APPENDIX A SAMPLE BET SPECIFICATION

(This recommended BET specification is available from www.nebb.org)

NEBB recommends that these BET Specifications be referenced as related documents in other appropriate sections of the project specifications.

SECTION XXXXX – BUILDING ENVELOPE TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

This Section includes testing building envelope systems.

1.2 DEFINITIONS

Acceptance Criteria: The measured value(s) or range(s) that determine if the results of the test pass or fail.

Accuracy: The capability of an instrument to indicate the true value of a measured quantity.

ACH_{75}: The ratio of the air leakage rate at 75 Pa (0.3 in. H_20), corrected for a standard air density, to the volume of the test zone (1/h).

AHJ: The local governing **A**uthority **H**aving **J**urisdiction over the installation.

Air Barrier System: A system in the building construction that is designed and installed to reduce air leakage either into or through the building envelope.

Air Change Rate: The calculated number of times the total air volume of a defined space is replaced in a given unit of time. This is ordinarily computed by dividing the total volume of the room supply or exhaust air in cubic meters (cubic feet), per unit of time, by the total volume of the subject space. It is normally expressed as air changes per hour, ACH.

Air Exfiltration: Air leakage out of the building.

Air Infiltration: Air leakage into the building.

Airflow Rate: The volume of airflow through the fan or blower door per unit of time (m^3/s or ft^3/min, cfm).

Air Leakage Area: The effective leakage area (A_L) at the test pressure.

Air Leakage Change Rate: Air leakage rate in volume units/h divided by the building space volume with identical volume units, normally expressed as air changes per hour, ACH.

Air Leakage Graph: A graphic representation that shows the relationship of measured airflow rates to the corresponding measured pressure differences, usually plotted on a log-log scale.

Air Leakage Rate: The total volume of air passing through the test zone or building envelope per unit of time (ft^3/min [cfm] or m^3/s).

Discussion: This movement includes flow through joints, cracks, and porous surfaces, or a combination thereof. The driving force for such an air leakage, in service can be mechanical pressurization and de-pressurization, natural wind pressures, or air temperature differentials between the building interior and the outdoors, or a combination thereof.

Air Leakage Site: A location on the building envelope or air barrier system where air can move between the building interior and the outdoors.

Air Tightness: The degree to which a test zone or building envelope resists the flow of air.

Discussion: Air leakage rate, effective leakage area and the rating term such as ACH_{50} are examples of measures of building tightness.

Anomalous Thermal Image: An observed thermal pattern of a structure that is not in accordance with the expected thermal pattern.

Baseline Building Pressure: The natural building pressure difference measured when there is no flow through the blower door. This is also referred to as the Bias Pressure.

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.

Building Envelope: The boundary or barrier separating the interior volume of a building from the outside environment.

Discussion: For the purpose of this test procedural standards, the interior volume is the deliberately conditioned space within a building, generally not including attics, basements, and attached structures, for example, garages, unless such spaces are connected to the heating and air conditioning system, such as a crawl space plenum.

Building Pressure Difference: The pressure differential across the test zone or building envelope.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

Certificate of Compliance (Conformance): A written statement, signed by a qualified party, attesting that the items or services are in accordance with specified requirements, and accompanied by additional information to substantiate the statement.

Certification: The process of validation required to obtain a certificate of compliance.

CFM_{75}: The airflow leakage value in cubic feet per minute at a test pressure of 75 Pascals (Pa). The subscript value defines the test pressure.

Closed: The condition of a building used to test the air barrier in an unoccupied building to test the air barrier with intentional openings sealed.

Differential Pressure (ΔP): The difference between two pressures measured between a sample point and reference point.
Discussion: This movement includes flow through joints, cracks, and porous surfaces, or a combination thereof. The driving force for such an air leakage, in service can be wind pressures, or air temperature differentials between the building interior and the outdoors, or a combination thereof.

Deficiency: Any circumstance or operation that affects the measurement results as compared to the design criteria required by the contract documents.

