

STUDY OF THE VARIABILITY OF AIR LEAKAGE RATE BETWEEN IN-SITU TESTED AND  
LABORATORY TESTED FENESTRATION

by

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# STUDY OF THE VARIABILITY OF AIR LEAKAGE RATE BETWEEN IN-SITU TESTED AND LABORTATORY TESTED FENESTRATION

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## ABSTRACT

The air leakage measured using the laboratory test of fenestration is important to gauge its initial performance and for certification. Field testing based on a statistical approach was carried out in this study on newly installed fenestration product to study the nature of distribution of air leakage measurements. The measured values from these tests were also compared to the laboratory tested value of the same product and to the values as suggested in field testing guidelines as provided in AAMA 502. Results indicate that field measured values at standard pressure difference follow a normal distribution with a mean and a variance. The results also show that while number of test results fall within a certain range of the laboratory value and the AAMA 502 stipulated value, there are number of values that are higher than them.

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# Chapter 1

## Introduction

The widely used Fenestration Standard, NAFS and AAMA (AAMA, 2012), clearly stipulates in section 0.1.1- Applicability that provisions in the standard apply to laboratory testing only. For field testing in the US the NAFS refers to AAMA 502 (AAMA, 2012). The AAMA 502 provides guidance in terms of the way the field testing might be carried out and guidance in terms of the interpretation of results with respect to performance values that are stipulated in the AAMA. For Canada, the NAFS makes no reference in terms of using AAMA 502. Some reference to the similar guidance in Canada can be found in CSA A440.4. In the Annex D (informative) to A440.4 it provides information on the field testing of window and door installations.

AAMA 502 (AAMA, 2012) addresses the need to carry out field testing that is often necessary to verify the performance against the values that are used for certification. It stipulates the parameters for the time-frame in which testing can be done after installation. The standard is limited to the field testing of newly installed fenestration products. It is intended for testing prior to issuance of the occupancy permit and for a period not to exceed 6 months after installation of the fenestration product. The CSA A440.4 stipulates that the standard “does not require routine field testing”. There are no time limit stipulations in CSA A440.4.

For air leakage testing AAMA 502 allows for the testing to be carried out at the same pressure differences as required for NAFS but allows the air leakage to be 1.5 times the value that is used for certifying the product as per the NAFS. The CSA A440.4 indicates the air leakage testing to be carried out at a pressure of 75 Pa. With respect to the air leakage testing the annex recognizes the difficulty in doing the test for air exfiltration and suggest that air infiltration alone may be acceptable way of determining the air leakage characteristics. It provides a detailed list of allowable rates of air leakage for field testing based on the original rating and the size of windows. CSA A440.4, also has a separate section for doors in which it stipulates the maximum air leakage rates for doors based on the original rating. The maximum values stipulated for sliding doors are as follows:

Rating A1 – 2.79 m<sup>3</sup>/h, Rating A2 – 1.65 m<sup>3</sup>/h, rating A3 – 1.00 m<sup>3</sup>/h.

Other than the two standards indicated above there is some mention in Woods et al. in 1995 about determining the rationale for field testing. They suggest that field air leakage testing on existing buildings, for values of greater than 15% of the design values for windows and doors would call for intervention to reduce air leakage.

Both the AAMA 502 and the CSA A440.4 indicate that the field testing for air leakage is to be done in accordance with ASTM E783-02. However, it is evident that the acceptable values for field testing are not similar. AAMA 502 appears to be more widely used compared to similar requirements in CSA A440.4.

There has been discussion in popular media about the field testing with respect to water leakage in accordance with AAMA 502. An example of it is a BSC Experts Session in 2014, Baker in 2014 talks in much detail about windows and water leakage testing in relationship to field performance. In it the question of “how much testing?” has been raised. Baker suggests that for punched windows and door a total of 1% to 2% of the total number of units installed to be tested. AAMA 502 suggests a minimum of three units to be tested in the field.

Neither the suggestion made by Baker (Baker, 2014) nor suggestion made in AAMA 502 are indicative of any statistical basis for determining the sample sizes for testing in the field. It would seem they are more reflective of the practicality and the cost of field testing which in itself may be rationale reason to determine the extent of field testing to be done. On the other hand, ASTM E783-02 in section 9 provides some guidance in terms of sampling based on statistical considerations.

Practical considerations related to field testing are well addressed by Goncalves et al in 2007. They provide some guidelines to decide on the choice of sample selection for testing. They recommend at least three tests, one each at the beginning, the middle and end of the installation.

## **Statement of the Problem**

ASTM E783-02 raises caution in terms of comparing field results to laboratory results. In section 5.3 it indicates that correlation between actual performance of in-service products and the response to these tests has not been established because of insufficient data.

It has been determined through a literature review (shown later) that little is known about the air leakage performance of newly installed fenestration products in comparison to its laboratory tested performance. Little data exists on relating laboratory performance and field performance of fenestration products after installation.

## **Significance of This Study**

There exists a significant body of work related to air leakage characteristics of whole buildings. In particular the energy loss through infiltration has shown to be excessive. Most studies that focus on the benefits of improving the air tightness of buildings examine it from a whole building perspective. In high rise apartment buildings where operable fenestration is a norm, the air leakage characteristics of the fenestration can form a substantial portion of the whole building air leakage. It is therefore important that designers particularly in such buildings are aware about the differences between the specified air leakage values and the field-tested air leakage values.

## **Research Objectives**

The main objective of this project is to examine the nature of differences between the air leakage determined in a laboratory condition to that measured in the field for the same product that is newly installed.

## **Chapter 2**

### **Review of Related Literature and Studies**

As stated in ASTM E-283, laboratory standard for measuring air leakage in fenestration products, section 5, part 3," The correlation between the laboratory and field test results, and the correlation between the actual performance of in service products and the response to these tests have not been yet established because of insufficient data" (ASTM Standard, 2012).

As part of this study various aspects of air leakage through buildings were examined as they relate to the research objective. The work involved a review of literature and studies that were found through searches and from discussion with a few experts in the field. The findings are categorized under appropriate headings

#### **Air Leakage, Importance, and Impacts on Buildings**

Air leakage as the uncontrolled and usually unintentional movement of the air across the building envelope is a critical factor affecting building's long-term durability and energy performance. It has a major influence on noise transmission, smoke propagation, overall indoor space quality and comfort health (Proskiw & Phillips, 2008; Kalamees et al., 2008; Becker, 2009; Domhagen, 2016).

Moisture convection through the building envelope may cause severe moisture load imposed on the structure. Indoor air exfiltration in cold climates can cause condensation or moisture accumulation which leads to the microbial growth on materials, the change in their properties or even to structural deterioration. Air leakage through a building envelope could introduce outdoor airborne pollutants as well as, radon gas into the indoor air. (Kalamees et al., 2008; Domhagen, 2016)

#### **Air Leakage, Impact on Energy Consumption**

According to the North American insulation manufacturers association's (NAIMA) study of seven buildings in 1990 and 1997, airtightness plays a significant role in energy saving in buildings (Fennell & Haehnel, 2005). Thirty six percent of annual energy consumption in the U.S. belongs to the building sector. The largest single energy end user in buildings is space



heating and cooling, which counts for over 50% of their energy use. In the residential building sector, 50% of the energy is consumed for space heating and 6% for space cooling (Sherman, 1980).

Different studies have shown air infiltration affects the heating load in commercial and residential buildings by 24% to 50% (Younes et al., 2012; Canada mortgage and housing corporation (CMHC), 2007). The energy use in buildings is affected by variation in air tightness to the variation in total air exchange rates. In less air tight buildings, a higher imbalance between supply and exhaust air flow is required to create negative or positive indoor pressure (Domhagen, 2016).

In 1982, Persily attributed one third of heating and cooling loads in buildings to air infiltration (Younes et al., 2012). In a 2001 study, by Orme on the effects of air infiltration and ventilation on energy consumption in buildings, It was estimated that one third of energy (delivered for heating and cooling in buildings) is attributed to air change and space conditioning energy losses (Orme, 2001). In a study conducted in a cooling dominated weather condition in California, Probst in 2004 showed that infiltration may cause a 50 % increase in cooling energy consumption (Probst, 2004). The Washington, D.C. -based U.S. Department of Energy office of the building technologies department at 2005, estimated that infiltration is responsible for 33 percent of total heating energy use which only could save 3.3 percent of total cooling energy. A further study in 2005, on investigation of the impact of commercial building envelope airtightness on HVAC energy use done by the U.S Department of Energy found that 3 to 36% of energy cost could be saved through air tightness (Goedken, 2007). Dale et al in 1985, reported that after a 53% decrease in air infiltration in two test rooms, energy consumption decreased approximately up to 20% (Becker, 2009). The National Institute of Standards and Technology estimated that 15% of the heating loads in commercial buildings is caused by air infiltration (Younes et al., 2012).

### **Airtightness v/s Ventilation Requirements**

The requirements in air tightness standard should be compatible with natural ventilation requirements. The extent of air infiltration with respect to ventilation on the one hand and energy conservation on the other hand, are the main factors to be assessed by the designers.

Energy conservation may be achieved by restricting air infiltration, but extensive air tightness may lead to condensation and dampness problems (Provan & Younger, 1986). Extreme airtightness affects the indoor air quality and can be hazardous to one's health, where pollutant levels inside a building may be much higher than outside levels (Sherman, 1980). In an extreme airtight design, energy consumption will not necessarily decrease due to expansion of ventilation requirements to maintain an acceptable indoor air quality (Alfano et al., 2016). The related extreme airtightness problems could be avoided by supplying heating and ventilation at the expense of energy conservation. Balance is required between energy conservation needs and natural ventilation requirements for the complete building and its component parts such as, windows (Provan et al., 1986).

### **Windows Contribution to Air Leakage**

Nowadays windows and glass curtain walls represent a higher portion of the large building's exterior cladding. Window air tightness is a determining element in the performance evaluation of this type of building envelopes. This is essential in pre-construction and construction phase of buildings to avoid undesirable problems occurring in duration of building service life. Obviously, resistance to air and water penetration are not the only performance criteria for fenestration products to consider, but in fact they contribute to the majority of in service performance failures of building envelopes (Gonçalves & Jutras, 2007).

The contribution of windows and doors to the whole building, air tightness varies from 15% to 31% as shown by the American society of heating and cooling (ASHRAE) in 1997 and Kalamees in 2008 respectively. Windows count for 40% of the total energy demand of buildings. Correct assessment of window air leakage rates can help proper ventilation system design and could avoid energy waste (Alfano et al., 2016; Fennell & Haehnel, 2005). Implementing air tightness improvement measures to window and walls can save energy in buildings of up to 12% (Woods, 1995).

Prime locations of air leakage in windows could be cracks and joints between various parts of windows such as sash, frame, or weather stripping. The physical defects in windows could contribute to excessive air leakage rates. In 1979, Weidt et al, concluded in their windows air leakage assessment report that the majority of window defects were related to

manufacturing and fabrication process and few were related to the abuse of windows during construction. Weather stripping discontinuity, sash fit and hardware seal failures were shown as main factors contributing to high air leakage rates. In Daoud's report in 1992, windows with less visible defects produced 46% lower air leakage rates than the mean value. They concluded that visible defects due to design and fabrication were the most frequent, where 50% of the windows were suffering from either or both sources. Maintenance problems were responsible for almost 30% of the defects and installation defects were the least frequent, at almost 25%. Minor repairs were shown to improve the air tightness performance by 10 to 30%. (Daoud, 1992). Despite of window retrofit by substitution of existing window to high performance one, and changing the rubber seal on the window frame, Alfano et al, did not notice any improvement due to the existing installation issues.

The operation type was defined as one of the factors influencing window air leakage performance in Weidt et al. report in 1979. Their test results indicated that 70% of double sliders and 84% of single slider windows had higher field air leakage rates than manufacture's laboratory reports.

Daoud et al. investigated the effect of window dimensions, to see if there is any optimum dimension at which air infiltration is minimized. Since there are other factors involved (Such as window defect location), no clue was found regardless of the window type except that larger windows, have larger perimeters and a higher volume of air infiltration. However, the amount of leakage is not portion of the crack length as windows leak more at corners, meeting rails and meeting stiles than along the crack length (CSA Group, 2017).

Weidt et al. and Daoud et al. reports, supported the impact of manufacturers on window performance. Window design, fabrication procedure, quality of workmanship procedure highly depends on the manufacturer performance.

Weidt et al. found no clues on window material difference, effecting air leakage performance of the window, however off shored materials could represent lower quality because of the lack of proper quality control (Trudeau, 2016). Imported materials vary widely in quality due to the absence of control and low-grade material use. They performed 13% below those locally produced and 9% below the average (Daoud et al., 1991). Addressing cultural,

economic, technical issues, confirming the compatibility of products with shop drawings and in situ testing of products is important when using offshore products versus inshore ones (Hubbs, 2016).

### **Measuring Window's Air Tightness Performance in Laboratory v/s Field**

AAMA/NWWDA-101, CAN/CSA-A440, AAMA 501 are principal industry standards determining air leakage resistance laboratory performance criteria and AAMA 502, AAMA 503, CAN/CSA-A440.4 (appendix D) are the principal industry standards, for determining air leakage resistance field performance criteria of windows and curtain walls in North America (Gonçalves & Jutras, 2007). NAFS (North American Fenestration Standard/Specification for windows, doors, and skylights), is a harmonized performance standard published jointly by CSA (Canadian Standards Association) in Canada, AAMA (American Architectural Manufacturers Association) and WDMA (Window and door association manufacturers) in the United states (Jaugelis, 2014).

### **Air Leakage Measurements Standards**

ASTM E283 Standard, covers laboratory test procedure for determining air leakage rates of exterior windows, curtain walls and doors under specified pressure differences across the specimen. Although, temperature and relative humidity fluctuations can cause shrinkage and affect air leakage rates of window components, but ASTM E208 specifies the air leakage rates under constant relative humidity and temperature of 20°C for labeling purposes. The measured rates in this test are associated with the assembly and not the installation. This test consists of sealing a test specimen into or against one face of an air chamber. Then supplying air to or exhausting air from the chamber at the required rate to maintain the specified test pressure difference across the specimen and measuring the resultant air flow. For this test, the specifying authority shall apply information such as specimen test size, test pressure difference (If nothing specified, it will be tested under 75 pa pressure difference), and direction of air flow (exfiltration or infiltration). Air leakage rates, can be reported as total air leakage per unit length of operable crack perimeter ( $L/(s.m)(ft^3/min.ft^2)$ ) and per unit area of outside frame dimension ( $L/(s.m^2)(ft^3/min.ft^2)$ ) (ASTM Standard, 2012).

The Canadian window performance standard CAN/CSA-A440-M90 provides three categories for the rating of operable windows when tested at a specified temperature of 20°C and pressure difference of 75 Pascal. Ratings are named as A1, A2 and A3 when air leakage is less than 2.79, 1.65 and 0.55 (m<sup>3</sup>/h.m) relatively (Canadian standard association (CSA), 2004).

ASTM E783 (Field Measurement of Air Leakage through Installed Exterior Windows and Doors) and ASTM E1186 (Standard Practice for Air Leakage Site Detection in Building Envelope and Air Barrier Systems), are quantitative test method to qualitatively assess field air leakage through installed windows and doors and exterior building envelope and air barrier systems relatively. Regardless of the test method, the test procedure consists of sealing a chamber to cover the interior and exterior surface of the test specimen, supplying air to or exhausting air from the chamber at a rate required to maintain the specified test pressure and measuring the air flow rate result (lost or gained) across the testing specimen. Air leakage is typically undertaken at a pressure differential of 1.57 psf (75 pa) or 6.24 psf (300 pa).

The air flow through the test chamber will be adjusted to provide the specific test pressure difference across the test specimen. When the test condition and pressure difference is stabilized, test pressure difference and air flow will be recorded through the flow meter. This measured air flow is the total air flow. Extraneous air leakage will be documented to ensure the proper leakage measurement from the specimen. By subtracting the total air flow and the extraneous leakage, in terms of flow at standard conditions, air leakage through the specimen will be defined. The air leakage can be calculated for the test specimen, per both unit length of operable crack perimeter and unit area.

In Accordance to AAMA 502, allowable air leakage rates for field testing shall be 1.5 times the achieved laboratory test rating. In Canada, guidelines for air leakage rate measurements are provided by CSA A440.4. The allowable air leakage rates are indicated in architectural specification and depends on several factors such as building location, energy code and operation types (Gonçalves & Jutras, 2007.; ASTM, 2012). The building type has a shown a slight effect on window air infiltration performance. Residential buildings have 28% and

17% less air infiltration rates compared to those of office buildings, possibly due to extra care taken in selecting and maintaining windows (Daoud et al., 1991).

### **Performance Requirements**

Window air leakage performance is generally available performance according to ASTM E283. To estimate overall building air leakage, often energy simulation software simplify window air leakage calculations by only applying the stack and wind effect. However, temperature and pressure difference are important variables in determining the overall envelope air leakage performance. Temperature gradient could cause distortion and shrinkage of window components and impact the leakage characteristic under more extreme summer and winter condition. Henry et al. showed that air leakage rates increase in higher temperature and pressure differences. Most windows experienced higher or slightly higher leakage rates at colder temperatures however, nearly half remained in the same performance category. Window air leakage rate changes seemed to be more affected by the design rather than material and operation type. Henry et al. pointed out the fact that annual energy ratings do not take the seasonal temperature fluctuation into account for the Energy rating of windows. Even though their study showed air leakage increase has negligible effect on Annual Energy Ratings.

In a 1979 study on newly installed residential windows, the air leakage of installed 192 windows was compared with the standard used by the government and industry. The effect of sash and frame material, differences between production lines of a single manufacturer, differences between multiple manufacturers, installation practice, effects of cold weather on performance and changes in performance during the time were studied. Overall, 40% of all tested windows showed higher air leakage rates than the required standards and 60% of the windows exceeded manufacturer's specifications for performance. (Weidt & Weidt, 1979)

In Daoud et al. report in 1990 on air leakage performance, of 154 windows in Kuwait, only 6% of the samples consisting of tilt-and turn and fixed satisfied the air leakage performance required ratings. In contrast, with Weidt el al. study found 35% of the windows were showing less or equal to three times the ANSI/AAMA allowed air infiltration rate limit and the remaining windows, which were 65% of the test samples were showing higher rates.

Despite constructing a curtain wall system under laboratory conditions with a selected crew by the manufacture, it was shown in Becker report that it is impossible to achieve anticipated air tightness performance using original details based on a multitude of intermediate sealing at many points and perfect workmanship. Therefore, under in-situ construction conditions that is very much characterized by much poor workmanship and sealing practice, lower levels of air tightness is anticipated (Becker, 2009).

