

SECTION 07012 - BUILDING ENVELOPE AIR SEALING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This section includes the following:
 - 1. Air sealing quality control.
 - 2. Air sealing testing.
 - a. Pressurized theatrical fog testing.
 - b. Compartmentalized blower door testing.
- B. Related Sections include the following:
 - 1. Division 1 Section "Construction Progress Documentation" for developing a schedule that includes tests and inspections.
 - 2. Division 7 Section "Building Insulation" for spray-applied foam insulation, foam-in-place sealant, air-vapor barrier box for ceiling electrical boxes, and sealing perimeter of steel door frames.
 - 3. Division 7 Section "Joint Sealants" for interior and exterior joint sealants.
 - 4. Division 8 Section "Steel Doors and Frames" for foam-in-place sealant around interior perimeter.
 - 5. Division 9 Section "Gypsum Board Assemblies" for sealing of gypsum board at interface with adjacent construction and with penetrations through gypsum board assemblies.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 01330.
- B. Air Sealing Plan:
 - 1. Submit an Air Sealing Plan detailing the air sealing methods and materials and subcontractors to be used, the identity of the Air Sealing Representative, and an Air Sealing Schedule detailing both the air sealing work, as well as the anticipated timing of all the quality assurance testing.
- C. Submit air leakage test certification and compliance test reports.

1.4 QUALITY ASSURANCE

- A. Testing Agent: An independent agency with the experience and capability to conduct testing and inspecting indicated.
- B. Air Tightness Representative: The Contractor shall identify before the start of construction an assigned individual who is responsible for achieving the air tightness results. The air tightness

representative shall be on site throughout the construction process, especially during framing, rough plumbing, heating, electrical and ventilation and drywall and shall be present during air leakage testing and air sealing. The air tightness representative shall submit an air-sealing sequencing plan before the start of construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AIR SEALING LOCATIONS

- A. Rough Openings: Seal windows, doors, louvers, vents, outdoor air ducts, and any other penetrations in the exterior thermal envelop.
- B. Blind corners and cracks in the framing or exterior sheathing, including but not limited to joist pockets, structural framing, metal deck flutes, changes in materials, and louver blank-off panel.
- C. Foundation sills and joist headers between floors, cantilevered joists.
- D. Utility and Other Small Penetrations: Seal utility penetrations through exterior walls and ceilings with low-expansion polyurethane foam or acoustical sealant. Seal electrical ceiling boxes penetrating attic vapor barrier with air-vapor barrier box.
- E. Seal around wires, plumbing stacks, conduits and pipes that penetrate the top plate of interior and exterior walls, and penetrate attic vapor barrier with low-expansion polyurethane foam or acoustical sealant.
- F. Penetrations between area being tested for air leakage and adjoining interior spaces: Where partitions are fire rated, use sealants with appropriate fire ratings, otherwise use materials as noted above.

3.2 AIR TIGHTNESS TESTING

- A. Purpose: Quality assurance air tightness testing and whole-building air barrier compliance testing shall be for the purpose of identifying any areas that may not be adequately sealed. Testing will also assist in identifying those areas that do not need further sealing.
 - 1. Approach: Each component of the air barrier system shall be pre-tested during the construction at each building envelope milestone so as to avoid the necessity of removing or damaging subsequent installations by other trades. Perform quality assurance testing as specific assemblies are constructed, in order to quickly assess whether an acceptable standard of air sealing is being implemented.
 - 2. Quality Assurance Standard: Fog testing has no numerical standard and is therefore based on visual results and their interpretation. Satisfactory results are -when there is either no visible fog or at most very slight wisps of fog that are evident. Unsatisfactory results are when streams of fog come pouring out of the building at inadequately sealed joints. Determination of whether a tested assembly passes the quality assurance testing will be made jointly by the independent testing subcontractor, a representative of the Owner, the Architect and the Air Tightness Representative of the General Contractor.

Blower door testing and fog testing and the cost of bringing the building performance up to meet the standard shall be borne by the Contractor.