Effective Leakage Area: In order to take values generated by fan pressurization and to use them in determining natural air exchange, the effective leakage area of a building must be calculated. Each gap and crack in the building envelope contributes a certain amount of area to the total leakage area of the building. The Effective Leakage Area assumes that all of the individual leakage areas in the building are combined into a single idealized orifice or hole. The ELA will change depending on the reference pressure used to calculate it.

Envelope: The construction, taken as a whole or in part, that separates the indoors of a building from the outdoors.

Equivalent Leakage Area: EqLA, usually taken at 10Pa using 0.61 discharge coefficient, but for the purposes of this Specification, it is taken at 75 Pa.

Field-of-View (FOV): The total angular dimensions, expressed in degrees or radians, within which objects can be imaged, displayed, and recorded by a stationary imaging device.

Framing Spacing: Distance between the centerlines of joists, studs, or rafters.

Function: Function in this standard refers to the specific type of data measurement specified in Section 4, *Standards for Instrumentation and Calibration.*

Infrared Imaging System: An instrument that converts the spatial variations in infrared radiance from a surface into a two-dimensional image of that surface, in which variations in radiance are displayed as a range of colors or tones.

Infrared Thermography: The process of generating thermal images that represent temperature and emittance variations over the surfaces of objects.

Instantaneous Field of View (IFOV): The smallest angle, in milliradians, that can be instantaneously resolved by a particular infrared imaging system.

Intentional Opening: Openings within the envelope that are designed to remain open to atmosphere during the buildings operation. Intentional openings include building components such as air intake, exhaust louvers, pressure relief dampers or louvers, dryer and exhaust vents, combustion flues and any other leakage site that is designed to remain open during the buildings normal operation. Windows, doors, conduits, mechanical piping, sleeves and structural steel are not intentional openings.

M^3/S_{75}: The airflow leakage value in cubic meters per second at a test pressure of 75 Pascals (Pa). The subscript value defines the test pressure.

Masonry Veneer: Frame construction with a non-load bearing exterior masonry surface.

May: Used to indicate a course of action that is permissible as determined by the NEBB Certified BET Firm.

Minimum Resolvable Temperature Difference (MRTD): A measure of the ability of the operators of an infrared imaging system to discern temperature differences with that system. The MRTD is the minimum temperature difference between a four-slot test pattern of defined shape and size and its blackbody background at which an average observer can discriminate the pattern with that infrared imaging system at a defined distance.

N/A: *Not Available, Not Applicable, or Not Accessible.* The simple notation "N/A" without definition is not allowed.

NEBB Certified BET Firm: A *NEBB Certified BET Firm* is a firm that has met and maintains all the requirements of the National Environmental Balancing Bureau for firm certification in Building Envelope Testing and is currently certified by NEBB. A NEBB Certified BET Firm shall employ at least one NEBB Certified BET Professional in a full time management position.

NEBB Certified BET Report: The data presented in a NEBB Certified BET Report accurately represents system measurements obtained in accordance with the current edition of the NEBB *Procedural Standards for Building Envelope Testing.* A NEBB Certified BET Report does not necessarily guarantee that systems measured conform to the design requirements or stated guidelines. The report is an accurate representation of the measured results only.

NEBB Certified BET Professional: A *NEBB Certified BET Professional* is a full time employee of the firm in a management position who has successfully passed the professional level written and practical qualification examinations and maintains the professional re-qualification requirements of NEBB.

Nominal Airflow Rate: The flow rate indicated by the blower door using the manufacturer's calibration coefficients (m^3/s or ft^3/min, CFM).

Orifice Blower Door: A blower door in which airflow rate is determined by means of the pressure drop across an orifice or nozzle.

Open: The condition of a building used to test the ventilation rate in a occupied building with intentional openings unsealed.

Precision: The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

Precision Index of the Average: The sample standard deviation divided by the square root of the number of samples.

Pressure Station: A specified induced change in the building pressure difference from the initial zero-flow building pressure difference (Pa, in. w.c.).

PPM: Parts per million

Procedure: The approach to and execution of a sequence of work operations to yield a repeatable and defined result.