Most of the studies focused on the whole buildings airtightness and its effects on energy consumption but in high rise apartments with high portion of glazed envelope systems, operable fenestration's air tightness could affect the building air tightness significantly. It is important that the designers nowadays be aware about the differences between the specified air leakage values and the field-tested air leakage values.

### **Uncertainty and Lack of Sufficient Data on Field Performance**

Having well trained test operators, properly calibrated and reliable equipment, clear calculation methods and standards are few prerequisites for accurate air leakage rate measurements. Despite all the mentioned prerequisites, air leakage results always show uncertainty due to different pressure differences around the building envelope. This pressure difference is result of the temperature, wind speed and relative humidity difference which create air leakage rate variations.

Under repeatability circumstances, where the operator and equipment remained the same, Delmotte and Laverge in 2011, reported a standard deviation of 1.4% and a maximum variation of 4% in 10 pressurization air leakage tests. This number increased to 2.7% and 7.9% under reproducibility conditions, where the test operator and test equipment had changed. In 1982, Persily found a 5.5% standard deviation and 19.4% maximum variation in 28 performed pressurization tests on a house during a three-month period. In Calm weather, this statistic decreased to 1.7% and 4.8% due to the high impact of the wind speed on repeatability of pressurization test results. (Bracke et al. , 2016). In a study on seasonal variation of air tightness in semi-detached houses over a period of one week, the measurements Kim and Shaw noticed were a standard deviation of 1.7% and maximal variation of 4.2% (Kim & Shaw, 1986). In Bracke et al. study on two passive houses in Belgium, their measurements in the first house which was

built with traditional methods using masonry walls, through conducting 48 pressurization tests, done in 7 different days in a 5-month period, showed a standard deviation of 1.1% to 3.5% within the same day. In the second house which had a wood-frame structure, the variation within the same day was higher and was reported as a standard deviation of 2.7% and an average maximum variation of 7.7%. The average standard deviation for both tested houses was 3.2 and 3.5 m<sup>3</sup>/h relatively. Bracke et al. could find no correlation between wind speed and air leakage in their study but air leakage results showed more variation on windy days. But It can't be concluded that wind effect is negligible as its effect could get masked by usual variations in air tightness measurements (Bracke et al., 2016).

Windows in the Weidt et al. report showed approximately 29% average decline in performance between the time they were manufactured and the time they were installed. Their results indicated no significant trend for air leakage performance to deteriorate during cold weather(Weidt et al., 1979).

Studies are available on air leakage seasonal variations, but different building methods and climate are important factors impacting the drawing conclusions. Persily, in multiple tests conducted in one house in a period of one-year, reported 30% higher air leakage rates in the winter compared to lowest measurement results in the summer. He also reported lower air leakage rates in the presence of higher relative humidity, as he claimed that moisture in hot summers results in a swelling of the wood and disappearing of small gaps and cracks (Bracke et al., 2016). Kim and Shaw measured a seasonal variation of 20% in their test performances on two houses with the highest air leakage rates appearing in the winter(Kim & Shaw, 1986). Elmroth and Logdberg measured 70% air leakage increase in five houses during the first year of occupancy in Sweden. Carlsson and Kronvall in 1984 had found no significant change in fifteen timber frame houses, 1 to 4 years after construction. Warren and Webb in 1980 found evidences of a 40% increase in air leakage in one house during the winter and 83% increase in air tightness in three other houses, during one year after construction. In 1992, Bassett's study on five houses showed no significant trend in airtightness variation during the first year of their construction(Bassett, 1992).



Bracke et al. study showed a 13% increase in air leakage over each single test day over a duration of 7 test days in their first case study. Their second case study which was a similar traditional wood frame house (similar to Persily study in 1982), in contrast, showed no decrease in air leakage during summer. The reason of having different results despite of climate and construction method similarities, could be that all joints between wood panels and around envelope details such as windows were sealed with tape and along with wood swelling it could even make the building tighter. Following a different pattern, Dickinson and Feustel performed a study on 10 houses in three different climates in 1986 that showed a 45% higher air leakage in the summer. The fact that the winter results were showing less variation can be explained by large quantities of snow on and around the building envelope (Bracke et al., 2016).

Lux in 1987 studied 30 relatively air tight houses, six years after original air tightness tests were conducted (only five houses did not have any interventions performed on them). The maximum air leakage increase was measured at 32% but one of the houses showed 9% more air tightness compared to the original amounts. Proskiwi's case studies, showed maximum increase in air tightness of 37 % and a 30% decrease over the period of 5 years (G. Proskiwi, 1992). Reiß and Erhorn compared air leakage rates of passive houses after construction in a two-year period, and reported 30% increase in air leakage rates. In their study, an increase of 216% in air leakage was reported and a few houses showed decreases up to 39% (Bracke et al., 2016). Temse and Bredene is a report on air leakage re-measurements, supported air leakage increase by 29% and 45% over a two year period due to construction wear and tears (Bracke et al., 2016).

In a recent study by Wahlgren et al in 2015, air tightness of the building was shown varying as much as 10% throughout the year. The main reason could be variation in relative humidity and temperature fluctuations. Domhagen's research results, showed a strong correlation between increased indoor relative humidity and increased airtightness, as well as a strong correlation between decreased relative humidity and decreased airtightness. Persily's study showed 25% of air tightness fluctuation throughout a year (Domhagen, 2016).

Gids et al. Study supports that a large portion of air leakage can be attributed to design and workmanship in whole building air tightness evaluation. (Bracke et al., 2016).

### **Some Thoughts from the Literature Review**

The energy implications of air leakage from the point of view of whole building have been of interest. As one of the studies indicated the implications if reducing air leakage can be as significant as improving R values in roofs or walls or improving SHGC. As we improve the air tightness of buildings and with energy recovery from ventilated air the air leakage characteristics of operable fenestration products will become relatively more important. The values of air leakage specified in the certification process need to reflect in some form the air leakage values achieved after installation. Recent changes to field testing standards such as AAMA 502 appear to deal with this issue. However, we still do not know the level of variation, statistically speaking, in the field installed window. Although the Weidt in 1979 study is decades old it did show that variations can be significant. Some of these variations may be controlled by better quality control during manufacturing and more care during installation. However, without undertaking a study on such variations it may be viewed as mere speculation.

## **Chapter 3**

### **Methodology**

To review the fenestration air leakage performance, choosing an appropriate building, reviewing the architectural and window shop drawings, selecting test samples, conducting visual inspection and field air leakage tests were the main steps.

#### **Selection of Building for Field Testing**

A building under construction was selected for the air leakage field testing of the fenestration product. The building is located in a built-up-area of Toronto, Ontario, Canada. The exterior cladding of the building was completely installed and the interior finishes were complete to a varying degree.

The building HVAC system was not operational. The building is over 60 storeys high and the general construction method and the materials used are typical of condominium buildings being constructed in Toronto at the time of this study – it's exterior envelope uses window-wall type of construction, and the structure is cast-in-place concrete with unenclosed cantilevered balconies.

The choice of the building was predominantly dictated by the need to study fenestration that would not have been subjected to use by the occupants, and the ability to get a sample size adequate for statistical purposes. The chosen building provided that opportunity.

Access to the building for conducting field tests as well as access to building architectural and window shop drawings were other important factors affecting this selection. The manufacturer of fenestration products used in the project, indeed cooperated a lot in sharing laboratory test reports and other required information.

#### **Selection of Type of Fenestration for Testing**

This building provided an opportunity to choose fixed windows, operable windows and sliding patio doors for testing.

In this study sliding patio doors were chosen for testing predominantly because of the ease of access to the exterior side through the balcony. Such access would be necessary as part of the testing.

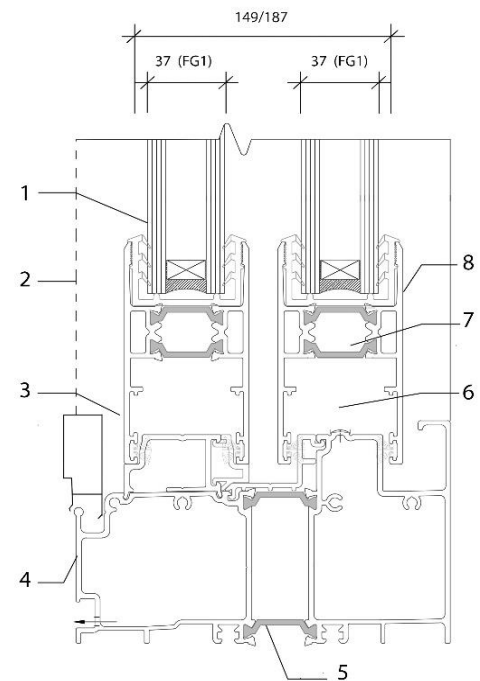
The laboratory test results that formed the basis of the certification of the patio door and the details of the patio door were made available by the manufacturer. *(Refer to Appendix A)*

### Description of the Tested Fenestration Product

As mentioned before the building had many different types of windows and sliding doors that were used as part of the exterior envelope. For the purpose of this study it was decided to use an operational fenestration products available in forms of horizontal sliding windows and horizontal sliding doors.

It was decided to test sliding doors primarily because the exterior of these doors would be accessible through the balconies across which they were installed. This would allow access to sliding doors throughout the building without the need to access the exterior via suspended stages.

The description of the sliding door as stated in the laboratory test results is stated in this section and more detailed in the Appendix A. The installed door was the same as the laboratory door but with different dimensions.



1 - IGU, 2- Fly screen, 3 - Fixed panel, 4- Threshold,

5-Thernal break, 6- Roller, 7- Thermal break, 8-Sliding panel

**Figure 1 - Cross-section at the sill of the door assembly**

The door is described as a thermally broken aluminum exterior sliding door set on a frame with a width from the inside to the outside of 149 mm. It has one fixed panel and one operable panel both with IGUs. It has a fiberglass fly screen in aluminum frame on rollers. The frame finish is anodized aluminum. The handle and locking hardware consists of pull handle on each side of the operable door, single point hook lock and an interior side lock lever. The overall door frame size of the laboratory tested sample was 2260mm high x 1830mm wide. The operable and fixed panel were each 890 mm high x 716 mm wide. The weather stripping of polypile was used at all fixed and operable rails, operable panel lock stile and fixed and operable interlocks. Composite dust plugs were used at the end of interlock stile.

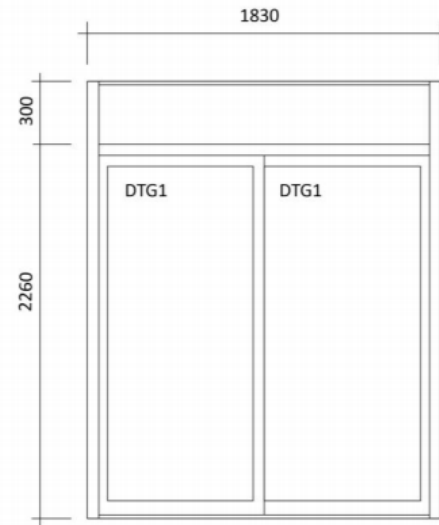


Figure 2 – Elevation view of the door assembly

All corners in the frame were square cut and butted aluminum sealed with butyl tape and secured with long pan head screws. All corners in the panels were mitered and sealed with sealant and secured with two aluminum corners and one plastic corner bracket. (*Refer to Figure 1 and 2*).

The air leakage reported in the laboratory test report was 0.5 (L/s/m<sup>2</sup>) at 75 Pascal pressure difference in infiltration and exfiltration as tested in accordance with ASTM E283.

### Selection of Samples for Testing Identifying the Population

As indicated in architectural and shop drawings, there are different types of patio doors in the building. Test samples were selected on a randomized basis. However, before making the random selection, it was necessary to identify same type patio door's locations at identical window wall system combinations.

Identical window walls were named based on the lowest floor level; for example, W7, is the window wall system combination on level 7, 8, 14, 16, 19 and 20; or W11 is the window wall system combinations on level 11, 17 and 18. (*Refer to table 1 in Appendix B, Part A&B*)

Window wall combinations, consisting of fixed and operable windows and patio doors, are named as a, b and c in the window shop drawings. For example, “W11-1b” is the window wall system for 11th, 17th and 18th Floor; 1b indicates the location of the system (south east elevation) and its combination of operational types. 1b is, for instance, the combination of awning and fixed “TG2” windows at bypass locations; and fixed and sliding doors of type TG2 and DTG2 at balcony location with the dimensions specified in the drawings. *(Refer to table 2 and 3 in Appendix B, Parts A&B)*

After determining different window wall combinations and configurations, the ones consisting of sliding doors have been selected at each floor. As indicated in window shop drawings, there are two types of different sliding doors from the same series, which comprise of thermally broken aluminum exterior sliding doors with frames of 149 mm wide. The frame’s finishing is painted Duranar Sunstorm gray; with clear top coat for exterior and Duracron gloss white; on the interior.

The sliding door hardware consists of pull handles on each side, single point hook lock and interior side lock lever. Both types of sliding doors have double glazed sealed units, however, with different thicknesses and sound transmission ratings. Insulated glass units comprise of FG1 and FG2 with thicknesses of 37 mm and 39 mm, and STC rating of 33 (Typical) and 36 respectively.

One type of patio door DTG1– which will be called Type I in this study – is chosen to be studied. The drawings indicated that there were 460 Type I sliding doors on this project. All these Type I doors were categorized under the same classification in terms of their air leakage characteristics. A further examination revealed that Type I doors that were installed in two different heights. Three Hundred Ten (310) sliding doors with the same height and same air leakage characteristics formed the final population for this study.

Typically, the size of the samples in such a study needs to be determined based on the level of confidence and the confidence interval desired from the expected results. It is assumed that the air leakage of the doors would follow a normal distribution. In this particular

instance, the variables that impact the air leakage characteristics are the variations in the manufacturing process and the variations in the installation process. Variations related to degradation from use and environmental factors is minimal as the doors are tested before they have been substantially used.

### Identifying the Distribution of the Population

The distribution of the doors by floors is shown below. *(Refer to Table 1)*

Floor	Number of Type I Patio Doors	
	Total	Tested
<b>Podium</b>	<b>None</b>	<b>None</b>
To 10 <sup>th</sup>	24	0
11 <sup>th</sup> – 15 <sup>th</sup>	11	4
16 <sup>th</sup> -20 <sup>th</sup>	18	2
21 <sup>st</sup> – 25 <sup>th</sup>	26	3
26 <sup>th</sup> – 30 <sup>th</sup>	33	2
31 <sup>st</sup> – 35 <sup>th</sup>	27	2
36 <sup>th</sup> – 40 <sup>th</sup>	41	3
41 <sup>st</sup> – 45 <sup>th</sup>	22	1
46 <sup>th</sup> – 50 <sup>th</sup>	54	7
51 <sup>st</sup> – 55 <sup>th</sup>	33	5
55 <sup>th</sup> and more	21	3
<b>Total</b>	<b>310</b>	<b>32</b>

**Table 1– Distribution of Type 1 Patio Doors by Floors – Total and Tested**

As previously mentioned after defining the sample type, window shop drawings and architectural plans were used to identify the distribution of the samples and confirm their being identical, to be field tested. However, after a site visit it was determined that conducting field air leakage test is impossible on some of the selected sliding doors. For instance, in some of the suites on lower floors, interior gypsum boards were installed or were under progress of the installation, therefore, there was not enough room to tape the poly chamber to the window frame or sliding doors were not accessible in some of the suites because, building materials had blocked the access.

### Determination of the Test Samples

In this study, overall 32 sliding doors which counts approximately, for 10% of the total sliding door population aimed to be field air leakage tested. As it was impossible to check all the suite's sliding doors accessibilities prior to random selection, and to consider all the

unforeseen situations, 10 more sliding doors were added to the list. Therefore 32 sliding doors targeted to be tested from the 40 randomly selected ones, out of 310. *(Refer to table 4 to 6 in Appendix B, Part A&B)*

### **Field Air Tightness Test Standard and Equipment**

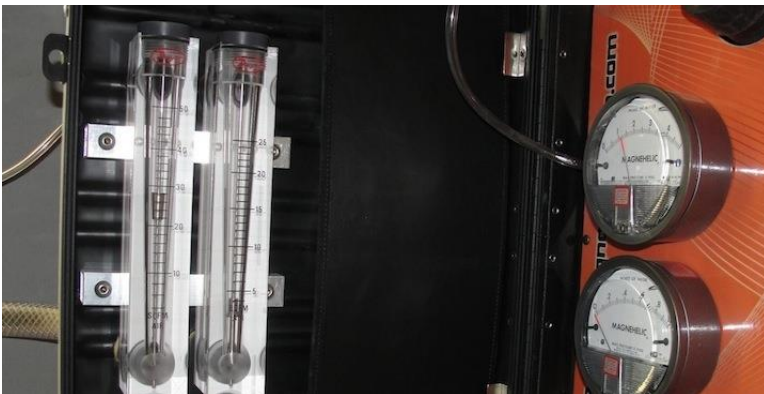
All the sliding doors that were tested for this study were done in accordance with ASTM E783. A calibrated Wind Maker Plus test kit was used to carry out the testing. Figure 3 to 5 shows the test apparatus and a typical test assembly.



**Figure 3 - Typical test assembly**



**Figure 4 - Wind Maker test equipment**



**Figure 5 - Air flow and Pressure measuring devices**

In general, the test procedure consisted of the following steps:

- The patio door was examined from the inside and the outside for signs of conditions that may impact air leakage measurements.



- Ambient conditions of temperature and relative humidity were measured. Wind speeds were noted based on local weather reports.
- A chamber was created on the interior using poly sheets. The fan apparatus was connected to the chamber.
- The exterior was isolated with poly sheets taped to the frame.
- The chamber was depressurized and infiltration was measured at 4 different pressure differences: 25, 50, 75 and 100 Pa. Visual observations using smoke pencils and infrared thermographic camera were made to study paths of air leakage.
- The exterior poly sheet was removed and the step 5 was repeated.

The 32 tests were done over a period of 5 days. The weather conditions on these days varied widely. The results obtained from field tests were tabulated and corrections applied to bring the air leakage measurements to 20°C.

### **Correction of the Temperature and Pressure**

As stated before, climate condition can affect the air leakage performance of fenestration products in different ways. For example, it can impact the material characteristic, creates shrinkage, and affects the air leakage performance, despite of the fact that according to the Canadian standard association (CSA), stated in part 1.6.2, air leakage test results measured in cold temperature versus the laboratory measured ones have shown an insignificant difference.

