
USACE / NAVFAC / AFCEA / NASA UFGS-07 27 00.45 10 (May 2012)

Preparing Activity: USACE New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2012

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BUILDING AIR BARRIER SYSTEM 05/12

NOTE: This guide specification covers the requirements for the building air barrier system, it also covers the building air tightness testing to verify that the building air barrier is installed properly. Air barrier system drawings must accompany this specification section when used in a project.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

NOTE: The following is recommended reading:

- Engineering and Construction Bulletin ECB 2009-29
Building Air Tightness Requirements
- ECB 2011-1 High Performance Energy and
Sustainability Policy
- Building Air Tightness and Air Barrier Continuity
Requirements, Alexander Zhivov, Ph.D and Wagdi Anis
- U.S. Army Corps of Engineers, Air Leakage Test

Protocol for Measuring Air Leakage in Buildings,
USACE ERDC

The Designer shall design a continuous air barrier to control air leakage into, or out of, the conditioned space. Identify all air barrier components of each envelope assembly on the drawings and detail the joints, interconnections and penetrations of the air barrier components. Clearly identify the boundary limits of the building air barriers, and of the zone or zones to be tested for building air tightness on the drawings. Often the air barrier does not encompass the mechanical room because of all the louvered openings in this room. An air barrier between the mechanical room and the remainder of the building is thus required. It follows that utility shafts emanating from such mechanical rooms must also be constructed with an air barrier.

Provide a design that supports the air barrier so as to withstand the maximum positive and negative air pressure to be placed on the building without displacement or damage to the air barrier materials, and to transfer the load to the structure.

Keep in mind that window and door assemblies are part of the building air barrier system. One must be able to trace a continuous plane of air-tightness throughout the building envelope and make flexible and seal all moving joints. The allowable leakage rates of windows, exterior doors, curtain wall assemblies, skylights, and other such components must be identified in the associated specification sections for these components.

On the drawings, detail the sealing of the joints between the air barrier material of each assembly in a flexible manner to the air barrier material of adjacent assemblies, allowing for the relative movement of these assemblies and components.

On the drawings, detail the sealing of all penetrations of the air barrier caused by electrical boxes, plumbing fixture boxes, and other assemblies. If these assemblies are not airtight, detail them to be airtight either by showing how the assembly is to be sealed and how the interface between the assembly and the air barrier is to be sealed or by extending the air barrier over the assembly.

Keep in mind that the air barrier must be durable to last the anticipated service life of the assembly. Do not install lighting fixtures with ventilation holes through the air barrier.

For any fixed open louvers such as at elevator shafts, provide a motorized damper in the closed

position and connected to the fire alarm system to open on call; also the damper must fail in the open position.

Provide dampers and controls to close all ventilation or make-up air intakes and exhausts, atrium smoke exhausts and intakes, etc when leakage can occur during inactive periods.

Compartmentalize garages under buildings by providing air-tight vestibules at building access points.

Compartmentalize spaces under negative pressure such as boiler rooms and provide make-up air for combustion.

1.1 CONTRACTOR RESPONSIBILITY

The Contractor is responsible for the construction of an air barrier system that is contiguous and connected across the six surfaces of the building envelope meeting the performance requirements as outlined in this specification.

Perform a building air tightness test and thermography test to demonstrate that the building envelope is properly sealed and insulated. The testing shall be performed in accordance with the procedures outlined in this specification.

1.2 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a RID outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM C1060	(2011a) Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
ASTM D4541	(2009e1) Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM E1186	(2003; R 2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
ASTM E1827	(2011) Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
ASTM E779	(2010) Standard Test Method for Determining Air Leakage Rate by Fan Pressurization

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 6781	(1983) Thermal Insulation - Qualitative Detection of Thermal Irregularities in Building Envelopes - Infrared Method
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1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Choose the first bracketed item for Navy, Air Force

and NASA projects, or choose the second bracketed item for Army projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Building Air Tightness Test Procedures[; G][; G, [____]]
Thermography Test Procedures[; G][; G, [____]]

SD-06 Test Reports

Test Report
Building Air Tightness Test
Thermography Test Report

SD-07 Certificates

Air Barrier Inspector
Building Air Tightness Test Technician

1.4 ADMINISTRATIVE AND PROCEDURAL REQUIREMENTS

This section includes administrative and procedural requirements for accomplishing an airtight building enclosure that controls infiltration or exfiltration of air.

- a. Coordinate between the trades, the proper scheduling and sequencing of the work, preconstruction meetings, inspections, tests, and related actions including inspection and test reports.
- b. Ensure that all penetrations through the air barrier system, and all paths of air infiltration or exfiltration, are sealed airtight.

1.4.1 Air Barrier System

The airtight components of the building enclosure and the joints, junctures and transitions between materials, products, and assemblies forming the airtightness of the building enclosure are called the air barrier system.