Range: The upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

Resolution: The smallest change in a measured variable that an instrument can detect.

Shall: The term is used to indicate mandatory requirements that must be followed in order for the project to become a NEBB certified project. Work must conform to these standards and procedures and no deviation is permitted: In the event unique circumstances prevent a required action from being fulfilled, a notation shall be included in the BET report explaining the reason that the requirement was not completed. For example, such notation could be one of the following: *Not Available, Not Applicable, or Not Accessible.* The simple notation "N/A" without definition is not allowed.

Should: The term is used to indicate that a certain course of action is preferred but not necessarily required.

Single Zone: A space in which the pressure differences between any two places, differ by no more than 5% of the inside to outside pressure difference.

> Discussion: A multi-room space that is interconnected within itself with door-sized openings through any partitions or floors is likely to satisfy this criterion if the fan airflow rate is less than 3 m^3/s (6357 ft^3/min).

Specified Test Pressure: The required induced differential static air pressure across the specimen.

Standard: A required qualification, action, or result for BET work.

Standard Operating Procedure: An internal policy prepared by each BET firm and / or prepared by the Owner/Buyer. Procedures are written to provide guidance, direction,

and step-by-step details relating to issues such as safety, testing protocols, acceptance criteria, etc. NEBB BET Firm SOP's shall be utilized in an absence of SOP's prepared by the Owner.

Test Pressure Difference or Differential: The measured pressure difference across the building envelope, expressed in Pascals (Pa) or in inches of water column (in. w.c.).

Test Zone: A building or a portion of a building that is configured as a single zone for the purpose of this standard. For detached dwellings, the test zone envelope normally comprises the thermal envelope.

Test Zone Envelope: The barrier or series of barriers between a test zone and the outdoors and internal spaces not included in the test zone.

Testing: The use of specialized and calibrated instruments to measure fluid quantities, temperatures, pressures, rotational speeds, electrical characteristics, velocities, and sound and vibration levels,

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are addressed in the current edition of the NEBB *"PROCEDURAL STANDARDS FOR THE TESTING, ADJUSTING AND BALANCING OF ENVIRONMENTAL SYSTEMS".*

Thermal Pattern: A representation of colors or tones that indicate surface temperature and emittance variation.

Thermogram: A recorded image that maps the apparent temperature pattern of an object or scene into a corresponding contrast or color pattern.

Total air flow: The volume of air flowing per unit of time through the test zone inclusive of the air flowing through the test zone under differential test pressure conditions converted to standard conditions for temperature and density.

Unit of Length: The sum of all perimeters of operable ventilators, sash, or doors that are contained in the test specimen based on overall dimensions of such parts. Where two such operable parts meet two adjacent length's of perimeter shall be counted as only one length.

Zone: A volume of building served by a single ventilation system. For buildings with natural ventilation only, the whole building shall be considered a zone.

1.3 BET FIRM QUALIFICATIONS

The BET Firm shall be NEBB Certified in Building Envelope Testing. Building envelope testing shall be conducted by the NEBB Certified BET Professional or by technicians directly under the supervision of the NEBB Certified BET Professional.

1.4 BET FIRM SUBMITTALS

1.4.1 Qualification Data: When requested, submit 2 copies of evidence that BET firm and this Project's BET team members meet the qualifications specified in Sub-section 1.3 *BET Firm Qualifications.*

1.4.2 BET Agenda: When requested, submit 2 copies of the BET Agenda. Include a complete set of report forms intended for use on this Project.

1.4.3 Certified BET Reports: Submit a final BET report in accordance with the current edition of the NEBB *Procedural Standards for Building Envelope Testing.*

1.5 QUALITY ASSURANCE

1.5.1 The NEBB Certified BET Firm shall submit a copy of the firm's NEBB BET Certification.

1.5.2 When requested, the NEBB Certified BET Firm shall provide the NEBB Certificate of Conformance Certification.

1.5.3 BET Report Forms: Prepare report forms in accordance with the requirements from the current edition of the NEBB *Procedural Standards for Building Envelope Testing.*

1.5.4 Instrumentation Calibration: Calibration of instruments shall be in accordance with the current edition of the NEBB *Procedural Standards for Building Envelope Testing.*

1.6 CONSTRUCTION TEAM RESPONSIBILITY TO BET AGENCY

1.6.1 Provide the NEBB Certified BET Firm with a conformed set of contract documents that pertain to the air barrier (drawings, specifications, and approved submittals), including all current approved change orders and contract modifications.