To conduct a better statistical review over sliding doors air tightness performance and its correlation with laboratory's performance, it was required to minimize variables. The measurements have been taken in different temperature conditions, therefore, standardization would help investigating the actual impact of temperature difference on final air leakage test results.

Standard temperature and pressure difference in the laboratory performance tests are considered as 20°C and 75 Pascals. As per sea level standard atmospheric pressure of 101,325 Pascals, any field pressure difference with the standard one could be neglected.

The laboratory test standard temperature of 20°C, compared to the field test's various temperatures, could affect the test results, therefore to validate the comparisons, field test

results must be temporarily corrected. To calculate the effect of temperature difference and correct the results to obtain a standardized air leakage value, the density of the air was calculated on each test date according to temperature. This calculation is based on using Steve Gribble on-line air density calculator and online engineering toolbox. Having the test results in that specific air density and having the standard 20°C air density, we could standardize the air leakage results. The standardized conditions are shown at each test results analysis and data collection in Appendix B. *(Refer to Appendix B)*

### **Thermography Analysis**

In few windows, infrared thermography was done to investigate possible drafts and leakages. It helped to find colder spots at window frame and joints. Thermography scan was done before beginning of each test, during the test and after finishing the test and scanned pictures were compared to the after test's scanned pictures to find possible leakage and draft paths.

### **Smoke Pencil Findings**

In windows with higher air leakage rates, smoke pencil was used to determine possible leakage paths.

## Chapter 4

### Test Results

As previously stated, air tightness performance of randomly selected test samples have been evaluated in accordance to ASTM E-783. Tests were conducted on five different days. Data collected on each day reflects environmental conditions that are similar for those dates. *(Refer to table 2)*

Date	Inside Temp. (oC)	Average outside Temp. (oC)	Wind Dir - Speed Km/h
Nov. 19, 2016	12 to 15	10	W - 20 to 26
Dec. 1, 2016	7 to 8	5	W - 24 to 38
Dec. 3, 2016	5 to 13	4.75	NW - 11 to 25
Dec. 16, 2016	13	-6	W - 24 to 31
Dec. 28, 2016	20	-1	W - 25

**Table 2 – Temperature and Wind Conditions during Testing**

To evaluate air leakage performance of fenestration products, often they should be tested at 75 Pascal standard pressure difference.

Laboratory airtightness performance test report indicates that test sample (type 1), has 0.5 (L/s/m<sup>2</sup>) air leakage rate at 75 Pascal pressure difference. To evaluate airtightness performance of newly installed sliding doors, thirty two (32) sliding doors of the same size and configuration, tested in field at 75 Pascal standard pressure difference. Samples were selected from various heights and elevations. For the purpose of this study test samples were also tested at 25, 50 and 100 Pascal pressure differences.

A preliminary review of the air leakage test results indicated that there are 2 outliers on the higher end and 5 outliers on the lower end of the results. These were further removed from the analysis. *(Refer to table 3)*

The excluded test results are plotted in table below.

Test Number	Level	Date	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
13	10	Dec 1, 2017	1.567	1.639	2.073	2.319
16	53	Dec 3, 2017	0.471	0.864	1.975	1.486
19	38	Dec 3, 2017	0.012	0.036	0.042	0.024
24	36	Dec 16, 2017	0.143	0.182	0.104	0.143
25	36	Dec 16, 2017	0.039	0.039	0.130	-0.065
29	49	Dec 28, 2017	0.000	-0.088	0.088	0.126
30	49	Dec 28, 2017	-0.389	0.063	-0.251	0.013

**Table 3 – Excluded test results from the study (Outliers)**

Air leakage test results of the remaining 25 tests, organized by the dates on which they were done, are shown in tables 4 to 8. *(Refer to tables 4 to 8)*

Test Number	Level	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
1	47	0.117	0.410	0.585	0.667
2	46	0	0.328	0.503	0.585
3	43	0.117	0.012	0.199	0.339
4	20	0.257	0.456	0.714	1.358
5	17	0.023	0.351	0.293	0.410
6	14	0.421	0.515	0.515	0.620
7	14	0.339	0.573	0.749	0.913

**Table 4– Air Leakage rates – Nov. 19, 2016**

Test Number	Level	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
8	64	0.012	0.729	0.775	0.694
9	64	0.220	0.393	0.521	0.509
10	58	0.058	0.497	0.407	0.765
11	54	0.086	0.620	0.604	0.827
12	11	0.382	0.609	0.654	0.839

**Table 5 - Air Leakage rates – Dec. 1, 2016**

Test Number	Level	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
14	53	0.060	0.435	0.483	0.556
15	53	0.423	0.930	0.894	1.317
17	50	0.809	1.075	1.112	1.232
18	50	0.157	0.435	0.592	0.616
20	35	0.012	0.036	0.423	0.024
21	35	0	0.254	0.604	0.809
22	26	0.423	0.640	0.785	0.749
23	26	0.568	0.737	0.846	0.544

**Table 6 - Air Leakage at 75 Pa – Dec. 3, 2016**

Test Number	Level	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
26	22	0.385	0.526	0.526	0.796
27	22	0.039	0.501	0.886	0.937
28	22	0.436	0.976	1.155	1.053

**Table 7- Air Leakage at 75 Pa – Dec. 16, 2016**

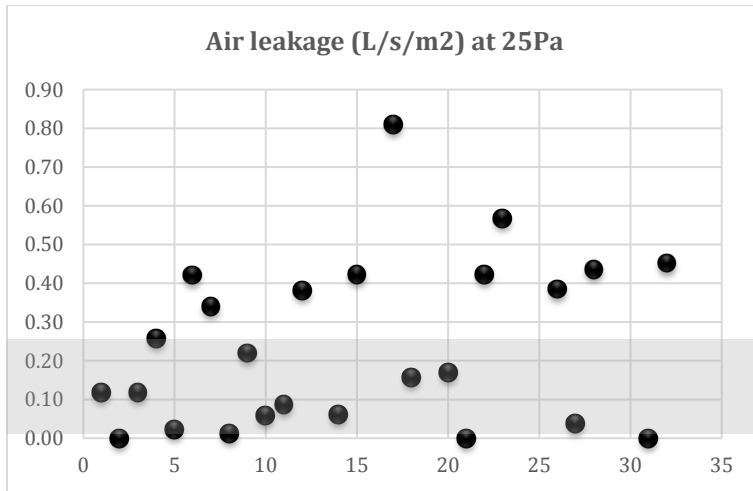
Test Number	Level	Air leakage at 25 pa (L/s)/m <sup>2</sup>	Air leakage at 50 pa (L/s)/m <sup>2</sup>	Air leakage at 75 pa (L/s)/m <sup>2</sup>	Air leakage at 100 pa (L/s)/m <sup>2</sup>
31	48	0.0	0.577	0.904	0.904
32	54	0.452	0.565	0.628	0.967

**Table 8 - Air Leakage at 75 Pa – Dec. 28, 2016**

## **Review of the Test Results at Different Pressure Differences**

### **Review of Test Results at 25 Pascal Pressure Difference:**

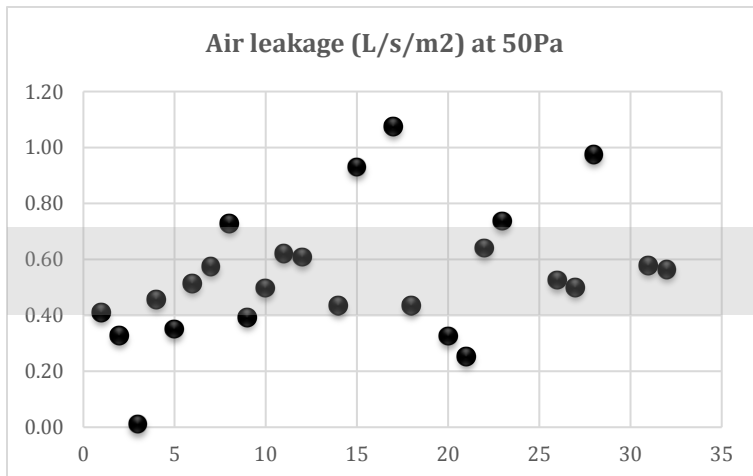
The average test result, at 25 Pascal pressure difference is calculated to be 0.28 (L/s/m<sup>2</sup>). Approximately 40% of the results are higher than the average rate. Most of the results are below 0.25(L/s/m<sup>2</sup>) which the range is shown in grey on the chart. The minimum recorded test result is almost 0 (L/s/m<sup>2</sup>) and the maximum is 0.81 (L/s/m<sup>2</sup>). *(Refer to figure 6)*



**Figure 6 – Test results in 25 Pa pressure difference**

### **Review of Test Results at 50 Pascal Pressure Difference**

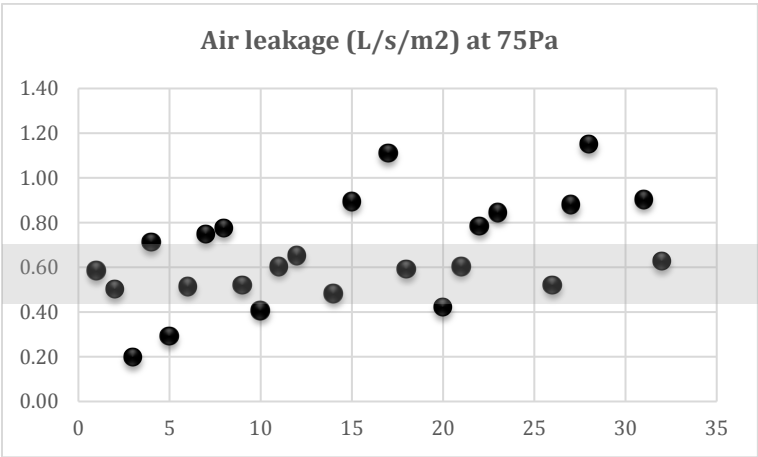
As shown in chart below, average test result at 50 Pascal pressure difference is 0.54 (L/s/m<sup>2</sup>). Almost 44% of the results are higher than the average rate. Most of the results are in range of 0.40 to 0.65 (L/s/m<sup>2</sup>) which is shown in grey in chart below. The minimum reported test result is 0.01 (L/s/m<sup>2</sup>) and the maximum test result is 1.08 (L/s/m<sup>2</sup>). (*Refer to figure 7*)



**Figure 7– Test results in 50 Pa pressure difference**

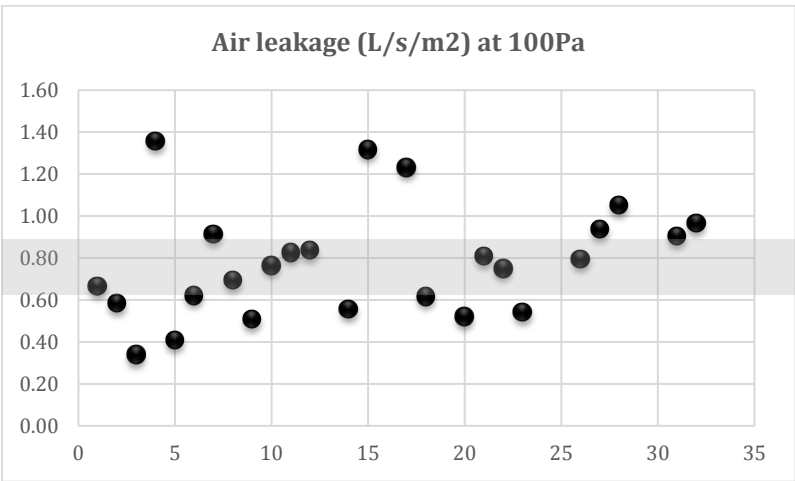
Average test result at 75 Pascal pressure difference is calculated to be 0.65 (L/s/m<sup>2</sup>), among the test results at this pressure difference approximately 44% are higher than the average rate. Most of the results are in range of 0.45 to 0.7 (L/s/m<sup>2</sup>), which is shown in grey in chart

below. The minimum measured air leakage rate is 0.2 (L/s/m<sup>2</sup>) and the maximum rate is 1.16 (L/s/m<sup>2</sup>). (Refer to figure 8)



**Figure 8 – Test results in 75 Pa pressure difference**

As demonstrated in table below average of the test results at 100 Pascal pressure difference is calculated to be 0.78 (L/s/m<sup>2</sup>). Approximately 48% of the results are higher than the average rate. Most of the results are in range of 0.60 to 0.85 (L/s/m<sup>2</sup>) which is shown in grey in the table below. The minimum measured value is 0.34 (L/s/m<sup>2</sup>) and the maximum measured value is 1.36 (L/s/m<sup>2</sup>). (Refer to figure 9)

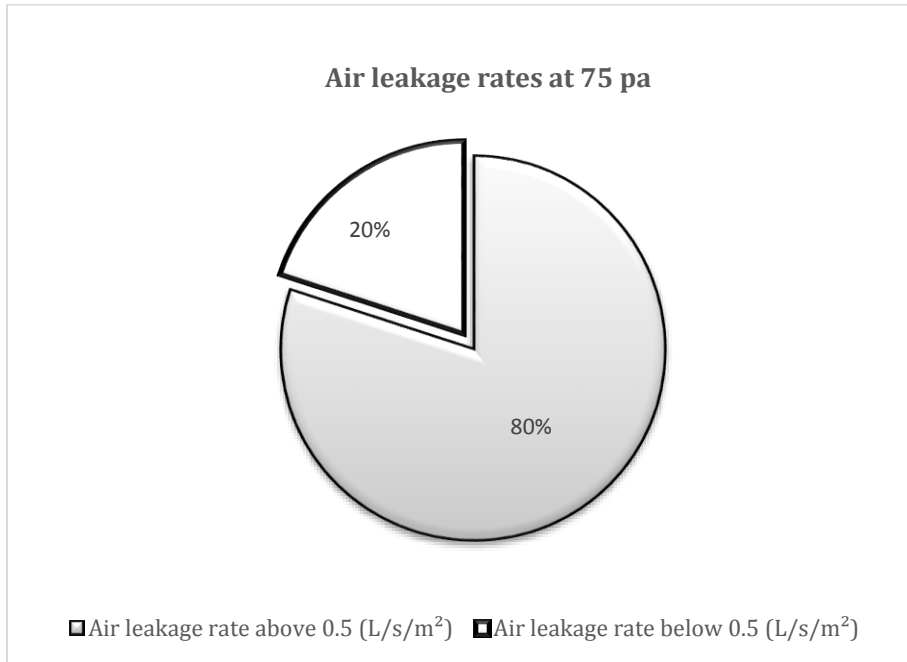


**Figure 9 – Test results in 100 Pa pressure difference**

## Analysis and Findings

### The Standard Field Test Pressure (75 Pascal):

Among all field air leakage tests at 75 Pascal, 80% of the test results are above 0.5 (L/s/m<sup>2</sup>) and 20% are below that. *(Refer to figure 10)*



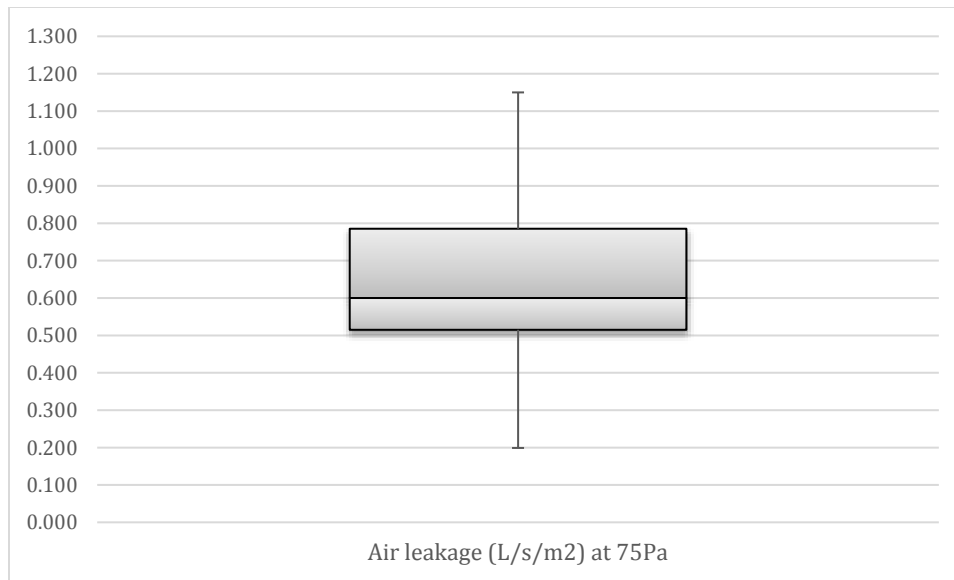
**Figure 10 – Air leakage results at 75 Pascal**

Based on valid 25 test results, various statistical measures have been determined. A box plot showing the minimum value, the maximum value, the median and the interquartile ranges are shown in Figure 11.

The frequency distribution of the air leakage measurements using a bin interval of 0.25 (L/s/m<sup>2</sup>) is demonstrated in Figure 12. Bin limits are considered starting from 0.19 and ending to 1.19. *(Refer to figure 11 and table 9)*

The median value is 0.604 (L/s/m<sup>2</sup>) with an interquartile range of 0.5 to 0.8 and the maximum and minimum measured values of 0.198 (L/s/m<sup>2</sup>) and 1.155 (L/s/m<sup>2</sup>) respectively.