1.4.2 Air Barrier System Characteristics

Ensure that the intent of constructing the building enclosure with a continuous air barrier system to control air leakage into or out of the conditioned space is achieved. The air barrier system shall have the following characteristics:

- a. Continuous with all joints sealed.
- b. Structurally supported to withstand positive and negative air pressures applied to the building enclosure.
- c. Connection shall be made between:
 - (1) Foundation and walls
 - (2) Walls and windows

- (3) Walls and doors
- (4) Different wall systems
- (5) Walls and roof
- (6) Walls and roof over unconditioned space
- (7) Walls, floors, and roofs across construction, control, and expansion joints.
- (8) Walls, floors, and roofs to utility, pipe and duct penetrations.

1.4.3 Inspection and Testing Services

Inspection and testing services are required to verify compliance with requirements specified or indicated. The inspection and testing agency shall submit a certified written [test report](#), in duplicate, of each inspection, test, or similar service to the Contractor with duplicate copies to the Contracting Officer not later than 10 days after each test.

Written reports of each inspection and test or similar service shall include all the report items described in [ASTM E1827](#). Additionally, the report shall also include the following information:

- a. Date of Issue
- b. Project title and number
- c. Name, address, and telephone number of testing agency
- d. Dates and locations of samples and tests or inspections
- e. Names of individuals making the inspection or test
- f. Designation of the Work and test method
- g. Identification of product and Specification Section
- h. Complete inspection or test data
- i. Test results and an interpretation of test results
- j. Comments or professional opinion on whether inspected or tested Work complies with Contract Document requirements
- k. Name and signature of laboratory inspector
- l. Recommendations on retesting

1.5 [BUILDING AIR TIGHTNESS TEST TECHNICIAN](#) RESPONSIBILITIES

The testing technician shall have 2 years experience in air tightness testing using the specified testing standard. Technician duties include:

- a. Describe the test procedures, test apparatus, and analysis method.
- b. Perform the Building Air Tightness Test.
- c. Perform the Thermography Test.
- d. Participate in identifying deficiencies in the building construction upon failure of a test to meet the specified leakage rate.
- e. Submit a report of each air tightness test whether successful or not not later than 10 days after the test.
- e. Submit a report of each thermography test identifying problem areas not later than 10 days after the test.

1.6 QUALITY CONTROL

Engage the services of an experienced [air barrier inspector](#) to oversee the sequencing and installation of the air barrier component materials and assemblies, to oversee the proper joining and sealing of the materials and

assemblies, to oversee the sealing of penetrations of the air barrier materials and assemblies, and to instruct the subcontractors on the above.

1.6.1 Qualifications

The inspector shall have 2 years experience in the installation of air barrier materials and assemblies including the experience in joining and sealing various components, and sealing of penetrations of air barriers. The inspector shall have experience coordinating and instructing subcontractors involved in the installation joining and sealing of air barrier materials and components.

1.6.2 Documentation and Reporting

Installers shall document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.

1.7 CONTRACTOR RESPONSIBILITIES

1.7.1 Coordination of Sub-Contractor(s)

Provide coordination between the Sub-Contractors involved in the construction of the air barrier system, coordinate the sequence of construction to ensure continuity of the air barrier system joints, junctures, penetrations, and transitions between materials and assemblies of materials and products from substructure to walls to roof. Provide quality assurance procedures, testing and verification as specified. Facilitate inspections, tests, and other quality control services specified elsewhere in the Contract Documents and required by the Contracting Officer.

1.7.2 Pre-Construction Conferences

Organize pre-construction conferences between the sub-contractors involved in the construction of or penetration of the air barrier system and the air barrier inspector to discuss where each sub-contractor begins and ends, the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.7.3 Construction Mock-Up

Build a construction mock-up of every joint, juncture, and transition between materials, products, and assemblies of products specified in the different sections to be installed. Work will not begin until the mock-up is satisfactory to the Contracting Officer.

1.8 AIR BARRIER SYSTEM PERFORMANCE REQUIREMENTS

The air leakage of the entire building shall meet the air requirements as specified in paragraph BUILDING AIR TIGHTNESS TEST.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 REPAIR AND PROTECTION

Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

3.2 TESTING AND INSPECTION

The following qualitative and quantitative tests and inspections shall be conducted in the presence of the Contracting Officer during installation of the air barrier system.

a. Qualitative Testing and Inspection:

- (1) Provide a Daily Report of Observations with a copy to the Contracting Officer.
- (2) Ensure continuity of the air barrier system throughout the building enclosure and that all gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.
- (3) Ensure structural support of the air barrier system to withstand design air pressures.
- (4) Ensure masonry and concrete surfaces are smooth, clean, and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.
- (5) Ensure site conditions for application temperature, and dryness of substrates are within guidelines.
- (6) Ensure substrate surfaces are properly primed.
- (7) Ensure laps in materials are at least a 2-inch minimum, shingled in the correct direction or mastic applied on exposed edges with no fishmouths.
- (8) Ensure that mastic is applied on cut edges.
- (9) Ensure that a roller has been used to enhance adhesion.
- (10) Measure application thickness of liquid applied materials to manufacturer's specifications for the specific substrate.
- (11) Ensure that the correct materials are installed for compatibility.
- (12) Ensure proper transitions for change in direction and structural support at gaps.
- (13) Ensure proper connection between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.

b. Quantitative Tests:

- (1) Provide written test reports of all tests performed with a copy to the Contracting Officer.
- (2) Determine the bond strength of coatings to substrate in accordance with [ASTM D4541](#).