1.6.2 Develop a project schedule with the input of the NEBB Certified BET Firm that coordinates the work of other disciplines and provides adequate time in the construction process to allow successful completion of the building envelope testing and remedial work.

1.6.3 Notify the NEBB Certified BET Firm of all schedule changes.

1.6.4 Ensure that the building enclosure is complete, including but not limited to, all structural components, the air barrier and vapor barrier complete, windows and doors installed, door hardware complete, door sweeps and weather stripping complete, floor and ceilings complete. Ensure that the building enclosure and components are complete and operational such that the performance of the building envelope tests would not be adversely affected.

1.6.5 Provide all project preparation and setup for the BET tests, this may include but is not limited to temporary sealing of intentional openings, removing ceiling tile, opening access doors, opening interior doors and affixing them so they cannot close during the tests. This may include preparation of adjoining

spaces. This would also include staging the building so no people will be opening doors or windows during the BET tests.

1.6.6 Provide temporary or permanent power for BET tests.

1.6.7 For building pressure test method using the Building Air Moving Equipment systems:

a. Ensure that all necessary building systems are complete and are operating in a safe manner.
b. Complete the installation of permanent electrical power systems serving the building systems. Such electrical systems shall be properly installed in accordance with all applicable codes to ensure the safety of all construction personnel.
c. Perform start up of all building systems in accordance with manufacturers' recommendations.
d. Complete the installation, programming, calibration and startup of all building control systems.

PART 2 - PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 EXAMINATION

Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper BET of systems and equipment. *Contract Documents* are defined in the General and Supplementary Conditions of Contract. Report deficiencies discovered.

3.1 PRELIMINARY PROCEDURES FOR BUILDING ENVELOPE TESTING

Conduct the Preliminary Procedures in accordance with procedures contained in the current edition of the NEBB *Procedural Building Envelope Testing* and this section. This includes that the Design Professionals and/or the Owner are responsible to define the objectives and the acceptance criteria for the testing. Additionally, they are responsible to define which air leakage test(s) are to be performed by the NEBB Certified BET Firm.

3.3 INSTRUMENTS AND EQUIPMENT

Instruments and equipment necessary to perform Building Envelope Testing shall meet the requirements of the current edition of the NEBB *Procedural Building Envelope Testing* and this section.

3.4 COMMON TEST PROCEDURES FOR BUILDING ENVELOPE TESTING

Perform Building Envelope Testing on all systems to be tested according to the procedures contained in the current edition of the NEBB *Procedural Building Envelope Testing* and this section. As stated in Section 3.1 above, the test method shall be defined by the Design Professionals and /or the Owner. The procedures listed below apply to both test methods and shall be followed when performing either the Blower Door Test Method or the Building Air Moving Equipment System Test method.

3.4.1 Establish the exterior test zone envelope. This is accomplished by defining the test zone envelope and ensuring it is appropriate for the goals of the test.

3.4.2 Select the appropriate test envelope condition; open or closed. For the closed condition, close all operable openings and seal other intentional openings to evaluate envelope air tightness. For the open condition, leave all operable openings in the normal operating condition of the building's occupancy to assess the envelope's effect on natural air change rates. The closed condition shall be the default option if no compelling reason exists to utilize the open condition.

3.4.3 Adjust all building components in accordance with Table 1 below and/or per the specification. For testing a building in the closed condition, close all operable openings and seal other intentional openings to evaluate envelope air tightness. For occupied condition, leave all operable openings in the normal operating condition of the building's occupancy.

3.4.4 Prior to conducting the test, perform the preliminary procedures identified in Section 3.1. If the performance of these preliminary procedures is the responsibility of others, survey the site and building to insure that all preliminary procedures have been properly completed.