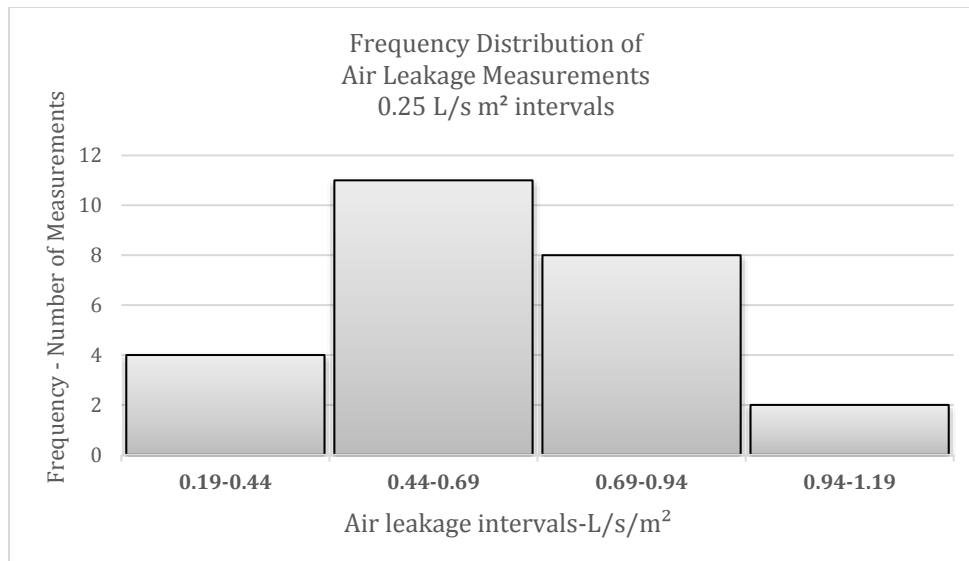


**Figure11 - Box plot of Sample Air Leakage Rate at 75 Pa**

Bin Limits	Frequency	Percentage
<b>0.19-0.44</b>	4	16%
<b>0.44-0.69</b>	11	44%
<b>0.69-0.94</b>	8	32%
<b>0.94-1.19</b>	2	8%
<b>Grand Total</b>	25	100%

**Table 9 - Frequency distribution pivot table**

Based on 25 measurements, the mean air leakage rate of the tests is 0.65 (L/s/m<sup>2</sup>) and the standard deviation is 0.231 (L/s/m<sup>2</sup>). The distribution follows a normal Gaussian distribution. The frequency of the occurrence in various bin limits are also plotted in figure below.*(Refer to figure 12 )*



**Figure 12 - Frequency Distribution of Air Leakage Measurements**

The maximum frequency percentage, which covers almost 44% of the total test results is in range of 0.44 to 0.69 (L/s/m²). Approximately 28% of the test results lie within the first standard deviation (SD) above and below the mean and 64% of the test results lie within the second standard deviations of the mean.

No mode is applicable to the achievable range of results. The average of the squared differences from the mean, which is defined as sample variance is calculated as 0.05.

The distribution follows a unimodal shape (Has just one peak). The distribution histogram is not completely symmetric and is slightly skewed right. The skewness is 0.3 and excess kurtosis is calculated as 0.06 and the frequency distribution histogram shows a slightly leptokurtic distribution which is very close to mesokurtic (Normal distribution).

Considering the random selection and the low threshold sampling (almost 25 samples), the confidence level (95.0%) is calculated as 0.09.

A summary of the various air leakage rates that can be used for comparison purposes are listed in below Table. The air leakage rates stipulated in A440.4-07, Table D3 for sliding doors have been used. The values in A440.4-07 are not provided in a manner that are consistent with present standards and the rates shown in Table 10 had to be normalized to the area of the door from the crack length. *(Refer to table 10)*

Source	Air leakage (L/s/m <sup>2</sup> )
Laboratory Tested Value (Used for Certification1)	0.500
Mean of Field Tested Value	0.653
Median of Field Tested Value	0.604
Minimum of Field Tested Value	0.198
Maximum of Field Tested Value	1.155
1.5 x Laboratory Value (AAMA 502 Allowable)	0.750
A440.4-07 Allowable – A1	0.977
A440.4-07 Allowable – A2	0.577
A440.4-07 Allowable – A3	0.350

**Table 10 – Air Leakage Rates for Comparative Analysis**

In comparing the field measured air leakage rates with different benchmarks, it becomes evident that the comparison is not straight forward. For instance, to compare the field measured values to the criteria set out by AAMA 502 or by A440.4-07, it is not clear if the average values should be used or that no field measured value should be greater than the criteria stated in those standards. If the latter is the case then it will be seen that 18 out of 25 or approximately 72% of the tested product will not meet the laboratory measured result, and 8 out the 25 or about 31% will not meet the AAMA 502 criteria based on the laboratory field result.

Similar conclusions can be drawn about the allowable values for A2 and A3 rated doors in A440.4-07. Only with the A1 rated doors in A440.4-7 the results show that over 90% of the tested product will meet the requirements. These results are similar to the results that are reported in Weidt et al in 1997 particularly for the products that were sliders. Another way to examine the data is the amount by which the measured values have exceeded the benchmarks. Comparing the field values of the product with the AAMA 502 benchmark it is

noted that the highest value of 1.155 exceeds the AAMA 502 benchmark by 54%. The rationale for the benchmarks is not evident in any of the publicly available document.

The dilemma that the scenario presents from a practical standpoint becomes evident in looking at the above discussion. However, this is one aspect of the issue. The bigger issue is that the measured values follow a certain distribution. This should be expected in any measurement of such performance values. In this particular instance, the measured values are distributed normally. In such a scenario, the method of sampling becomes a very important aspect of choosing to do the field tests. AAMA 502 indicates that three tests are to be performed. It is possible that the samples selected for the 3 tests would be from the 79% that would have met the AAMA 502 benchmark. What would that result tell us about the acceptability of the fenestration product relative based on the field testing. ASTM E783 provides some guidance in terms of sampling for field testing in this regard. It is recognized that practical and cost considerations often far outweigh the decisions regarding sample selection than the statistical nature of variation to be expected.

## Test Variables

There are conditions and factors which may vary from test to test and could affect the test results. Some of the obvious test variables could be counted as test dates, Interior conditions, or level of the suites on which test samples are installed and direction of test samples.

In this section test results are compared according to each test variable to find any possible trend affecting the result differences.

## Test Dates

As mentioned before, air leakage tests are done in five different dates. Tests are conducted on November 11, 2016 and December 1, 3, 16 and 28, 2017. Among thirty two (32) total air leakage tests, the previously mentioned two (2) outliers on lower end belong to December 1 and 3, 2017 and the five (5) outliers on higher end belong to December 3, 16 and 28, 2017. The average temperature on November 11, 2016; December 1, 3, 16 and 28, 2017; was recorded at 10 °C, 5 °C, 4.75 °C, (-6)°C and (-1)°C respectively. Average air leakage test results at 75 Pascal pressure difference at mentioned dates were 0.51, 0.84, 0.86, 0.67 and 0.61 (L/s/m<sup>2</sup>). (Refer to table 2 and 11)

The relevance of the temperature with the average test results of the same date, is plotted in the below table. (Refer to table 11)

Test date	Average temperature (°C)	Number of tests	Average test result at 75 Pa including outliers (L/s/m <sup>2</sup> )
Nov 11, 2016	10	7	0.51
Dec 1, 2017	5	6	0.84
Dec 1, 2017	4.75	10	0.86
Dec 1, 2017	-6	5	0.67
Dec 1, 2017	-1	4	0.61

**Table 11 - The average results in different temperatures**

## Test Floor Level

The relation between test results and the floor levels on which, the test samples are installed, is demonstrated in table below.

To make our review easier, tests are categorized in different groups, according height of the suites that samples are installed in. Different building floors are put in four (4) groups, each covering fifteen floors and ranging from the lowest to highest test floor levels. *(Refer to table 12)*

Test suite level	Number of tests	Average test result at 75 Pa including outliers (L/s/m <sup>2</sup> )
5-20	6	0.69
20-35	7	0.56
35-50	11	0.25
50-65	8	0.69

**Table 12 - Test results in different floor levels**

### Test Elevation

Among all the air leakage tests, nine tests are done on the sliding doors located on the north-east side of the building, six tests are done on the north-west side, eleven tests on the south-east side and three tests on the south-west side. The average test results in stated directions are 0.93, 0.71, 0.59, and 0.49 (L/s/m<sup>2</sup>) accordingly. *(Refer to table 13)*

Test suite Direction	Number of tests	Average test result at 75 Pa including outliers (L/s/m <sup>2</sup> )
North-east	9	0.93
North-west	6	0.71
South-east	11	0.59
South-west	3	0.49

**Table 13 - Test results in different elevations**

### Interior finishes

Nine tested sliding door samples were installed in suites with complete interior finishes. These samples include test numbers 4, 7, 12, 21, 23, 26, 27 and 28, which have air leakage rate of 0.71, 0.75, 0.65, 0.60, 0.85, 0.53, 0.53, 0.89 and 1.16 (L/s/m<sup>2</sup>) air leakage rates.

The average rate of air leakage in suites with completed interior finishes is approximately 0.68 (L/s/m<sup>2</sup>).

## **Extrapolate Data from Laboratory Test Results**

Air leakage is considerably important to performance of a building fenestration system. Air leakage can occur through cracks, pores of the material, holes, and other openings. Air pressure difference produces flow. In most of the situations and locations leaky openings are not known to details. Openings contributing to the total leakage could be thin laminar passages through joints and cracks, tortuous paths through porous materials or various shapes and sizes of holes. Flow characteristics depend on the shapes and sizes of leakage paths. There may be various openings and cracks contributing to the total air leakage and it is impossible to identify, measure and calculate air leakage from each of them individually. Although it is possible to apply pressure to overall selected building enclosure system and measure flow rates and air leakage.

Air leakage results can be taken from  $Q=C(\Delta p)^n$ , Where  $Q$  is the volume flow rate,  $C$  is a coefficient,  $\Delta p$  is pressure difference and “ $n$ ” is an exponent varying between 0.5 and 1.0. When “ $n$ ” is assumed equal to 0.65, it can represent many cases of wall and window air leakage.

In this series of air leakage tests, this question could rise, that if the specimen was tested in the laboratory at 25, 50 or 100 Pascal pressure difference, what could air leakage results be. To answer this question, we need to make some assumptions and use base of the laboratory test results to find the coefficient constant.

In laboratory air leakage tests at 75 Pascal pressure difference, air leakage result is reported to be 0.5 (L/S/m<sup>2</sup>). Knowing all the variables, including “ $n$ ” exponent we can find the coefficient ( $C$ ), to be 0.03 ((L/s) Pa<sup>0.65</sup>) /m<sup>2</sup>.

Assuming an identical test condition for all other tests in different pressure differences we can say that the laboratory test results could be 0.24, 0.38 and 0.6 (L/s/m<sup>2</sup>) if air leakage was ever measured at 25, 50 and 100 Pascal pressure difference accordingly. This air leakage rates could give us a benchmark to compare field test results in non-standard pressure differences.

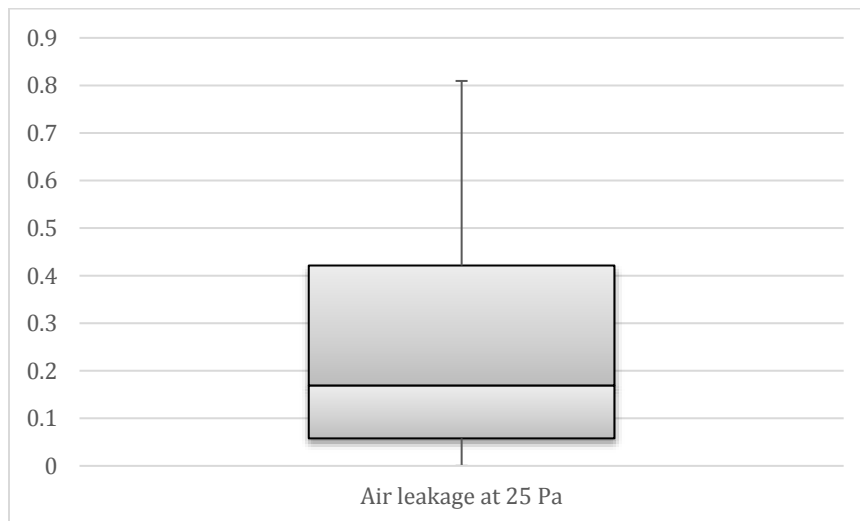
## Analysis of Extrapolated Air Leakage Results at Different Pressure Differences calculating from Laboratory Test Result at 75 Pascal

As mentioned in the previous section, twenty five (25) air leakage test results at 25, 50 and 100 Pascal pressure difference will be statically reviewed based on benchmarks resulted from laboratory standard test results.

A box plot showing the minimum value, the maximum value, the median and the interquartile ranges is prepared for test results at each pressure difference. Frequency distribution of air leakage measurements using a bin interval of 0.25 (L/S/m<sup>2</sup>) is demonstrated in separate figures.

### Extrapolated Air Leakage Results at 25 Pascal Pressure Difference

The median value of the test results at 25 Pascal pressure difference is 0.17 (L/S/m<sup>2</sup>) with an interquartile range of 0.05 to 0.42 and the maximum and minimum values of 0.00 (L/S/m<sup>2</sup>) and 0.81(L/S/m<sup>2</sup>) respectively. *(Refer to figure 14)*



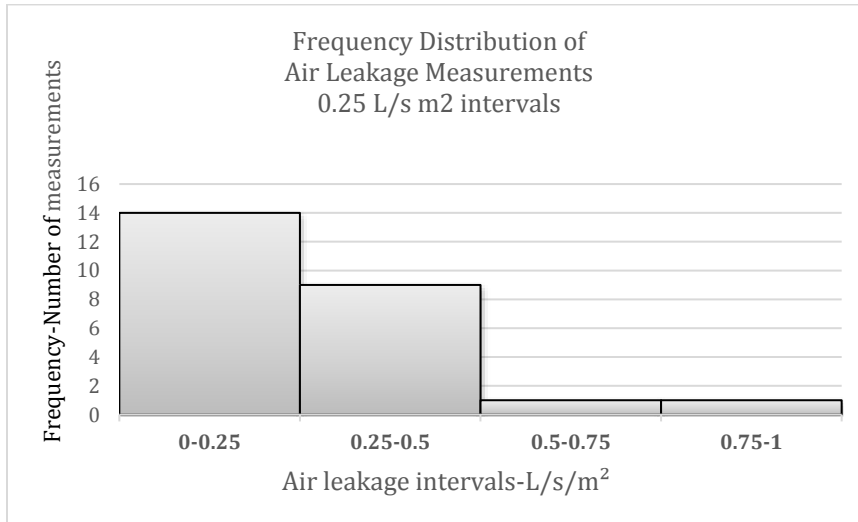
**Figure 14 - Box plot of Sample Air Leakage Rate at 25 Pa**

Frequency distribution of the air leakage measurements using a bin interval of 0.25 (L/S/m<sup>2</sup>) is demonstrated in table and figure below. *(Refer to table 14 and figure 15)*



Row Labels	Frequency	Percentage
0-0.25	14	56%
0.25-0.5	9	36%
0.5-0.75	1	4%
0.75-1	1	4%
Grand Total	25	100%

**Table 14 – Frequency distribution pivot table at 25 Pa**

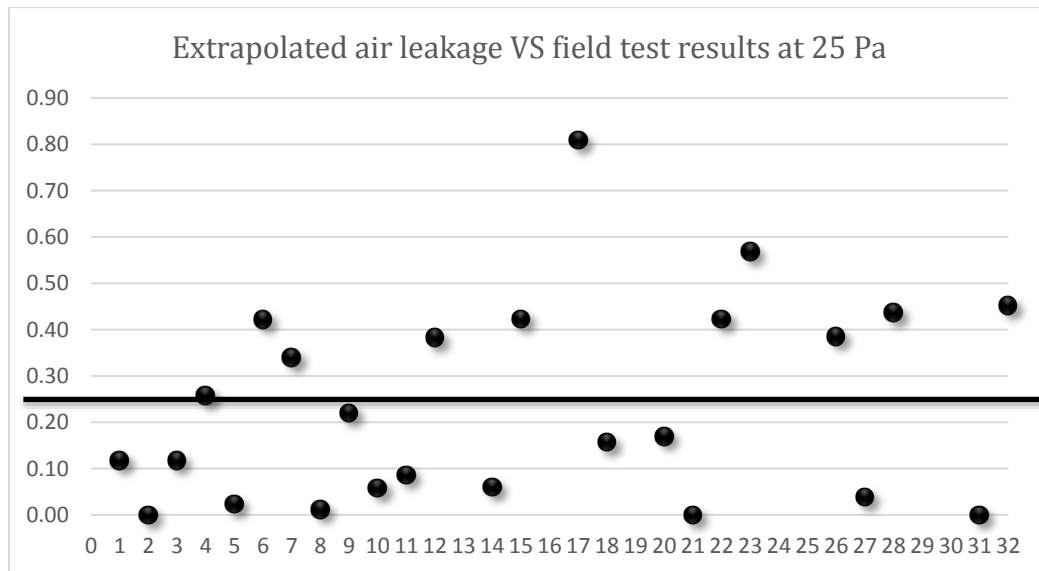


**Figure 15 - Frequency Distribution of Air Leakage Measurements at 25 Pa**

The mean value is 0.23 (L/s/m<sup>2</sup>) and the standard deviation which measures the random errors is 0.21 (L/s/m<sup>2</sup>). Approximately 46% of the data lie within one standard deviation of the mean. Fifty six percent of the data lie within two standard deviation below, and 36% of the data lie within two standard deviation above the mean value.

The maximum frequency percentage is in the range of 0.00 to 0.25 (L/s/m<sup>2</sup>), which covers almost 56% of total test results. The distribution is positively skewed (Skewed right). The skewness is 0.8. The excess Kurtosis is 0.22 which indicates that the distribution is Platykurtic which is flatter than a normal distribution with a wider peak. The probability for extreme values is less for a normal distribution, and the values are wider spread around the mean. Considering the random selection and the low threshold sampling (almost 25 samples), the confidence level (95.0%) is calculated as 0.08.

Figure No.18 demonstrates a comparison between the extrapolated air leakage result at 25 Pascal, which is assumed to be 0.24 (L/s/m<sup>2</sup>), with in-situ measured air leakage performance of the 25 teste samples.