3. Timing of Quality Assurance Testing: All testing shall be performed as soon as the envelop and sealing systems are in place, and before any additional materials are installed that would prevent proper implementation of the quality assurance testing.
 - a. Assemblies to be initially tested shall include the following to permit evaluation of installation and corrective measures to be implemented for the remainder of the project:
 - 1) First instance of each wall assembly type with at least one window.
 - 2) First instance of a ceiling area.
 - 3) First instance of typical wall/roof/ceiling assembly joints.
 - b. Upon completion of initial testing and corrective measures, the remainder of the facility shall be tested as the project progresses, and shall be conducted as established in the air sealing plan.

B. Pressurized Theatrical Fog Testing: Standard Test method of identifying air leakage locations by fan pressurization and the introduction of theatrical fog:

1. Scope:
 - a. Test method describes a standardized technique for locating air-leakage through a building envelope under pressurization or de-pressurization. This test method consists of mechanical pressurization of building, building component, or building section and the introduction of visible fog into the pressurized space. Observations are made of any resulting leakage with an indoor to outdoor static pressure difference adequate to induce a visible flow through the reference hole and any air leakage sites. This test method is used to locate and seal significant air leakage.
 - b. Strong winds shall be avoided during testing.
 - c. Test method is intended to evaluate the air-tightness of a building envelope. Test method does not measure air leakage rates, but can be used to locate and eliminate air leakage.
 - d. This test method is intended for the evaluation of the air-tightness of building envelopes of single-zone buildings or by isolating components or sections of the building envelope. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the testing agent and contractor to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
2. Terminology:
 - a. Definition of Terms Specific to this Standard:
 - 1) Theatrical Fog - A visible vapor generated by a fog generator, more commonly used in theatrical productions.
 - 2) Pressurization Fan - A blower door device that creates an induced pressure on one side of the building envelope boundary surface.
 - 3) Air-Leakage - An unintentional air movement across the building envelope.
 - a) Discussion - This movement includes flow through joints, cracks, and porous surfaces, or a combination thereof.
 - 4) Building envelope - The boundary or barrier separating the interior volume of a building conditioned spaces from the outside environment.
 - 5) Single zone - A space in which the pressure differences between any two places, differ by no more than 4% of the inside to outside pressure difference.
 - 6) Blower door - A fan pressurization device incorporating a controllable fan and instruments for airflow measurement and building pressure difference

- measurement that mounts securely in a door or other opening.
- 7) Building envelope pressure difference - The pressure difference across the test zone envelope (Pa, in. H₂O).
 - 8) Fan airflow rate - The volume of airflow through the blower door per unit of time (m³/s, ft³/min).
 - 9) Nominal airflow rate - The flow rate indicated by the blower door using the manufacturer's calibration coefficients (m³/s, ft³/min).
 - 10) Test pressure difference - The measured pressure difference across the building envelope, expressed in Pascals (Pa), (or in. of water or poundsforce/ft² or in. of mercury).
 - 11) Air tightness - The degree to which a test zone envelope resists the flow of air.
3. Apparatus:
- a. The following is a general description of the required apparatus: Any arrangement of equipment using the same principles and capable of performing the test procedure is permitted.
 - b. Major components:
 - 1) Air-Moving Equipment: Blower door assembly that is capable of moving air into and out of the enclosed space at the required flow rates. The system shall provide a pressure difference adequate to produce visible fog flow through the reference holes for the period required to identify and/or seal air leakage locations. Instrumentation shall be used to measure test pressure.
 - 2) Fog Generator: A device that produces a vapor that is visible in daylight or with artificial lighting (nighttime). The production rate shall be capable of maintaining a visible flow through the reference holes from the volume of the enclosed building envelope area that is being tested.
 - 3) Temporary Closures: Tarps, films, sheathing, or other materials necessary to enclose or isolate components or sections of the building envelope for pressurization.
4. Procedure:
- a. To create a single zone for this test procedure, all interconnecting doors in the conditioned space shall be opened such that a uniform pressure and a uniform distribution of fog will be maintained within the pressurized or de-pressurized space. Alternately, when creating an envelope on the outside of the building area to be tested, perform the test within each zone separately. Verify the uniformity of the pressure and fog distribution by confirming that the fog is flowing from all of the reference holes in the test area. Start the test when fog flow is observed at the lowest pressure that will be used in the test. Temporarily opening windows, doors, or other closures at the extremities of the test zone may aid in speeding the distribution of fog throughout the zone.
 - b. Place the fog generator inside the enclosed building envelope zone.
 - c. Make general observations of the condition of the building. Take notes on the conditions at the windows, doors, opaque walls, ceilings, roof and floor.
 - d. Verify that the fog is observed at the reference holes at all times during the test. If the fog generator cannot keep up with the leakage rate, seal all observed leakage openings until the flow of fog is observed at all of the reference holes. Reference holes may be made in temporary enclosure rather than through the building envelope. Reference holes shall be located at the extremities of the testing envelope to ensure that fog is present over the entire area being tested.
 - e. Connect the air duct or blower door assembly to the building envelope, using a

