasses for ASTM E741-2000 Testing.

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