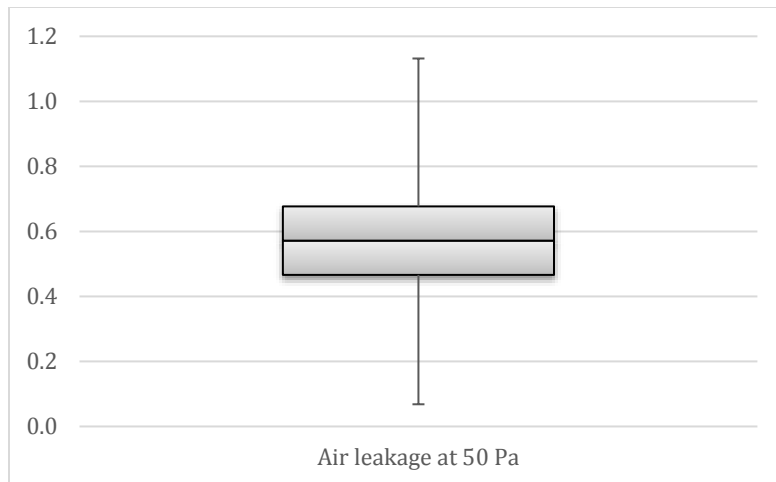
**Figure 18 - Extrapolated air leakage VS field test results at 25 Pa**

Approximately 45% of air leakage field test results exceed the laboratory extrapolated result. *(Refer to figure 18)*

### **Extrapolated Air Leakage at 50 Pascal Pressure Difference**

Based on the 25 test results, as demonstrated in below box plot, the median value is calculated to be 0.51 (L/s/m<sup>2</sup>) with an interquartile range of 0.41 to 1.07(L/s/m<sup>2</sup>). The minimum and maximum air leakage test results are 0.012 (L/s/m<sup>2</sup>) and 1.075 (L/s/m<sup>2</sup>) respectively. *(Refer to figure 19)*

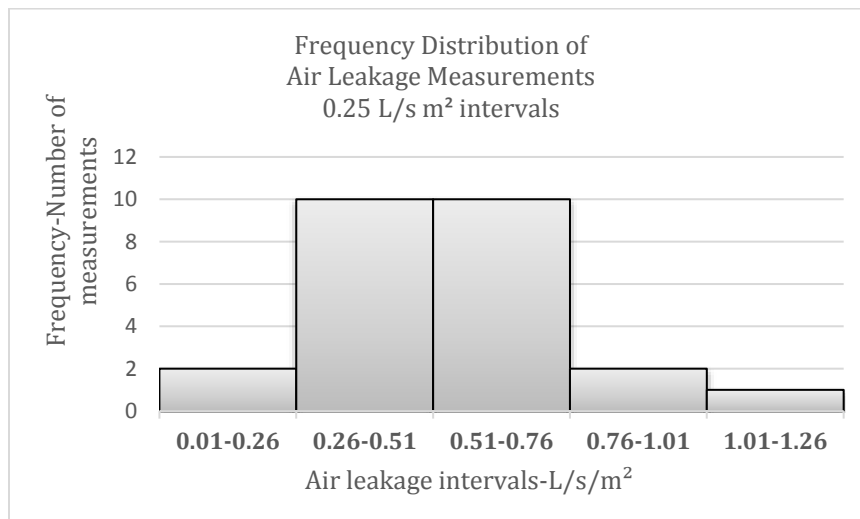
Frequency distribution of the air leakage measurements using a bin interval of 0.25 (L/S/m<sup>2</sup>) is demonstrated in table and figure below. Bin limits are considered starting from 0.01 (L/s/m<sup>2</sup>) and ending to 1.26 (L/s/m<sup>2</sup>). *(Refer to table 15 and figure 20)*



**Figure 19 - Box plot of Sample Air Leakage Rate at 50 Pa**

Row Labels	Frequency	Percentage
<b>0.33-0.58</b>	7	18%
<b>0.58-0.83</b>	10	38%
<b>0.83-1.08</b>	5	24%
<b>1.08-1.33</b>	2	13%
<b>1.33-1.58</b>	1	7%
<b>Grand Total</b>	25	100%

**Table 15 - Frequency distribution pivot table at 50 Pa**



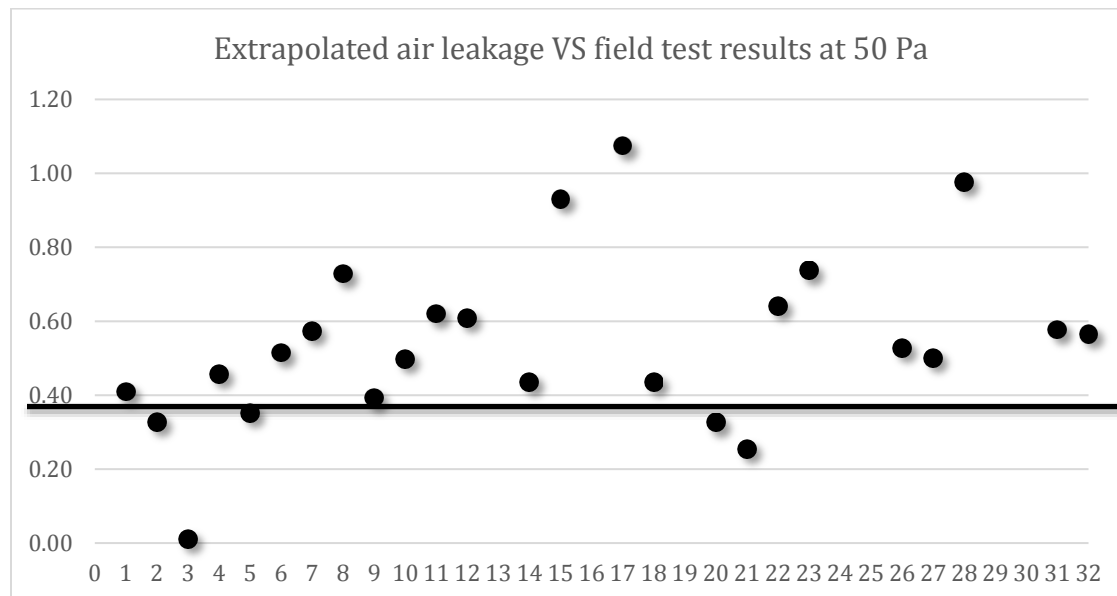
**Figure 20 - Frequency Distribution of Air Leakage Measurements at 50 Pa**

The mean value is 0.54 (L/s/m<sup>2</sup>) and the standard deviation which measures the random errors is 0.23 (L/s/m<sup>2</sup>). Approximately 40% of the data lie within one standard deviation

of the mean. Forty eight percent of data lie within two standard deviation below, and 48% of the data lie within two standard deviation above the mean value. The maximum frequency percentage is equal in the range of 0.26 to 0.51 (L/s/m<sup>2</sup>) and 0.51 to 0.76 (L/s/m<sup>2</sup>), which covers almost 80% of the total test results.

The distribution is positively skewed (Skewed right). The skewness is calculated to be 0.4. The excess Kurtosis is 0.97 which indicates that distribution is Platykurtic which is flatter than a normal distribution with a wider peak. The probability for extreme values is less compared to normal distribution, and the values are wider spread around the mean. Considering the random selection and low threshold sampling (almost 25 samples), the confidence level (95.0%) is calculated as 0.09.

Figure 21, demonstrates comparison between the extrapolated air leakage result at 50 Pascal, which is expected to be 0.38 (L/s/m<sup>2</sup>), with the in-situ measured performance of the sliding doors.

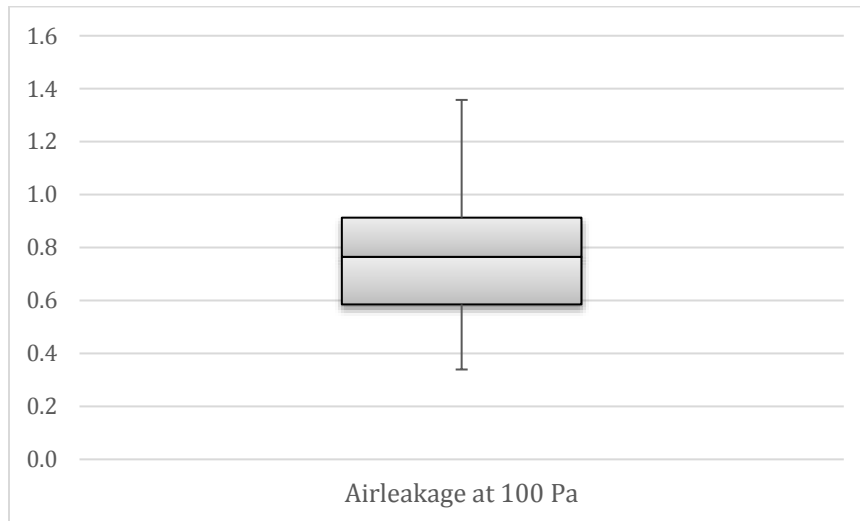


**Figure 21 - Extrapolated air leakage VS field test results at 50 Pa**

The Figure shows that approximately 76% of the tests exceed the laboratory extrapolated results when tested in the field. (*Refer to figure 21*)

### Extrapolated Air Leakage at 100 Pascal Pressure Difference

Based on the 25 test results a box plot shows the median value is 0.76 (L/s/m<sup>2</sup>) with an interquartile range of 0.6 to 0.9. The minimum and maximum test results are 0.33(L/s/m<sup>2</sup>) and 1.35 (L/s/m<sup>2</sup>) respectively. *(Refer to figure 22)*



**Figure 22 - Box plot of Sample Air Leakage Rate at 100 Pa**

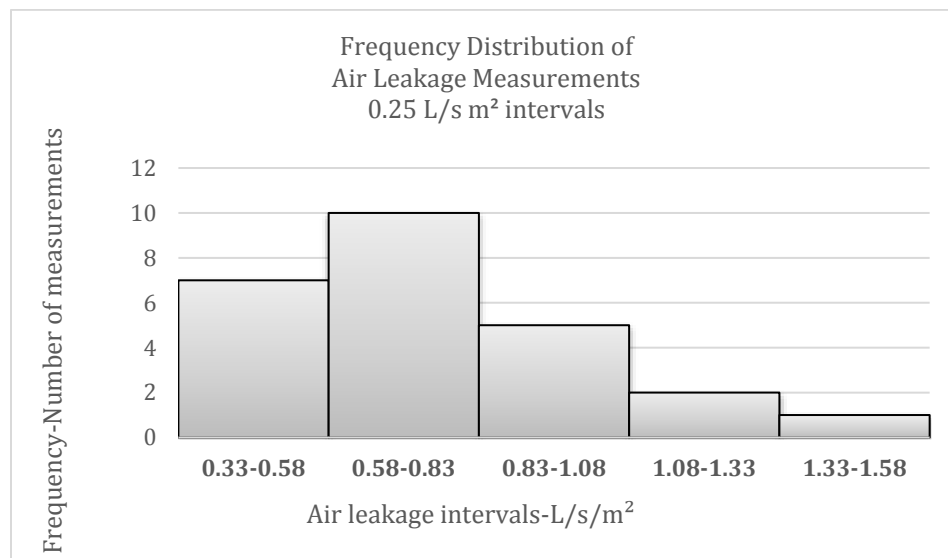
The frequency and percentage of the occurrence in various bin limits are plotted in table 16. Bin limits are considered starting from 0.33 (L/s/m<sup>2</sup>) and ending to 1.58 (L/s/m<sup>2</sup>) with the frequency of 0.25(L/s/m<sup>2</sup>). *(Refer to table 16 and figure 23)*

Row Labels	Frequency	Percentage
0.33-0.58	7	18%
0.58-0.83	10	38%
0.83-1.08	5	24%
1.08-1.33	2	13%
1.33-1.58	1	7%
<b>Grand Total</b>	25	100%

**Table 16 – Frequency distribution pivot table at 100 Pa**

The mean value is 0.78(L/s/m<sup>2</sup>) and the standard deviation which measures the random errors is 0.26 (L/s/m<sup>2</sup>). Approximately 38% of the data lie within one standard deviation

of the mean. Thirty one percent (31%) of the data lie within two standard deviation below, and 28 % of the data lie within two standard deviation above the mean value.

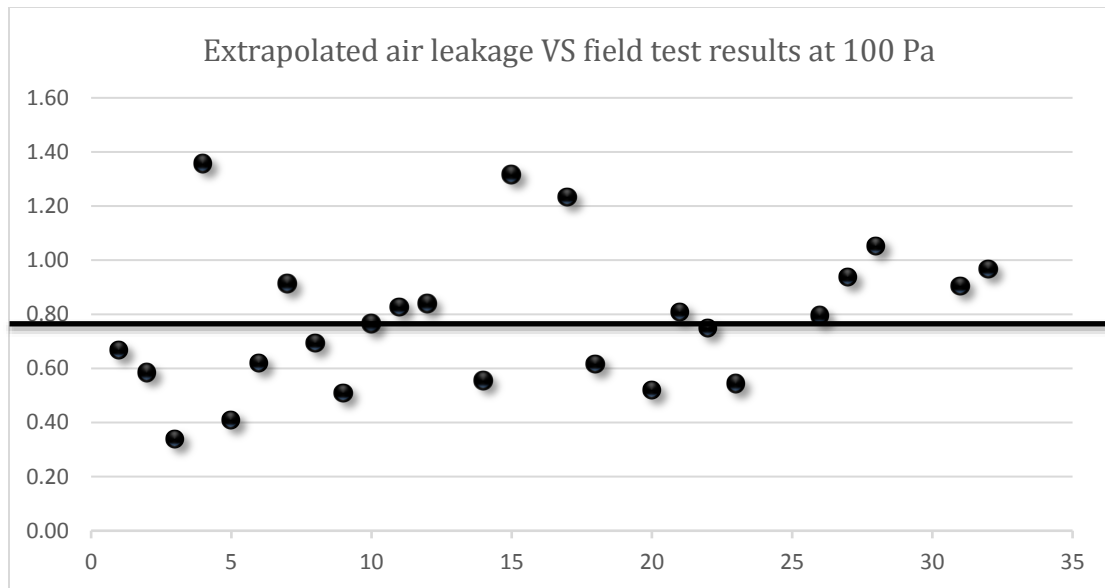


**Figure 23 - Frequency Distribution of Air Leakage Measurements at 100 Pa**

The maximum frequency percentage is in the range of 0.58 to 0.83 (L/s/m²), which covers almost 38 % of the total test results.

The distribution is negatively skewed (Skewed left). The skewness is calculated to be 0.6. The excess Kurtosis is 0.02 which indicates that the distribution is Platykurtic which is flatter than a normal distribution with a wider peak. The probability for extreme values is less than probability for normal distributions, and the values are wider spread around the mean. Considering the random selection and the low threshold sampling (almost 25 samples), the confidence level (95.0%) is calculated as 0.1.

Figure 24, demonstrates a comparison between the extrapolated air leakage result at 100 Pascal, which is expected to be 0.78 (L/s/m²), with the in-situ measured performance of the tested sliding doors.



**Figure 24 - Extrapolated air leakage VS field test results at 100 Pa**

The table shows that approximately 48% of the tests exceed the laboratory extrapolated results when tested in-situ field. *(Refer to figure 24)*

## Chapter 6

### Overview of the Study and Analysis

This study, with focusing on the field air tightness performance of newly installed windows, is done by measuring field air leakage rates of newly installed sliding doors in a 70 storey high-rise building in Toronto. The height of the building offered a better sampling opportunity as the thirty-two samples were randomly selected from over three hundred installed sliding doors.

The field's temperature corrected air leakage results were compared to the laboratory performance report of the same product to evaluate the certified performance correlation with the actual produced, transported, and installed fenestration products.

Along with the statistical review of the measured performances, to evaluate the air tightness performance into some details, the influence of some of the variables on air leakage rates also has been studied.

The average test results at 25, 50, 75, 100 Pascal for 25 valid tests were calculated to be 0.24, 0.54, 0.65 and 0.78 (L/s/m<sup>2</sup>) and 40%, 44%, 44% and 48 % of the tests were exceeding the average results at each specified test pressure difference accordingly.

Among the twenty-five (25), valid field air leakage tests at standard test pressure of 75 Pascal, 80% of the results were above 0.5 (L/s/m<sup>2</sup>) which is the achieved laboratory test result. The extrapolated air leakage for 25, 50 and 100 Pascal pressure differences were calculated to be 0.24, 0.38 and 0.6 (L/s/m<sup>2</sup>) and roughly 45%, 76% and 48% of the test results exceeded the expected air leakage rates at each pressure difference accordingly.

A summary of the various air leakage rates at standard pressure difference of 75 Pascal, that can be used for comparison are listed in Table 10. As previously discussed the values in A440.4-07 had to be normalized to the area of the door from the crack length. In comparing the field measured air leakage rates with different benchmarks, it becomes evident that the comparison is not straight forward due to some reasons including

- Lack of clear rational for comparison benchmarks set by different standards,



- Lack of clearly defined methods of sampling considering distribution figures
- Practical and cost considerations which often far outweigh the decisions regarding sample selection than the statistical nature of variation to be expected.

Considering previously noted test variables indicated that at 75 Pascal pressure difference in this study, test results shows no trend or relation with the test dates and different exterior air temperatures. This may not support the theory of not getting affected by exterior air temperature but It could be due to unequal number of tests on each day specifically in the colder days or random sampling. Test results at different pressure differences show no relation with their location and floor height. Some factors could affect the result such as small electrical heaters in each of the suites in lower floors or Industrial heaters in upper floor's corridors which could affect the air pressure and temperature. The average air leakage results in suites with installed and taped gypsum boards and sealed exterior and interior interfaces, was measured to be lower than the total average test results.

In thermography scan of the windows, no significant changes captured before, in during and after the monitoring. This could be due to insufficient test duration as if we want to capture frames with lower temperature resulting from air flow (air leakage) we may require to increase the flow duration. Thermography scanning helped identifying the colder spots on sliding doors, which were mainly including frame corners, between operable sashes and window track, and meeting stiles.

Smoke pencil test helped identifying primary location of the leakage in few test samples with obviously higher leakage rates. This leakage areas were mostly related to weather stripping or hardware irregularities on hand rails (Refer to the appendix test description and results).

## **Conclusion**

The purpose of this study was to examine the nature of differences between the air leakages determined in a laboratory condition to that measured in the field for the same products that is newly installed. The results indicated that in conducting tests based on random sampling the measured values will follow a distribution with a mean and a variance.

Sampling from newly installed windows eliminate factors such as aging and degrading. In this particular case measurements made on sliding door indicate that the air leakage test results follow a normal distribution. The mean value of the field measurements is higher than the laboratory measurements but are within the range of the AAMA 502 allowable values. However, there are values that are greater than the allowable rates

Based on this work it can be said that it is important to base the comparison of field and laboratory tested values on the recognition that these measurements will be based on some variations. The nature of such variations need to be further studied and taken into account when comparing field and laboratory values.

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## **Appendixes**



## **Appendix A**

### **Laboratory Sample Description**

# Laboratory Sample Description

The sample description information is taken from the manufacturer laboratory test report. The laboratory test report shows no modification required on the sliding door. As reported by the Architectural testing laboratory, the sliding door has achieved an air tightness rating of 0.5 l/s/m<sup>2</sup> (0.1 cfm/ft<sup>2</sup>), as per ASTM E283 test standard.