3.4.5 Establish the interior test zone. This is accomplished by opening all interior building doors including fire doors, corridor doors, pass-throughs, in the test zone so that a uniform inside pressure is created within the zone. If there are hard ceilings with access doors, all access doors are to be open.

3.4.6 Measure and record the wind velocity and direction on the windward side of the building at a distance 30 to 50 feet away from the buildings. Preferred test conditions are wind velocity of 0 to 2 m/s (0 to 4 mph). If the surrounding building induced winds or the wind is gusting more than 4 mph above the steady state wind then the test should not be performed due to accuracy limits.

3.4.7 Measure and record the outside temperature. Preferred test conditions are outside temperatures from 2°C to 35°C (35°F to 95°F). If test is performed below 2°C (35°F) there is a possibility of freezing pipes. If the test is performed above 35°C (95°F) damaging finished materials, building finishes or worker safety becomes a concern.

3.4.8 Measure and record the indoor and outdoor temperatures at the beginning of the test so that their average values can be calculated.

3.4.9 Determine the height & temperature factor. The factor is the product of the absolute value of the indoor/outdoor air temperature difference multiplied by the building height**. If the factor is less than 200 m°C (1,180 ft°F),** perform the test. **If the factor is greater than 200 m°C (1,180 ft°F),** the stack effect may influence the building envelope pressure difference and will reduce the accuracy of the result. When the factor is greater than the above stated values, the entire test shall be performed both under a pressurization and depressurization modes

utilizing ASTM E 1827 Blower Door Test Method and the minimum induced test pressure shall be 25 Pa (0.10 in.w.c.).

TABLE 1: Recommended Pre-Test Building Preparations

Building Component	Envelope Conditions	
	Closed	**Open**
Exhaust fans with back draft dampers	Sealed	No preparation
Supply fans with back draft dampers	Sealed	No preparation
Furnace room door for furnace outside test zone	Closed	Closed
Combustion air intake damper for boilers	Closed	Closed
Outside air intake damper for Air Handling Unit inside test zone	Sealed	Closed
Outside air intake for Air Handling Unit inside test zone without damper	Sealed	No preparation
Exhaust, Air Handling Units, Make-up Air Units, Energy Recovery Units, Supply fans, Furnaces, Fan Coil Units, Boilers, Gas Hot Water Heaters, All equipment requiring combustion air (including kitchen equipment, HVAC, etc.)	Off	Off
Fan inlet grilles with motorized damper	Closed	Closed
Fan inlet grills without motorized damper	Sealed	No preparation
Ventilators designed for continuous use	Sealed	Sealed
Supply and exhaust ventilator dampers	Sealed	Held closed
Clothes dryer	Off	Off
If clothes dryer is connected to the dryer vent	No preparation	No preparation
Vented combustion appliance	Off	Off
Ventilation to other zones	Sealed	Sealed
Windows	Closed and Latched	Closed and Latched
exterior doors	Closed and Latched	Closed and Latched
Window air conditioners	Sealed	No preparation
Through the wall air conditioners outside air vent	Sealed	No preparation
Openings leading to outside the test zone	Closed	Closed
All HVAC ducts going from inside the test zone to outside the test zone and back into the test zone	Sealed	Sealed
All electrical conduits going from inside the test zone to outside the test zone and back into the test zone	Sealed	Sealed
Openings within the test zone	Open	Open
Floor drains and plumbing traps	Filled	Filled
Elevator pressure relief openings	Closed	Closed
Elevator Doors	Closed	Closed
Elevator Door Frame spacing between the elevator door and frame if the elevator connects an area outside the air barrier	Sealed	Open
Elevator Door Frame spacing between the elevator door and frame if the elevator connects an area within the air barrier	Open	Open
Rooms with Exterior, non-ducted louvers (interior doors)	Closed	Closed
Loading Dock Doors (interior doors)	Closed	Closed

3.4.10 Open all doors, windows, and other openings that connect portions of the building outside the test zone envelope with the outdoors. For example, if the

building is a combination of office and warehouse, and only the office portion of the building is to be tested then open the warehouse doors. If the entire office and warehouse is to be tested, then all office and warehouse doors are to be closed to the outside but the doors between the office and warehouse are to be open.