window, door, vent, or other opening in the temporary enclosure of building area being tested. Seal or tape these and other openings to avoid leakage at these points if required to maintain an adequate pressure to maintain enough pressure throughout the test area to assure fog flow at all reference holes.

- f. Because specific building pressures are not required and the results of the test is not quantitative, leakage between the test zone and other sections of the building envelope not being tested are allowed as long as the pressure and fog production are adequate to assure the flow of fog from all of the reference holes. Maintain the test pressure at or below 20 Pa relative to the outdoors to reasonably model actual building operating pressures.
 - g. Locating Reference Holes: Use more than one reference hole location across the building envelope area to be tested; example one on each façade. Drill the reference holes in the center at the extremities of the test area. Locations shall include holes at the highest and lowest level on the windward and leeward sides of the building envelope or test area. Buildings more than three stories, or 25.5 f), may require multiple tests at more than one height on the exterior envelope to verify adequate pressures throughout the test area.
 - h. Size of Reference Hole(s): The reference hole is designed to verify that the pressure and fog level in the pressurized or depressurized space is adequate to locate any open penetrations in the building envelope area being tested. A 1/4-inch diameter hole shall be drilled through the envelope materials in the required locations. For construction with thick wall materials or cavity walls, a 1/8-inch inside diameter tube shall be installed through the entire wall thickness to verify that the test conditions are met at the reference hole locations.
 - i. The range of the induced pressure difference shall be not less than 10 Pa (0.04 in. H₂O). Verify that the far end of the building or section of building being tested has reached the desired compliance test pressure using the ASTM E779 test method.
 - j. Localized test can be performed using this test method by "washing" the selected surface with fog. This method requires reference holes in the zone being tested in a pattern frequent enough to verify that the building pressure and fog density is adequate to locate any leakage sites, typically a minimum of 4' O.C. both vertically and horizontally.
5. Report:
- a. Report the following information:
 - 1) Building description, including location (street, city, state/province, zip or postal code, and country).
 - 2) Type of building construction and penetrations.
 - 3) Condition of openings in building envelope including:
 - a) Doors, windows, ventilation openings, dampers, chimneys closed or not installed.
 - b) Statement whether the test zone is interconnected with other sections of the building and how the openings are closed.
 - 4) Statement of whether the test zone is enclosed on the inside or outside.
 - b. Procedures, including the test equipment used (manufacturer, model, S/N).
 - c. Measurement data, including:

- 1) Fan pressurization measurement (inside-outside) required to generate fog flow at the reference holes, if recorded.
- 2) Reference-hole size, type and location.
- 3) Wind speed/direction and whether wind speed is estimated to exceed 0 to 2 m/s (0 to 4 mph).
- 4) Locations of air leakage noted and/or sealed.

3.3 BLOWER DOOR TESTING

- A. Blower door testing shall be performed in accordance with ASTM E779, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.
- B. The building shall achieve a maximum air leakage of 0.40 cfm50/sq.ft.of external, above grade building shell surface area (not including basement walls).
- C. When calculating surface area for meeting the maximum air leakage ratio, the surface areas adjoining other interior spaces shall be included as part of the exterior wall, as these partitions should be air tight for purposes of maintaining acoustic and/or fire ratings.
- D. Prepare test reports for each area of the building tested in accordance with ASTM E779. Test results shall be approved in writing by the Architect for each test location before the work is concealed and made inaccessible.

END OF SECTION 07012