**Operation type:** Thermally broken aluminum exterior sliding door

**Frame:** 149 mm wide

**FG1 Sealed Unit:** Double glazed sealed units, 35 mm thick with STC rating of 33.  
 6 mm clear ESR42, annealed  
 23 mm Black warm edge spacer with argon gas  
 6 mm clear annealed

**Frame Finish:**  
 Exterior: DURANAR SUNSTORM XL, cosmetic gray mica with clear top coat  
 Interior: DURACRON gloss white

**Hardware:**  
 Pull handle on each side  
 Single point hook lock  
 Interior side lock lever

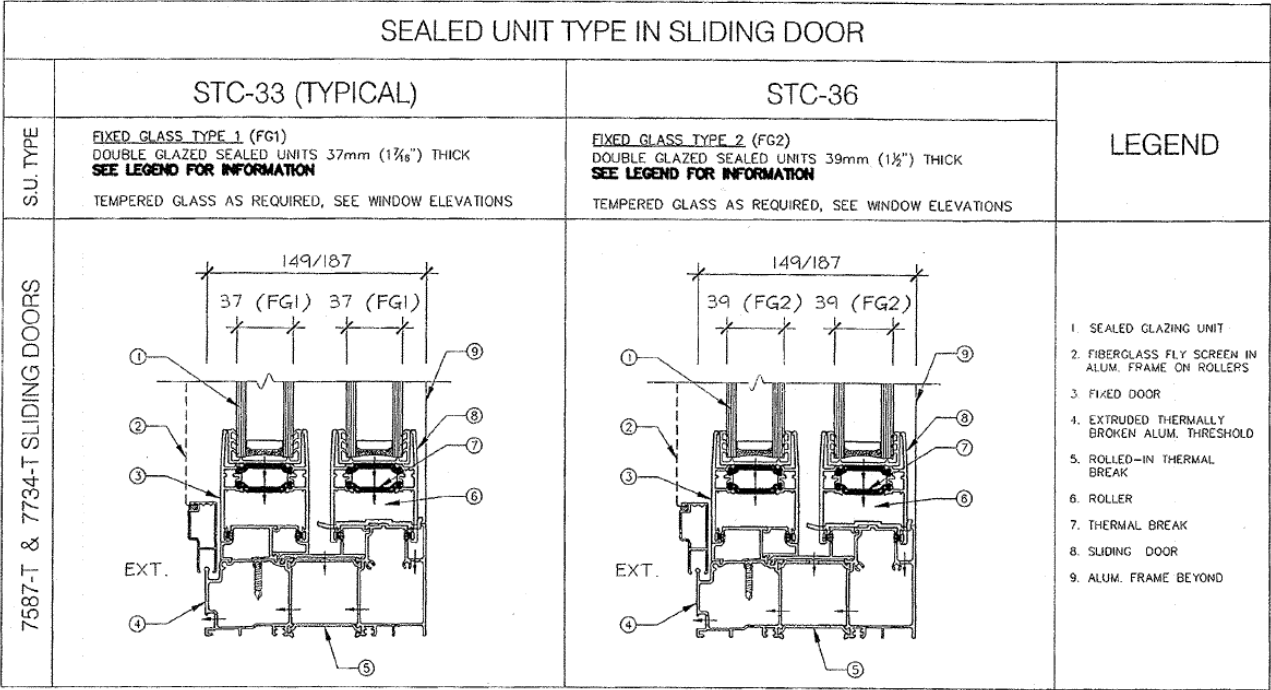


Figure 1: Sealed unit types and details

**Performance Requirements:**

Met requirements set out by O.B.C 2012

Product	Air tightness (l/s/m <sup>2</sup> ) *	Water tightness (Pa) OBC 12	Wind Load		Thermal performance	
			Deflection	Overload	U- Value	SHGC
<b>Sliding Door</b>	0.5 @ 75 Pa	412	2.24	3.13	0.40	0.28

\*As per NAFS-11 window standard, Canadian rating table 6.4

**Product Size:**

Size	Height (millimeter)	Width(millimeter)
<b>Overall Door frame size</b>	2260	1830
<b>Operable panel</b>	890	1716
<b>Fixed Panel</b>	890	1716

**Frame Construction:**

Frame member	Material/Joint cut	Description/Detail
<b>Head, sill, and jambs</b>	Aluminum	Thermally broken, dual-strutted, extruded aluminum with 49 mm wide polyamide thermal break (43 mm separation). Head, jambs, and sill utilized a Snap-On PVC cover.
<b>All corners</b>	Square-cut and butted aluminum	Sealed with butyl tape and secured with four # 8x1" long pan head screws per corner.

**Panel Construction:**

Panel member	Material/Joint type	Description/Detail
<b>Rails and stiles</b>	Aluminum	Thermally improved dual-strutted, extruded aluminum with 49 mm wide polyamide thermal break (43 mm separation).
<b>All corners</b>	Mitered	Sealed with sealant and secured with two aluminum corners and one plastic corner bracket. The plastic corner bracket was secured to each panel member with three #8x1 long pan head screws on each side and a ¼" x ¾" long Allen head screw secured diagonally through the corner bracket. The corner keys were also secured to the members with epoxy glue.

**Weather Stripping:**

Description	Quantity	Location
<b>0.270" backed by 0.260" high polypile</b>	2 Raws	All fixed and operable panel rails and operable panel lock stile
<b>0.270" backed by 0.260" high polypile</b>	1 Raws	Fixed and operable interlocks
<b>Composite dust plugs (Plastic holder, foam pad and finned pile)</b>	4	Two per end of interlock stile each aligned with stile center fine pile

**Glazing:**

Glass type	Spacer type	Interior Lite	Exterior Lite	Glazing method
<b>1" 1G</b>	Aluminum box	¼" tempered	¼" tempered	Channel glazed with a wraparound PVC gasket and sealed with a silicone cap bead

Location	Quantity	Daylight Opening	Glass Bite
		Millimeters	Inches
<b>Operable panel</b>	1	725x 1600	5/8"
<b>Fixed panel</b>	1	725x 1600	5/8"

**Air leakage Test results**

Title of the test	Results	Allowed
<b>Air leakage Infiltration per ASTM E283 at 75 Pa (1.57 psf)</b>	0.5 l/s/m <sup>2</sup> (0.1 cfm/ft <sup>2</sup> )	1.5 l/s/m <sup>2</sup> (0.3 cfm/ft <sup>2</sup> )
<b>Air leakage Exfiltration per ASTM E283 at 75 Pa (1.57 psf)</b>	0.5 l/s/m <sup>2</sup> (0.1 cfm/ft <sup>2</sup> )	1.5 l/s/m <sup>2</sup> (0.3 cfm/ft <sup>2</sup> )
<b>Canadian Air infiltration/exfiltration level</b>	A3	0.5 l/s/m <sup>2</sup> (0.1 cfm/ft <sup>2</sup> )

Tables 1,2,3,4,5,6 and 7: Test sample description (Reference: Laboratory test report and window shop drawing)

## **Appendix B**

### **Population Identification Tables**

Population Identification Tables

L+A5:L6level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4b
6	W6-3b	W6-1b	W6-1a	W6-4a	W6-3a	W6-5c	W6-5b	W6-2	W6-5a	W6-4b	
7	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
8	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
9	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
10	W10-3b	W10-1b	W10-1a	W10-4a	W10-3a	W10-5c	W10-5b	W10-2	W10-5a	W10-4b	
11	W11-3b	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b	W11-2	W11-5a	W11-4b	
12	W12-3b	W12-1b	W12-1a	W12-4a	W12-3a	W12-5c	W12-5b	W12-2	W12-5a	W12-4b	
13	W12-3b	W12-1b	W12-1a	W12-4a	W12-3a	W12-5c	W12-5b	W12-2	W12-5a	W12-4b	
14	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
15	W10-3b	W10-1b	W10-1a	W10-4a	W10-3a	W10-5c	W10-5b	W10-2	W10-5a	W10-4b	
16	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
17	W11-3b	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b	W11-2	W11-5a	W11-4b	
18	W11-3b	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b	W11-2	W11-5a	W11-4b	
19	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
20	W7-3b	W7-1b	W7-1a	W7-4a	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b	W8-4b
21	W21-3b	W21-1b	W21-1a	W21-4a	W21-3a	W21-5c	W21-5b	W21-2	W21-5a	W21-4b	
22	W22-3b	W22-1b	W22-1a	W22-4a	W22-3a	W22-5c	W22-5b	W22-2	W22-5a	W22-4b	
23	W23-3b	W23-1b	W23-1a	W23-4a	W23-3a	W23-5c	W23-5b	W23-2	W23-5a	W23-4b	
24	W24-3b	W24-1b	W24-1a	W24-4a	W24-3a	W24-5c	W24-5b	W24-2	W24-5a	W24-4b	
25	W25-3b	W25-1b	W25-1a	W25-4a	W25-3a	W25-5c	W25-5b	W25-2	W25-5a	W25-4b	
26	W21-3b	W21-1b	W21-1a	W21-4a	W21-3a	W21-5c	W21-5b	W21-2	W21-5a	W21-4b	
27	W27-3b	W27-1b	W27-1a	W27-4a	W27-3a	W27-5c	W27-5b	W27-2	W27-5a	W27-4b	
28	W21-3b	W21-1b	W21-1a	W21-4a	W21-3a	W21-5c	W21-5b	W21-2	W21-5a	W21-4b	
29	W22-3b	W22-1b	W22-1a	W22-4a	W22-3a	W22-5c	W22-5b	W22-2	W22-5a	W22-4b	
30											
31	W27-3b	W27-1b	W27-1a	W27-4a	W27-3a	W27-5c	W27-5b	W27-2	W27-5a	W27-4b	
32	W27-3b	W27-1b	W27-1a	W27-4a	W27-3a	W27-5c	W27-5b	W27-2	W27-5a	W27-4b	
33	W23-3b	W23-1b	W23-1a	W23-4a	W23-3a	W23-5c	W23-5b	W23-2	W23-5a	W23-4b	
34	W23-3b	W23-1b	W23-1a	W23-4a	W23-3a	W23-5c	W23-5b	W23-2	W23-5a	W23-4b	
35	W27-3b	W27-1b	W27-1a	W27-4a	W27-3a	W27-5c	W27-5b	W27-2	W27-5a	W27-4b	
36	W22-3b	W22-1b	W22-1a	W22-4a	W22-3a	W22-5c	W22-5b	W22-2	W22-5a	W22-4b	
37	W21-3b	W21-1b	W21-1a	W21-4a	W21-3a	W21-5c	W21-5b	W21-2	W21-5a	W21-4b	
38	W21-3b	W21-1b	W21-1a	W21-4a	W21-3a	W21-5c	W21-5b	W21-2	W21-5a	W21-4b	
39	W22-3b	W22-1b	W22-1a	W22-4a	W22-3a	W22-5c	W22-5b	W22-2	W22-5a	W22-4b	
40	W22-3b	W22-1b	W22-1a	W22-4a	W22-3a	W22-5c	W22-5b	W22-2	W22-5a	W22-4b	

Table 1– Different Fenestration Types and their distributions (Part A)

41	W41-3b	W41-1b	W41-1a	W41-4a	W41-3a	W41-5c	W41-5b	W41-2	W41-5a	W41-4b	
42	W42-3b	W42-1b	W42-1a	W42-4a	W42-3a	W42-5c	W42-5b	W42-2	W42-5a	W42-4b	
43	W43-3b	W43-1b	W43-1a	W43-4a	W43-3a	W43-5c	W43-5b	W43-2	W43-5a	W43-4b	
44	W44-3b	W44-1b	W44-1a	W44-4a	W44-3a	W44-5c	W44-5b	W44-2	W44-5a	W44-4b	
45	W45-3b	W45-1b	W45-1a	W45-4a	W45-3a	W45-5c	W45-5b	W45-2	W45-5a	W45-4b	
46	W46-3b	W46-1b	W46-1a	W46-4a	W46-3a	W46-5c	W46-5b	W46-2	W46-5a	W46-4b	
47	W47-3b	W47-1b	W47-1a	W47-4a	W47-3a	W47-5c	W47-5b	W47-2	W47-5a	W47-4b	
48	W48-3b	W48-1b	W48-1a	W48-4a	W48-3a	W48-5c	W48-5b	W48-2	W48-5a	W48-4b	
49	W48-3b	W48-1b	W48-1a	W48-4a	W48-3a	W48-5c	W48-5b	W48-2	W48-5a	W48-4b	
50	W47-3b	W47-1b	W47-1a	W47-4a	W47-3a	W47-5c	W47-5b	W47-2	W47-5a	W47-4b	
51											
52	W47-3b	W47-1b	W47-1a	W47-4a	W47-3a	W47-5c	W47-5b	W47-2	W47-5a	W47-4b	
53	W48-3b	W48-1b	W48-1a	W48-4a	W48-3a	W48-5c	W48-5b	W48-2	W48-5a	W48-4b	
54	W48-3b	W48-1b	W48-1a	W48-4a	W48-3a	W48-5c	W48-5b	W48-2	W48-5a	W48-4b	
55	W55-3b	W55-1b	W55-1a	W55-4a	W55-3a	W55-5c	W55-5b	W55-2	W55-5a	W55-4b	
56	W56-3b	W56-1b	W56-1a	W56-4a	W56-3a	W56-5c	W56-5b	W56-2	W56-5a	W56-4b	
57	W57-3b	W57-1b	W57-1a	W57-4a	W57-3a	W57-5c	W57-5b	W57-2	W57-5a	W57-4b	
58	W58-3b	W58-1b	W58-1a	W58-4a	W58-3a	W58-5c	W58-5b	W58-2	W58-5a	W58-4b	
59											
60	W58-3b	W58-1b	W58-1a	W58-4a	W58-3a	W58-5c	W58-5b	W58-2	W58-5a	W58-4b	
61	W61-3b	W61-1b	W61-1a	W61-4a	W61-3a	W61-5c	W61-5b	W61-2	W61-5a	W61-4b	
62	W61-3b	W61-1b	W61-1a	W61-4a	W61-3a	W61-5c	W61-5b	W61-2	W61-5a	W61-4b	
63	W58-3b	W58-1b	W58-1a	W58-4a	W58-3a	W58-5c	W58-5b	W58-2	W58-5a	W58-4b	
64	W57-3b	W57-1b	W57-1a	W57-4a	W57-3a	W57-5c	W57-5b	W57-2	W57-5a	W57-4b	
65	W58-3b	W58-1b	W58-1a	W58-4a	W58-3a	W58-5c	W58-5b	W58-2	W58-5a	W58-4b	
66	W66-3b	W66-1b	W66-1a	W66-4a	W66-3a	W66-5c	W66-5b	W66-2	W66-5a	W66-4b	
67	W67-3b	W67-1b	W67-1a	W67-4a	W67-3a	W67-5c	W67-5b	W67-2	W67-5a	W67-4b	
68	W68-3b	W68-1b	W68-1a	W68-4a	W68-3a	W68-5c	W68-5b	W68-2	W68-5a	W68-4b	
69	W69-3b	W69-1b	W69-1a	W69-4a	W69-3a	W69-5c	W69-5b	W69-2	W69-5a	W69-4b	
70											
71	W70-3b	W70-1b	W70-1a	W70-4a	W70-3a	W70-5c	W70-5b	W70-2	W70-5a	W70-4b	

Table 1- Different Fenestration Types and their distributions (Part B)

Level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4a
6	W6-3b	W6-1b	W6-1a	W6-4a (1 DTG1)	W6-3a	W6-5c	W6-5b	W6-2	W6-5a	W6-4b (2 DTG1)	
7	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
8	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
9	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
10	W10-3b	W10-1b	W10-1a	W10-4a (2 DTG1)	W10-3a	W10-5c	W10-5b	W10-2	W10-5a	W10-4b (2 DTG1)	
11	W11-3b	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b (1 DTG1)	W11-2	W11-5a (1 DTG1)	W11-4b	
12	W12-3b	W12-1b	W12-1a	W12-4a (2 DTG1)	W12-3a	W12-5c	W12-5b	W12-2	W12-5a	W12-4b (2 DTG1)	
13	W12-3b	W12-1b	W12-1a	W12-4a (2 DTG1)	W12-3a	W12-5c	W12-5b	W12-2	W12-5a	W12-4b (2 DTG1)	
14	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
15	W10-3b	W10-1b	W10-1a	W10-4a (2 DTG1)	W10-3a	W10-5c	W10-5b	W10-2	W10-5a	W10-4b (2 DTG1)	
16	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
17	W11-3b (1 DTG1)	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b	W11-2	W11-5a	W11-4b	
18	W11-3b	W11-1b	W11-1a	W11-4a	W11-3a	W11-5c	W11-5b	W11-2	W11-5a	W11-4b	
19	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
20	W7-3b	W7-1b	W7-1a	W7-4a (2 DTG1)	W7-3a	W7-5c	W7-5b	W7-2	W7-5a	W7-4b (2 DTG1)	W8-4a (2 DTG1)
21	W21-3b	W21-1b	W21-1a	W21-4a (2 DTG1)	W21-3a (2 DTG1)	W21-5c	W21-5b (2 DTG1)	W21-2	W21-5a	W21-4b (2 DTG1)	
22	W22-3b (1 DTG1)	W22-1b	W22-1a	W22-4a (1 DTG1)	W22-3a (2 DTG2)	W22-5c	W22-5b (2 DTG1)	W22-2	W22-5a	W22-4b (2 DTG1)	
23	W23-3b (1 DTG2)	W23-1b	W23-1a	W23-4a (1 DTG2)	W23-3a (2 DTG2)	W23-5c	W23-5b (2 DTG2)	W23-2	W23-5a	W23-4b (2 DTG2)	
24	W24-3b	W24-1b	W24-1a	W24-4a (2 DTG1)	W24-3a (2 DTG1)	W24-5c	W24-5b (2 DTG1)	W24-2	W24-5a	W24-4b (2 DTG2)	
25	W25-3b	W25-1b	W25-1a	W25-4a (2 DTG1)	W25-3a (2 DTG1)	W25-5c	W25-5b (2 DTG1)	W25-2	W25-5a	W25-4b (2 DTG1)	
26	W21-3b	W21-1b	W21-1a	W21-4a (2 DTG1)	W21-3a (2 DTG1)	W21-5c	W21-5b (2 DTG1)	W21-2	W21-5a	W21-4b (2 DTG1)	
27	W27-3b (1 DTG1)	W27-1b	W27-1a	W27-4a (2 DTG1)	W27-3a (2 DTG1)	W27-5c	W27-5b (2 DTG1)	W27-2	W27-5a	W27-4b (2 DTG1)	
28	W21-3b	W21-1b	W21-1a	W21-4a (2 DTG1)	W21-3a (2 DTG1)	W21-5c	W21-5b (2 DTG1)	W21-2	W21-5a	W21-4b (2 DTG1)	
29	W22-3b (1 DTG1)	W22-1b	W22-1a	W22-4a (1 DTG1)	W22-3a (2 DTG2)	W22-5c	W22-5b (2 DTG1)	W22-2	W22-5a	W22-4b (2 DTG1)	
30											
31	W27-3b (1 DTG1)	W27-1b	W27-1a	W27-4a (2 DTG1)	W27-3a (2 DTG1)	W27-5c	W27-5b (2 DTG1)	W27-2	W27-5a	W27-4b (2 DTG1)	
32	W27-3b (1 DTG1)	W27-1b	W27-1a	W27-4a (2 DTG1)	W27-3a (2 DTG1)	W27-5c	W27-5b (2 DTG1)	W27-2	W27-5a	W27-4b (2 DTG1)	
33	W23-3b (1 DTG2)	W23-1b	W23-1a	W23-4a (1 DTG2)	W23-3a (2 DTG2)	W23-5c	W23-5b (2 DTG2)	W23-2	W23-5a	W23-4b (2 DTG2)	
34	W23-3b (1 DTG2)	W23-1b	W23-1a	W23-4a (1 DTG2)	W23-3a (2 DTG2)	W23-5c	W23-5b (2 DTG2)	W23-2	W23-5a	W23-4b (2 DTG2)	
35	W27-3b (1 DTG1)	W27-1b	W27-1a	W27-4a (2 DTG1)	W27-3a (2 DTG1)	W27-5c	W27-5b (2 DTG1)	W27-2	W27-5a	W27-4b (2 DTG1)	
36	W22-3b (1 DTG1)	W22-1b	W22-1a	W22-4a (1 DTG1)	W22-3a (2 DTG2)	W22-5c	W22-5b (2 DTG1)	W22-2	W22-5a	W22-4b (2 DTG1)	
37	W21-3b	W21-1b	W21-1a	W21-4a (2 DTG1)	W21-3a (2 DTG1)	W21-5c	W21-5b (2 DTG1)	W21-2	W21-5a	W21-4b (2 DTG1)	
38	W21-3b (1 DTG1)	W21-1b	W21-1a	W21-4a (2 DTG1)	W21-3a (2 DTG1)	W21-5c	W21-5b (2 DTG1)	W21-2	W21-5a	W21-4b (2 DTG1)	
39	W22-3b (1 DTG1)	W22-1b	W22-1a	W22-4a (1 DTG1)	W22-3a (2 DTG2)	W22-5c	W22-5b (2 DTG1)	W22-2	W22-5a	W22-4b (2 DTG1)	