3.4.11 Remove sufficient ceiling tiles for lay-in ceilings, or open sufficient access panels for hard ceilings, were the pressure between the ceiling cavity and the room is equalized to within +/-10% of the building envelope test pressure.

3.4.12 Record the condition of the buildings components including windows, exterior doors, interior doors, stairwell doors, elevator doors, walls, access doors, roof and floor (i.e. sealed or unsealed, open or closed, etc.).

3.5 BLOWER DOOR TEST METHOD PROCEDURES

3.5.1 Install the blower door in an entry door, window or vent opening. The openings must be sealed or taped to avoid leakage at these points. Orient the blower door appropriately for depressurization or pressurization as required. The installation should have minimal obstructions of airflow into and out of the building.

3.5.2 Install the pressure measuring instrument across the building envelope. It is good practice to use more than one location across the building envelope for pressure measurement. Preferred locations for exterior pressure measurement locations should be those that avoid extremes of exterior pressures. A good location avoids exterior corners and complex architectural features and should be close to the middle of the exterior wall.

3.5.3 In addition, buildings more than 4 floors or 12.2 m (48.0 ft) in height, shall have pressures measured at a minimum of 2 locations or every 4 floors, whichever is greater.

3.5.4 Average 10 baseline pressures points of 10 seconds per point, where the variation between any point and the mean must be no greater than 1 Pascal.

3.5.5 Zero the pressure sensor by connecting the differential ports together.
Note: Some blower doors may perform this or an equivalent step automatically. Follow the manufacturer's instructions accordingly.

3.5.6 Before beginning the test, measure and record the baseline building differential pressure across the airflow measurement device with the blower off. If a damper is used to control airflow, it should be in a fully closed position for the baseline building pressure measurements. If the air moving equipment employs a blank-off plate, it should be fully closed for the baseline building tests.

3.5.7 Start the blower door fans and pressurize / depressurize the building to the highest specified induced pressure differential. Measure and record the building envelope differential pressure.

3.5.8 Pressure readings are to be taken to produce an accurate average building pressure. Fluctuations in pressure due to wind require pressure measurements

to be taken on both the windward and leeward side of the building and averaged. If the buildings height or building configuration causes internal building pressure fluctuations then interior pressure shall be taken and averaged.

3.5.9 Perform a minimum of 10 building envelope pressure differentials and their corresponding airflow measurements for both the pressurization mode and the depressurization mode (a total of 20 measurements). The measurements shall be taken over a minimum of 10 seconds. The range of the building envelope pressure differences should be from a minimum of 25 Pa (0.10 in. w.c.) to maximum of 75 Pa (0.30 in. w.c.). Use increments of 5 Pa (0.02 in. w.c.) for the full range of building envelope pressure differences. (i.e. 25, 35,40, 45, 50, 55, 60, 65, 70, 75 Pa) or (0.10, 0.14, 0.16, 0.18, 0.20, 0.22, 0.24, 0.26, 0.28, and 0.30 in. w.c.).

3.5.10 Conduct tests at each building envelope pressure differential. Allow the fan and instrumentation to stabilize prior to taking any measurements. At each pressure differential, measure the airflow rate and the pressure differences across the envelope over at least a 10 second time interval. Average the airflow and pressure differentials over this time interval. For each building envelope pressure differential test, collect data for both pressurization and de-pressurization.

3.5.11 After conducting the pressure tests, measure and record the baseline building differential pressure across the airflow measurement device with the fan off and sealed.

3.5.12 Report the building envelope pressure differential, and the airflow for each test and the beginning and ending baseline building differential pressure.

3.5.13 Subtract the average baseline differential pressure from the building envelope differential pressure and report this value for both pressurization and depressurization.
NOTE: Some equipment may perform this step, or an equivalent step, automatically follow the manufacturer's instructions accordingly.