3.3 BUILDING AIR TIGHTNESS TEST

A building air tightness test shall follow the guidance in the U.S. Army Corps of Engineers Air Leakage Test Protocol for Measuring Air Leakage in Buildings. This protocol is available on the Whole Building Design Guide website- http://www.wbdg.org/references/pa_dod_energy.php. The fan pressurization test to determine final compliance with the airtightness requirement shall be conducted when all components of the air barrier system have been installed and inspected, and have passed any intermediate testing procedures as detailed in the construction drawings and specifications. The test may be conducted before finishes that are not part of the air barrier system have been installed. For example, if suspended ceiling tile, interior gypsum board, or cladding systems are not part of the air barrier system, the test may be conducted before they are installed.

3.3.1 Test Requirements

Perform the air leakage test in accordance with [ASTM E779](#); submit detailed test methods and procedures indicating the test apparatus, and the analysis methods to be employed for the Building Air Tightness Test not later than 60 days after Notice to Proceed with the following additions and exceptions::

- a. The test consists of measuring the flow rates required to establish a minimum of 12 positive and 12 negative building pressures. The lowest test pressure shall be [25 Pa 3.75 psi](#); the highest test pressure shall be [75 Pa 11.25 psi](#); and there must be at least [25 Pa 3.75 psi](#) difference between the lowest and highest test pressures.
- b. Measure the test pressure in a representative location such that pressures in the extremities of the enclosure can be shown to not exceed 10 percent of the measured test pressure. At least 12 bias pressure readings must be taken across the envelope and averaged over at least 20 seconds each before and after the flow rate measurements. None of the bias pressure readings must exceed 30 percent of the minimum test pressure when testing in both directions.
- c. Where it can be shown that it is impossible to test in both directions, then the building may be tested in the positive direction only, provided the bias pressure does not exceed 10 percent of the minimum test pressure.
- d. The mean value of the air leakage flow rate calculated from measured data at [75 Pa 0.3 in wg](#) shall not exceed [\[1.27\] \[0.76\] liters/sec per square meter \[0.25\] \[0.15\] cu ft/minute per square foot](#) of envelope area and the upper confidence limit as defined by [ASTM E779](#). Reference measurements at standard conditions of [101.325 KPa 14.696 psi](#) and [20 degrees C 68 degrees F](#). The envelope area is to be supplied [and] [or] confirmed by the Designer of Record (DOR).

- e. Conduct the test with ventilation fans and exhaust fans turned off and the outdoor air inlets and exhaust outlets sealed (by dampers or masking). Provide a responsible HVAC technician with the authority to place the HVAC system in the correct mode for the pressure test. The test technician shall have unhindered access to mechanical rooms, air handlers, exhaust fans, and outdoor air and exhaust dampers.
- f. Ensure that all windows in the enclosure are kept closed. Prohibit entry and exit through doors in the test enclosure during the test. Discard data collected while the pressures and flows are affected by a door opening and closing.
- g. Report the results of the Building Air Tightness Test. Perform a diagnostic evaluation in accordance with [ASTM E1186](#), whether the building achieves the air tightness requirement or not. Use the diagnostic evaluation to assist in identifying and eliminating air leakage so the building meets the requirement upon retesting. Also, express the testing results in terms of the Equivalent Leakage Area (EqLA) at [75 Pa 11.25 psi](#). The EqLA is the equivalent area of a flat plate that leaks the same amount as the building envelope at [75 Pa 11.25 psi](#).

3.4 THERMOGRAPHY TEST

Test the building envelope using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of [ASTM C1060](#) and [ISO 6781](#). The Contracting Officer will witness the testing. Testing shall occur just before the building air tightness test. Testing shall also occur during the air tightness test so that areas of building air leaks are detected. If the building air tightness test is failed, thermographic testing shall be repeated just before and during subsequent air tightness tests until the air tightness test is successful.

3.4.1 Thermography Test Procedures

Submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed not later than 60 days after Notice to Proceed.

3.4.2 Thermography Test Report

Provide a report. The report shall include thermographs in color and a color temperature scale to define the temperature indicated by the various colors. The report shall identify the high temperature reading, the outdoor air temperature, the building indoor air temperature, and the wind speed and direction. The report shall note any areas of compromise in the building envelope, and shall note all actions required and taken to correct those areas.

3.4.3 Final Test

Final thermography test report shall demonstrate the problem areas have been corrected. Submit the complete test and analysis for review and approval.

-- End of Section --