Table 2– Sliding Door Types and their Distributions (Part A)



40	W22-3b (1 DTG1)	W22-1b	W22-1a	W22-4a (1 DTG1)	W22-3a (2 DTG2)	W22-5c	W22-5b (2 DTG1)	W22-2	W22-5a	W22-4b (2 DTG1)	
41	W41-3b (1 DTG1)	W41-1b	W41-1a (2 DTG1)	W41-4a (2DTG1)	W41-3a (2DTG1)	W41-5c	W41-5b (2DTG1)	W41-2	W41-5a	W41-4b (2DTG1)	
42	W42-3b (1 DTG1)	W42-1b (1 DTG1)	W42-1a (2 DTG1)	W42-4a (2 DTG1)	W42-3a (2 DTG1)	W42-5c	W42-5b (2 DTG1)	W42-2	W42-5a	W42-4b (2 DTG1)	
43	W43-3b	W43-1b (1 DTG1)	W43-1a (2 DTG1)	W43-4a (2 DTG1)	W43-3a (2 DTG1)	W43-5c	W43-5b (2 DTG1)	W43-2	W43-5a	W43-4b (2 DTG1)	
44	W44-3b	W44-1b (1 DTG1)	W44-1a (2 DTG1)	W44-4a (2 DTG1)	W44-3a (2 DTG1)	W44-5c	W44-5b (2 DTG1)	W44-2	W44-5a	W44-4b (2 DTG1)	
45	W45-3b	W45-1b (1 DTG1)	W45-1a (2 DTG1)	W45-4a (2 DTG1)	W45-3a (2 DTG1)	W45-5c	W45-5b (2 DTG1)	W45-2	W45-5a	W45-4b (2 DTG1)	
46	W46-3b	W46-1b (1 DTG1)	W46-1a (2 DTG1)	W46-4a (2 DTG1)	W46-3a (2 DTG1)	W46-5c	W46-5b (2 DTG1)	W46-2	W46-5a	W46-4b (2 DTG1)	
47	W47-3b	W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)	W47-5c	W47-5b (2 DTG1)	W47-2	W47-5a	W47-4b (2 DTG1)	
48	W48-3b	W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)	W48-5c	W48-5b (2 DTG1)	W48-2	W48-5a	W48-4b (2 DTG1)	
49	W48-3b	W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)	W48-5c	W48-5b (2 DTG1)	W48-2	W48-5a	W48-4b (2 DTG1)	
50	W47-3b	W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)	W47-5c	W47-5b (2 DTG1)	W47-2	W47-5a	W47-4b (2 DTG1)	
51											
52	W47-3b	W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)	W47-5c	W47-5b (2 DTG1)	W47-2	W47-5a	W47-4b (2 DTG1)	
53	W48-3b	W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)	W48-5c	W48-5b (2 DTG1)	W48-2	W48-5a	W48-4b (2 DTG1)	
54	W48-3b	W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)	W48-5c	W48-5b (2 DTG1)	W48-2	W48-5a	W48-4b (2 DTG1)	
55	W55-3b	W55-1b (1 DTG1)	W55-1a (2 DTG1)	W55-4a (2 DTG1)	W55-3a (2 DTG1)	W55-5c	W55-5b (2 DTG1)	W55-2	W55-5a	W55-4b (2 DTG1)	
56	W56-3b	W56-1b (1 DTG1)	W56-1a (2 DTG1)	W56-4a(2 DTG1)	W56-3a(2 DTG1)	W56-5c	W56-5b(2 DTG1)	W56-2	W56-5a	W56-4b(2 DTG1)	
57	W57-3b	W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)	W57-5c	W57-5b (2 DTG1)	W57-2	W57-5a	W57-4b (2 DTG1)	
58	W58-3b	W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)	W58-5c	W58-5b (2 DTG1)	W58-2	W58-5a	W58-4b (2 DTG1)	
59											
60	W58-3b	W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)	W58-5c	W58-5b (2 DTG1)	W58-2	W58-5a	W58-4b (2 DTG1)	
61	W61-3b	W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)	W61-5c	W61-5b (2 DTG1)	W61-2	W61-5a	W61-4b (2 DTG1)	
62	W61-3b	W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)	W61-5c	W61-5b (2 DTG1)	W61-2	W61-5a	W61-4b (2 DTG1)	
63	W58-3b	W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)	W58-5c	W58-5b (2 DTG1)	W58-2	W58-5a	W58-4b (2 DTG1)	
64	W57-3b	W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)	W57-5c	W57-5b (2 DTG1)	W57-2	W57-5a	W57-4b (2 DTG1)	
65	W58-3b	W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)	W58-5c	W58-5b (2 DTG1)	W58-2	W58-5a	W58-4b (2 DTG1)	
66	W66-3b	W66-1b (1 DTG1)	W66-1a (2 DTG1)	W66-4a (2 DTG1)	W66-3a (2 DTG1)	W66-5c	W66-5b (2 DTG1)	W66-2	W66-5a	W66-4b (2 DTG1)	
67	W67-3b	W67-1b (1 DTG1)	W67-1a (2 DTG1)	W67-4a (2 DTG1)	W67-3a (2 DTG1)	W67-5c	W67-5b (2 DTG1)	W67-2	W67-5a	W67-4b (2 DTG1)	
68	W68-3b	W68-1b (1 DTG1)	W68-1a (2 DTG1)	W68-4a (2 DTG1)	W68-3a (2 DTG1)	W68-5c	W68-5b (2 DTG1)	W68-2	W68-5a	W68-4b (2 DTG1)	
69	W69-3b	W69-1b (2 DTG1)	W69-1a (2 DTG1)	W69-4a (2 DTG1)	W69-3a (2 DTG1)	W69-5c	W69-5b (2 DTG1)	W69-2	W69-5a	W69-4b (2 DTG1)	
70											
71	W70-3b	W70-1b	W70-1a	W70-4a	W70-3a	W70-5c	W70-5b	W70-2	W70-5a	W70-4b	

Table 2– Sliding Door Types and their Distributions (Part B)

Level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4a
6				W6-4a (1 DTG1)						W6-4b (2 DTG1)	
7				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
8				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
9				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
10				W10-4a (2 DTG1)						W10-4b (2 DTG1)	
11							W11-5b (1 DTG1)		W11-5a (1 DTG1)		
12				W12-4a (2 DTG1)						W12-4b (2 DTG1)	
13				W12-4a (2 DTG1)						W12-4b (2 DTG1)	
14				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
15				W10-4a (2 DTG1)						W10-4b (2 DTG1)	
16				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
17	W11-3b (1 DTG1)										
18											
19				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
20				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
21				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
22	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
23	W23-3b (1 DTG2)			W23-4a (1 DTG2)	W23-3a (2 DTG2)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
24				W24-4a (2 DTG1)	W24-3a (2 DTG1)		W24-5b (2 DTG1)			W24-4b (2 DTG2)	
25				W25-4a (2 DTG1)	W25-3a (2 DTG1)		W25-5b (2 DTG1)			W25-4b (2 DTG1)	
26				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
27	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
28				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
29	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
30											
31	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
32	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
33	W23-3b (1 DTG1)			W23-4a (1 DTG1)	W23-3a (2 DTG1)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
34	W23-3b (1 DTG1)			W23-4a (1 DTG1)	W23-3a (2 DTG1)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
35	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
36	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
37				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
38				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
39	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	

Table 3– Type 1 Distribution (Part A)

40	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
41	W41-3b (1 DTG1)		W41-1a (2 DTG1)	W41-4a (2DTG1)	W41-3a (2DTG1)		W41-5b (2DTG1)			W41-4b (2DTG1)	
42	W42-3b (1 DTG1)	W42-1b (1 DTG1)	W42-1a (2 DTG1)	W42-4a (2 DTG1)	W42-3a (2 DTG1)		W42-5b (2 DTG1)			W42-4b (2 DTG1)	
43		W43-1b (1 DTG1)	W43-1a (2 DTG1)	W43-4a (2 DTG1)	W43-3a (2 DTG1)		W43-5b (2 DTG1)			W43-4b (2 DTG1)	
44		W44-1b (1 DTG1)	W44-1a (2 DTG1)	W44-4a (2 DTG1)	W44-3a (2 DTG1)		W44-5b (2 DTG1)			W44-4b (2 DTG1)	
45		W45-1b (1 DTG1)	W45-1a (2 DTG1)	W45-4a (2 DTG1)	W45-3a (2 DTG1)		W45-5b (2 DTG1)			W45-4b (2 DTG1)	
46		W46-1b (1 DTG1)	W46-1a (2 DTG1)	W46-4a (2 DTG1)	W46-3a (2 DTG1)		W46-5b (2 DTG1)			W46-4b (2 DTG1)	
47		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)		W47-5b (2 DTG1)			W47-4b (2 DTG1)	
48		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
49		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
50		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)	0	W47-5b (2 DTG1)			W47-4b (2 DTG1)	
51											
52		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)		W47-5b (2 DTG1)			W47-4b (2 DTG1)	
53		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
54		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
55		W55-1b (1 DTG1)	W55-1a (2 DTG1)	W55-4a (2 DTG1)	W55-3a (2 DTG1)		W55-5b (2 DTG1)			W55-4b (2 DTG1)	
56		W56-1b (1 DTG1)	W56-1a (2 DTG1)	W56-4a(2 DTG1)	W56-3a(2 DTG1)		W56-5b(2 DTG1)			W56-4b(2 DTG1)	
57		W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)		W57-5b (2 DTG1)			W57-4b (2 DTG1)	
58		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
59											
60		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
61		W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)		W61-5b (2 DTG1)			W61-4b (2 DTG1)	
62		W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)		W61-5b (2 DTG1)			W61-4b (2 DTG1)	
63		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
64		W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)		W57-5b (2 DTG1)			W57-4b (2 DTG1)	
65		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
66		W66-1b (1 DTG1)	W66-1a (2 DTG1)	W66-4a (2 DTG1)	W66-3a (2 DTG1)		W66-5b (2 DTG1)			W66-4b (2 DTG1)	
67		W67-1b (1 DTG1)	W67-1a (2 DTG1)	W67-4a (2 DTG1)	W67-3a (2 DTG1)		W67-5b (2 DTG1)			W67-4b (2 DTG1)	
68		W68-1b (1 DTG1)	W68-1a (2 DTG1)	W68-4a (2 DTG1)	W68-3a (2 DTG1)		W68-5b (2 DTG1)			W68-4b (2 DTG1)	
69		W69-1b (2 DTG1)	W69-1a (2 DTG1)	W69-4a (2 DTG1)	W69-3a (2 DTG1)		W69-5b (2 DTG1)			W69-4b (2 DTG1)	
70											
71											

Table 3– Type 1 Distribution (Part B)

Level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4a
6				W6-4a (1 DTG1)						W6-4b (2 DTG1)	
7				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
8				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
9				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
10				W10-4a (2 DTG1)						W10-4b (2 DTG1)	
11							W11-5b (1 DTG1)		W11-5a (1 DTG1)		
12				W12-4a (2 DTG1)						W12-4b (2 DTG1)	
13				W12-4a (2 DTG1)						W12-4b (2 DTG1)	
14				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
15				W10-4a (2 DTG1)						W10-4b (2 DTG1)	
16				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
17	W11-3b (1 DTG1)										
18											
19				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
20				W7-4a (2 DTG1)						W7-4b (2 DTG1)	W8-4a (2 DTG1)
21				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
22	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
23	W23-3b (1 DTG2)			W23-4a (1 DTG2)	W23-3a (2 DTG2)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
24				W24-4a (2 DTG1)	W24-3a (2 DTG1)		W24-5b (2 DTG1)			W24-4b (2 DTG2)	
25				W25-4a (2 DTG1)	W25-3a (2 DTG1)		W25-5b (2 DTG1)			W25-4b (2 DTG1)	
26				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
27	W27-3b (1 DTG1)			W27-4a (1DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
28				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
29	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
30											
31	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
32	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
33	W23-3b (1 DTG1)			W23-4a (1 DTG1)	W23-3a (2 DTG1)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
34	W23-3b (1 DTG1)			W23-4a (1 DTG1)	W23-3a (2 DTG1)		W23-5b (2 DTG1)			W23-4b (2 DTG1)	
35	W27-3b (1 DTG1)			W27-4a (2 DTG1)	W27-3a (2 DTG1)		W27-5b (2 DTG1)			W27-4b (2 DTG1)	
36	W22-3b (1 DTG1)			W22-4a (2 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
37				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
38				W21-4a (2 DTG1)	W21-3a (2 DTG1)		W21-5b (2 DTG1)			W21-4b (2 DTG1)	
39	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	

Table 4– Excluding other Sizes than 2.26cm x 1.83 cm in Type 1 Distribution (Part A)

40	W22-3b (1 DTG1)			W22-4a (1 DTG1)	W22-3a (2 DTG2)		W22-5b (2 DTG1)			W22-4b (2 DTG1)	
41	W41-3b (1 DTG1)		W41-1a (2 DTG1)	W41-4a (2DTG1)	W41-3a (2DTG1)		W41-5b (2DTG1)			W41-4b (2DTG1)	
42	W42-3b (1 DTG1)	W42-1b (1 DTG1)	W42-1a (2 DTG1)	W42-4a (2 DTG1)	W42-3a (2 DTG1)		W42-5b (2 DTG1)			W42-4b (2 DTG1)	
43		W43-1b (1 DTG1)	W43-1a (2 DTG1)	W43-4a (2 DTG1)	W43-3a (2 DTG1)		W43-5b (2 DTG1)			W43-4b (2 DTG1)	
44		W44-1b (1 DTG1)	W44-1a (2 DTG1)	W44-4a (2 DTG1)	W44-3a (2 DTG1)		W44-5b (2 DTG1)			W44-4b (2 DTG1)	
45		W45-1b (1 DTG1)	W45-1a (2 DTG1)	W45-4a (2 DTG1)	W45-3a (2 DTG1)		W45-5b (2 DTG1)			W45-4b (2 DTG1)	
46		W46-1b (1 DTG1)	W46-1a (2 DTG1)	W46-4a (2 DTG1)	W46-3a (2 DTG1)		W46-5b (2 DTG1)			W46-4b (2 DTG1)	
47		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)		W47-5b (2 DTG1)			W47-4b (2 DTG1)	
48		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
49		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
50		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)		W47-5b (2 DTG1)			W47-4b (2 DTG1)	
51											
52		W47-1b (1 DTG1)	W47-1a (2 DTG1)	W47-4a (2 DTG1)	W47-3a (2 DTG1)		W47-5b (2 DTG1)			W47-4b (2 DTG1)	
53		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
54		W48-1b (1 DTG1)	W48-1a (2 DTG1)	W48-4a (2 DTG1)	W48-3a (2 DTG1)		W48-5b (2 DTG1)			W48-4b (2 DTG1)	
55		W55-1b (1 DTG1)	W55-1a (2 DTG1)	W55-4a (2 DTG1)	W55-3a (2 DTG1)		W55-5b (2 DTG1)			W55-4b (2 DTG1)	
56		W56-1b (1 DTG1)	W56-1a (2 DTG1)	W56-4a(2 DTG1)	W56-3a(2 DTG1)		W56-5b(2 DTG1)			W56-4b(2 DTG1)	
57		W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)		W57-5b (2 DTG1)			W57-4b (2 DTG1)	
58		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
59											
60		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
61		W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)		W61-5b (2 DTG1)			W61-4b (2 DTG1)	
62		W61-1b (1 DTG1)	W61-1a (2 DTG1)	W61-4a (2 DTG1)	W61-3a (2 DTG1)		W61-5b (2 DTG1)			W61-4b (2 DTG1)	
63		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
64		W57-1b (1 DTG1)	W57-1a (2 DTG1)	W57-4a (2 DTG1)	W57-3a (2 DTG1)		W57-5b (2 DTG1)			W57-4b (2 DTG1)	
65		W58-1b (1 DTG1)	W58-1a (2 DTG1)	W58-4a (2 DTG1)	W58-3a (2 DTG1)		W58-5b (2 DTG1)			W58-4b (2 DTG1)	
66		W66-1b (1 DTG1)	W66-1a (2 DTG1)	W66-4a (2 DTG1)	W66-3a (2 DTG1)		W66-5b (2 DTG1)			W66-4b (2 DTG1)	
67		W67-1b (1 DTG1)	W67-1a (2 DTG1)	W67-4a (2 DTG1)	W67-3a (2 DTG1)		W67-5b (2 DTG1)			W67-4b (2 DTG1)	
68		W68-1b (1 DTG1)	W68-1a (2 DTG1)	W68-4a (2 DTG1)	W68-3a (2 DTG1)		W68-5b (2 DTG1)			W68-4b (2 DTG1)	
69		W69-1b (2 DTG1)	W69-1a (2 DTG1)	W69-4a (2 DTG1)	W69-3a (2 DTG1)		W69-5b (2 DTG1)			W69-4b (2 DTG1)	
70											
71											