3.5.14 Measure and record the indoor and outdoor temperatures at the end of the test so that their average values can be calculated.

3.5.15 Repeat steps 8.2.3.9 through 8.2.3.14 for the alternate pressurization.

3.6 BUILDING AIR MOVING EQUIPMENT SYSTEM TEST METHOD PROCEDURES

This test method can be utilized for pressurization or depressurization testing of the building envelope, however, the test is not as accurate as the ASTM 779 that is the blower door tests. This test should not be considered an equal to those tests. This is due to several reasons; none of which pertain to the abilities of the NEBB Certified BET Firm or the capabilities of the required instrumentation and equipment to perform the Building Air Moving Equipment Test Method. The major features that could affect the ability to perform the test and the accuracy of this test relate to the following:

1. The ability of the installed HVAC equipment and systems to mechanically bring in sufficient amounts of outside air for pressurization and / or mechanically exhaust sufficient amounts of building air for depressurization.
2. The ability of the installed mechanical equipment and systems to generate the required airflows and associated static pressures to properly conduct the test
3. The configuration of the equipment installed in the system to accurately measure airflow and static pressures. The most accurate method to measure airflow in the field is by performing a duct traverse using a Pitot tube and digital manometer. To accurately perform a traverse measurement requires an adequate length of straight duct downstream from any equipment, fittings or obstructions to provide an ideal duct traverse plane in which to obtain an accurate duct traverse.
4. The ability of the most building air moving equipment systems to be manipulated in order to produce meaningful building pressure gradients

3.6.1 When using the Building Air Moving Equipment System Method Test, the NEBB Certified BET Firm shall follow NEBB TAB procedures to measure the airflow. The preferred method to measure the airflow is by the traverse method that complies with NEBB procedures. If airflow monitoring stations are used, it is the NEBB firm's responsibility to verify the accuracy of the airflow monitor.

3.6.2 If neither the traverse method nor the use of airflow monitoring stations is available then three (3) alternate methods of measuring airflow per the NEBB TAB procedures shall be used. The three different methods should correlate flow to each other within 10%.

3.6.3 The Building Air Moving Equipment Test Method consists of taking two sets of data at two different building pressures. The first set of data, identified as P_1, is taken the higher differential pressure value. The second set of data identified as P_2, is taken the lower differential pressure value. The criteria limits for values of P_1 and P_2 values shall be as follows:

a. P_1 value shall be between 75 and 35 Pa (0.30 in.w.c. and 0.14 in.w.c).
b. P_2 value shall be 1/3 of the P_1 value and shall be between 25 and 10 Pa (0.10 in.w.c. and 0.04 in.w.c).

If the above criteria cannot be achieved, then **the Blower Door Test Method SHALL be performed utilizing both the pressurization and the depressurization modes.**

A minimum of five replicate measurements of building envelope differential pressure and the corresponding airflow shall be taken at each value of P_1 and P_2. Thus, a total of 10 pressures measurements and 10 airflow measurements are required.

3.6.4 Install the pressure measuring instrument across the building envelope. It is good practice to use more than one location across the building envelope for pressure measurement. Preferred locations for exterior pressure measurement locations should be those that avoid extremes of exterior pressures. A good

location avoids exterior corners and complex architectural features and should be close to the middle of the exterior wall.

3.6.5 In addition, buildings more than 4 floors or 12.2 m (48.0 ft) in height shall have pressures measured at a minimum of 2 locations or every 4 floors, whichever is greater.

3.6.6 The pressures from each location should be averaged, typically using a manifold. Average the pressures over at least a 10 second time period.

3.6.7 Zero the pressure sensor

3.6.8 Measure and record the baseline building differential pressure by closing the dampers or otherwise seal off the fan(s) that will be creating the test flows.

3.6.9 Conduct five (5) tests at the P_1 building envelope pressure differential. Allow the fan and instrumentation to stabilize prior to taking any measurements. Measure the airflow and the building pressure differential simultaneously. Repeat until all 5 airflow measurements and 5 envelope pressure differential measurements have been taken. Each of the flow and corresponding pressure differentials measurements must occur within 5 minutes of each other.

3.6.10 Repeat the entire procedure at P_2 and conduct five (5) tests at the P_2 building envelope pressure differential. Allow the fan and instrumentation to stabilize prior to taking any measurements. Measure the airflow and then measure the building pressure differential. Repeat until all 5 airflow measurements and 5 envelope pressure differential measurements have been taken. Each of the flow and corresponding pressure differentials measurements must occur within 5 minutes of each other.

3.6.11 Average the 5 airflow measurements to each other and average the 5 pressure differentials to each other for the data obtained at P_1.

3.6.12 Average the 5 airflow measurements to each other and average the 5 pressure differentials to each other for the data obtained at P_2.

3.6.13 Measure and record Baseline Building Pressure Differential at the end of the test.

3.6.14 Measure and record the indoor and outdoor temperatures at the end of the test so that their average values can be calculated.
NOTE: It is advisable to check that the condition of the building envelope has not changed after each pressure reading, for example, that sealed openings have not become unsealed or that doors, windows, or dampers have not been forced open by the building envelope pressure testing.

3.7 DATA ANALYSIS AND CALCULATIONS FOR BOTH THE BLOWER DOOR TEST METHOD AND THE BUILDING AIR MOVING EQUIPMENT SYSTEM TEST METHOD

3.7.1 If the airflow measuring instrumentation being utilized does not provide the volumetric airflow at the temperature and pressure of the air flowing through the flowmeter during the test, the airflow values must be corrected for density.

3.7.2 When correcting the readings of the airflow measurements for density, the preferred method is to use the temperature and the actual barometric pressure. A method to correct for density using temperature and elevation is available, but does not account for weather impact. In the pressurization mode this will be the outside air temperature and barometric pressure. For depressurization test this will be the inside air temperature and barometric pressure.

3.7.3 Average the baseline building envelope pressures measured before and after the flow measurements. Subtract the average from the measured envelope differential pressures readings to determine the corrected induced envelope pressures.

3.7.4 Plot the measured airflow against the corrected induced pressure differences on a log-log plot to complete the air leakage graph for both pressurization and de-pressurization (for an example, see Appendix C, Section C.10 of the current edition of the NEBB *Procedural Building Envelope Testing.*

3.7.5 Use the data to determine the air leakage coefficient.

3.7.6 Correct the air leakage coefficient (C) to standard conditions. Use the data to determine the pressure exponent separately for pressurization and depressurization.

3.7.7 If the pressure exponent (n) is less than 0.45 or greater than 0.8, then the test is invalid and shall be repeated.

3.7.8 Use a log-linearized linear regression technique and the associated equation in Appendix C, Section C.5.5 of the current edition of the NEBB *Procedural Building Envelope Testing,* where Q is the airflow rate, in m^3/s (cfm), and ΔP is the differential pressure in Pa (in.w.c.). In determining the fit of the above equation, the confidence intervals of the derived air leakage coefficient (C) and pressure exponent (n) should be calculated.

3.7.10 The effective leakage area, A_L, can be calculated from the corrected air leakage coefficient and the pressure exponent using a reference pressure (ΔP_r). Calculate the leakage areas separately for pressurization and depressurization.

3.7.11 To obtain a single value for flow coefficient, pressure exponent and leakage area for use in other calculations, the average of these values from the pressurization and depressurization envelope flows and pressure differences, with their offsets removed, may be combined together. This combined data set then is used in the same way as each individual data set to obtain C, n, and A_L for the combined data. If the flow at a specified pressure difference, such as 50 Pa, is desired, it should be determined using the derived C and n and the specified reference pressure.

3.7.12 Determine the upper confidence limits for the derived values which shall not exceed the leakage rate per square footage of air barrier.

3.8 ACCEPTANCE

The acceptance criteria should be as specified in the contract documents or as agreed to between the Owner / Buyer and the NEBB Certified BET Firm.

3.9 FINAL REPORT

The final report shall be in accordance with the requirements of the current edition of the NEBB *Procedural Standards for the Building Envelope Testing.*