Table 4– Excluding other Sizes than 2.26cm x 1.83 cm in Type 1 Distribution (Part B)

Level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4a
6				1						2.3	
7				4.5						6.7	8.9
8				10.11						12.13	14.15
9				16.17						18.19	20.21
10				22.23						24.25	
11							25		26		
12											
13											
14				27						28.29	30.31
15				32.33						34.35	
16				36.37						38.39	40
17	41										
18											
19				42.43						44.45	46.47
20				48.49						50.51	52.53
21				54.55	56.57		58.59			60.61	
22	62.63			64.65	66.67		68.69			70.71	
23											
24											
25				72.73	74.75		76.77			78.79	
26				80.81	82.83		84.85			86.87	
27	88			89.9	91.92		93.94			95.96	
28				97.98	99.10		101.102			103.104	
29	105			106	107.108		109.110			111.112	
30											
31	113			114.115	116.117		118.119			120.121	
32	122			123.124	125.126		127.128			129.130	
33											
34											
35	131			132.133	134.135		136.137			138.139	
36	140			141.142	143.144		145.146			147.148	
37				149.150	151.152		153.154			155.156	
38				157.158	159.160		161.162			163.164	
39	165			166	167.168		169.170			171.172	

Table 5- Labeling and numbering type 1 (Size 2.26cm x 1.83 cm) (Part A)

40	173			174	175.176		177.178			179.180	
41	181		182.183	184.185	186.187		188.189			190.191	
42											
43		192	193.194	195.196	197.198		199.200			201.202	
44											
45											
46		203	204.205	206.207	208.209		210.211			212.213	
47		214	215.216	217.218	219.220		221.222			223.224	
48		225	226.227	228.229	230.231		231.232			233.234	
49		235	236.237	238.239	240.241		242.243			244.245	
50		246	247.248	249.250	251.252		253.254			255.256	
51											
52		257	258.259	260.261	262.263		264.265			266.267	
53		268	269.270	271.272	273.274		275.276			277.278	
54		279	280.281	282.283	284.285		286.287			288.289	
55											
56											
57											
58		290	291.292	293.294	295.296		297.298			299.300	
59											
60											
61											
62											
63											
64		301	302.303	304.305	306.307		308.309			310	
65											
66											
67											
68											
69											
70											
71											

Table 5- Labeling and numbering type 1 (Size 2.26cm x 1.83 cm) (Part B)

Level	WLevel-3b	WLevel-1b	WLevel-1a	WLevel-4a	WLevel-3a	WLevel-5c	WLevel-5b	WLevel-2	WLevel-5a	WLevel-4b	W8-4a
6											
7											
8											
9											
10											
11							25		26		
12											
13											
14							28		29		
15											
16											
17	41										
18											
19											
20							57				
21											
22						67	68		69		
23											
24											
25											
26						83			87		
27											
28											
29											
30											
31											
32											
33											
34											
35			132			135					
36						144				147	
37											
38	157										
39											

Table 6- Randomly selected type 1(Size 2.26cm x 1.83 cm) (Part A)



40											
41											
42											
43						198					
44											
45											
46						209					
47	214										
48			226								
49			236							244	
50	246		247								
51											
52											
53				271		274				277	
54			280	282							
55											
56											
57											
58		290									
59											
60											
61											
62											
63											
64		301								310	
65											
66											
67											
68											
69											
70											

Table 6– Randomly selected type 1(Size 2.26cm x 1.83 cm) (Part B)

Test Number	Sample size	sample number	Direction	Test Time	Test date	Temp Inside (°C)	Temp out side (°C)	Wind Speed	Relative Humidity	Construction Level	Marketing Level	Suit No.	Type
1	2260x1830	25	SW	8:00 a.m	11/19/2016	12°C	10 °C	W20 KPH	80%	47	52	E10	4a
2	2260x1830	26	NE	9:00 a.m	11/19/2016	12°C	10 °C	W20 KPH	80%	46	51	E05	5b
3	2260x1830	28	NE	10:00 a.m	11/19/2016	12°C	10 °C	W20 KPH	80%	43	48	E05	5b
4	2260x1830	29	SE	11:00 a.m	11/19/2016	12°C	10 °C	W20 KPH	80%	20	25	E07	4b
5	2260x1830	41	SW	12:00 p.m	11/19/2016	12°C	10 °C	WSW26 KPH	80%	16	21	E10	4a
6	2260x1830	57	NE	01:00 p.m	11/19/2016	12°C	10 °C	WSW26 KPH	80%	14	19	E06	5b
7	2260x1830	67	SE	02:00 p.m	11/19/2016	12°C	10 °C	WSW26 KPH	80%	14	19	E07	4b
8	2260x1830	68	NW	10:27 a.m	1/12/2016	7°C	5°C	WSW 38 KPH	70%	64	69	E03	1b
9	2260x1830	69	SE	11:49 a.m	1/12/2016	7°C	5°C	WSW 38 KPH	70%	64	69	E07	4b
10	2260x1830	83	NW	12:32 p.m	1/12/2016	7°C	5°C	W 24 KPH	70%	58	63	E03	1b
11	2260x1830	87	SE	1:14 p.m	1/12/2016	7°C	5°C	W 24 KPH	70%	54	59	E09	4a
12	2260x1830	132	SE	3.23 p.m	1/12/2016	7°C	5°C	W24 KPh	70%	10	15	E07	4b
13	2260x1830	135	NE	4:15 p.m	1/12/2016	7°C	5°C	W24 KPh	70%	10	15	E06	5b
14	2260x1830	144	SE	8:54 a.m	3/12/2016	5°C	2°C	NW 11 KPH	50%	53	58	E09	4a
15	2260x1830	147	SE	9:30 a.m	3/12/2016	5°C	2°C	NW 11 KPH	50%	53	58	E07	4b
16	2260x1830	157	NE	10.10 a.m	3/12/2016	7°C	4°C	WNW 25KPH	50%	53	58	E06	5b
17	2260x1830	198	NW	10.30 a.m	3/12/2016	7°C	4°C	WNW 25KPH	50%	50	55	E04	1a
18	2260x1830	209	SW	11:12 a.m	3/12/2016	8°C	5°C	WNW 25KPH	50%	50	55	E10	4a
19	2260x1830	214	SW	12:00 p.m	3/12/2016	9°C	6°C	NW 22KPH	50%	38	43	E10	4a
20	2260x1830	226	NW	1:01 p.m	3/12/2016	10°C	7°C	WNW 20KPH	50%	35	40	E04	1a
21	2260x1830	236	NE	1:25 p.m	3/12/2016	10°C	7°C	WNW 20KPH	50%	35	40	E05	5b
22	2260x1830	244	SE	2:14 p.m	3/12/2016	10°C	7°C	NW 24KHP	50%	26	31	E07	4b
23	2260x1830	246	NE	2:46 p.m	3/12/2016	8°C	5°C	NW 18KPH	50%	26	31	E05	5b
24	2260x1830	247	SE	8:30 a.m	16/12/2016	-	(-7)°C - Feels (-17)	W31KPH	60%	36	41	E07	4b
25	2260x1830	271	NE	10:00 a.m	16/12/2016	-	(-6)°C - Feels (-17)	W31KPH	60%	36	41	E05	5c
26	2260x1830	274	NE	12:17 p.m	16/12/2016	-	(-5)°C - Feels (-14)	WSW29KPH	60%	23	27	E06	5c
27	2260x1830	277	SE	1:40 p.m	16/12/2016	-	(-5)°C - Feels (-12)	WSW24KPH	60%	23	27	E07	5a
28	2260x1830	280	NE	2:50 p.m	16/12/2016	-	(-5)°C - Feels (-12)	WSW24KPH	60%	23	27	E05	5c
29	2260x1830	282	SE	10.00 a.m	12/28/2016	Very Hot	(0)°C - Feels (-8)	W25KPH	60%	49	54	E07	4b
30	2260x1830	290	NW	12:10 p.m	12/28/2016	Very Hot	(0)°C - Feels (-8)	W25KPH	60%	49	54	E04	1a
31	2260x1830	301	NW	2.00 p.m	12/28/2016	Very Hot	(0)°C - Feels (-8)	W25KPH	60%	48	53	E04	1a
32	2260x1830	310	NW	3.30 p.m	12/28/2016	Normal temp	(-1)°C - Feels (-8)	W25KPH	60%	54	59	E04	1a

Table 7– Test results

Extraneous Air leakage				Total air leakage							
SCFM in 25 Pa	SCFM in 50 Pa	SCFM in 75 Pa	SCFM in 100 Pa	SCFM in 25 Pa	SCFM in 50 Pa	SCFM in 75 Pa	SCFM in 100 Pa	Air leakage in 25Pa	Air leakage in 50Pa	Air leakage in 75Pa	Air leakage in 100Pa
8.5	9	9.8	10.5	9.5	12.5	14.8	16.2	0.022	0.079	0.112	0.13
10.5	10.6	12.2	13.8	10.1	13.4	16.5	18.8	-0.009	0.063	0.097	0.11
8.8	14	15.1	16.8	9.8	14.1	16.8	19.7	0.022	0.002	0.038	0.07
11.8	14.3	15.4	17.9	14	18.2	21.5	29.5	0.049	0.088	0.137	0.26
9.8	10.8	12.9	13.8	10	13.8	15.4	17.3	0.004	0.067	0.056	0.08
7.2	9.4	10.2	11.4	10.8	13.8	14.6	16.7	0.081	0.099	0.099	0.12
8.9	11.4	12.5	13.9	11.8	16.3	18.9	21.7	0.065	0.110	0.144	0.18
12.2	13.5	14.7	16.8	12.3	19.8	21.4	22.8	0.002	0.142	0.151	0.13
7.2	9.2	10.8	11.8	9.1	12.6	15.3	16.2	0.043	0.076	0.101	0.10
9.8	10.5	12.2	14.7	10.3	14.8	15.5	20.9	0.011	0.097	0.074	0.14
8.1	9.4	11.9	12.4	8.8	14.7	16.8	19.1	0.016	0.119	0.110	0.15
8.7	9.7	11.8	12.6	11.8	14.9	17.1	19.4	0.070	0.117	0.119	0.15
7.8	9.8	10.3	11.3	20.5	23.8	27.1	30.1	0.285	0.314	0.377	0.42
10.9	11	12.3	13.8	11.4	14.6	16.3	18.4	0.011	0.081	0.090	0.10
8.3	9.2	12.8	13.2	11.8	16.9	20.2	24.1	0.079	0.173	0.166	0.24
6.2	6.9	1.15	9	10.1	14.05	17.5	21.3	0.088	0.161	0.367	0.28
8.4	9.1	10.1	12.2	15.1	18	19.3	22.4	0.151	0.200	0.207	0.23
7.6	8.9	10.5	12	8.9	12.5	15.4	17.1	0.029	0.081	0.110	0.11
8.9	12.2	14.05	16.2	9	12.5	14.4	16.4	0.002	0.007	0.008	0.00
6.8	8.5	10.5	11.9	8.2	11.2	14	16.2	0.031	0.061	0.079	0.10
8.5	11.2	11.4	13.2	7.9	13.3	16.4	19.9	-0.013	0.047	0.112	0.15
7.8	8.7	8.9	11.3	11.3	14	15.4	17.5	0.079	0.119	0.146	0.14
8.5	12.2	15.3	20.4	13.2	18.3	22.3	24.9	0.106	0.137	0.157	0.10
7.8	11	14.1	15.8	8.9	12.4	14.9	16.9	0.025	0.031	0.018	0.02
7.8	8.9	10.1	12.7	8.1	9.2	11.1	12.2	0.007	0.007	0.022	-0.01
11.2	15.3	17.8	19.9	14.2	19.4	21.9	26.1	0.067	0.092	0.092	0.14
9.9	11.2	12.9	14.8	10.2	15.1	19.8	22.1	0.007	0.088	0.155	0.16
11.8	13.5	15.4	16.8	15.2	21.1	24.4	25	0.076	0.171	0.202	0.18
3.8	7.9	9.8	12.1	3.8	7.2	10.5	13.1	0.000	-0.016	0.016	0.02
7.1	12.2	17.2	19.7	4	12.7	15.2	19.8	-0.070	0.011	-0.045	0.00
	7.2	7.5	8.7	8.1	11.8	14.7	15.9	0.182	0.103	0.162	0.16
8.2	12.3	14.8	16.2	11.8	16.8	19.8	23.9	0.081	0.101	0.112	0.17

Table 8- Test results

Temp standard flow (SCFM) at 25Pa	Temp standard flow (SCFM) at 50Pa	Temp standard flow (SCFM) at 75Pa	Temp standard flow (SCFM) at 100Pa	Temp standard flow( L/s) at 25Pa	Temp standard flow ( L/s) at 50Pa	Temp standard flow (L/s) at 75Pa	Temp standard flow (L/s) at 100Pa	Air leakage (L/s)/m2at 25Pa	Air leakage (L/s)/m2at 50Pa	Air leakage (L/s)/m2at 75Pa	Air leakage (L/s)/m2at 100Pa	Standardized Air leakage (SCFM/ft²) at 25 pa	Standardized Air leakage (SCFM/ft²) at 50 pa	Standardized Air leakage (SCFM/ft²) at 75 pa	Standardized Air leakage (SCFM/ft²) at 100 pa
1.030	3.605	5.150	5.870	0.484	1.694	2.420	2.759	0.117	0.410	0.585	0.667	0.023	0.081	0.116	0.132
-0.412	2.884	4.429	5.150	-0.194	1.355	2.081	2.420	-0.047	0.328	0.503	0.585	-0.009	0.065	0.099	0.116
1.030	0.103	1.751	2.987	0.484	0.048	0.823	1.404	0.117	0.012	0.199	0.339	0.023	0.002	0.039	0.067
2.266	4.017	6.282	11.947	1.065	1.888	2.953	5.615	0.257	0.456	0.714	1.358	0.051	0.090	0.141	0.268
0.206	3.090	2.575	3.605	0.097	1.452	1.210	1.694	0.023	0.351	0.293	0.410	0.005	0.069	0.058	0.081
3.708	4.532	4.532	5.458	1.743	2.130	2.130	2.565	0.421	0.515	0.515	0.620	0.083	0.102	0.102	0.123
2.987	5.047	6.591	8.033	1.404	2.372	3.098	3.776	0.339	0.573	0.749	0.913	0.067	0.113	0.148	0.180
0.109	6.839	7.273	6.513	0.051	3.214	3.418	3.061	0.012	0.729	0.775	0.694	0.002	0.144	0.153	0.137
2.063	3.691	4.885	4.776	0.969	1.735	2.296	2.245	0.220	0.393	0.521	0.509	0.050	0.089	0.118	0.115
0.543	4.668	3.582	6.730	0.255	2.194	1.684	3.163	0.058	0.497	0.407	0.765	0.013	0.113	0.092	0.173
0.760	5.458	5.319	7.273	0.357	2.565	2.500	3.418	0.086	0.620	0.604	0.827	0.021	0.150	0.146	0.200
3.365	5.355	5.753	7.382	1.582	2.517	2.704	3.469	0.382	0.609	0.654	0.839	0.092	0.147	0.158	0.203
13.786	14.419	18.237	20.408	6.480	6.777	8.571	9.592	1.567	1.639	2.073	2.319	0.379	0.396	0.501	0.561
0.532	3.827	4.252	4.890	0.250	1.799	1.999	2.298	0.060	0.435	0.483	0.556	0.015	0.105	0.117	0.134
3.721	8.186	7.867	11.588	1.749	3.847	3.698	5.446	0.423	0.930	0.894	1.317	0.102	0.225	0.216	0.318
4.146	7.601	17.382	13.076	1.949	3.573	8.170	6.146	0.471	0.864	1.975	1.486	0.114	0.209	0.478	0.359
7.123	9.462	9.781	10.844	3.348	4.447	4.597	5.097	0.809	1.075	1.112	1.232	0.196	0.260	0.269	0.298
1.382	3.827	5.209	5.422	0.650	1.799	2.448	2.548	0.157	0.435	0.592	0.616	0.038	0.105	0.143	0.149
0.106	0.319	0.372	0.213	0.050	0.150	0.175	0.100	0.012	0.036	0.042	0.024	0.003	0.009	0.010	0.006
1.488	2.870	3.721	4.571	0.700	1.349	1.749	2.149	0.169	0.326	0.423	0.520	0.041	0.079	0.102	0.126
-0.638	2.233	5.316	7.123	-0.300	1.049	2.498	3.348	-0.072	0.254	0.604	0.809	-0.018	0.061	0.146	0.196
3.721	5.635	6.910	6.591	1.749	2.648	3.248	3.098	0.423	0.640	0.785	0.749	0.102	0.155	0.190	0.181
4.997	6.485	7.442	4.784	2.348	3.048	3.498	2.249	0.568	0.737	0.846	0.544	0.137	0.178	0.204	0.131
1.260	1.603	0.916	1.260	0.592	0.754	0.431	0.592	0.143	0.182	0.104	0.143	0.035	0.044	0.025	0.035
0.344	0.344	1.145	-0.573	0.161	0.161	0.538	-0.269	0.039	0.039	0.130	-0.065	0.009	0.009	0.031	-0.016
3.389	4.631	4.631	7.003	1.593	2.177	2.177	3.292	0.385	0.526	0.526	0.796	0.093	0.127	0.127	0.192
0.339	4.405	7.794	8.246	0.159	2.070	3.663	3.876	0.039	0.501	0.886	0.937	0.009	0.121	0.214	0.227
3.841	8.585	10.166	9.262	1.805	4.035	4.778	4.353	0.436	0.976	1.155	1.053	0.106	0.236	0.279	0.255
0.000	-0.773	0.773	1.105	0.000	-0.363	0.363	0.519	0.000	-0.088	0.088	0.126	0.000	-0.021	0.021	0.030
-3.424	0.552	-2.209	0.110	-1.609	0.260	-1.038	0.052	-0.389	0.063	-0.251	0.013	-0.094	0.015	-0.061	0.003
	5.081	7.953	7.953		2.388	3.738	3.738		0.577	0.904	0.904		0.140	0.219	0.219
3.977	4.971	5.523	8.506	1.869	2.336	2.596	3.998	0.452	0.565	0.628	0.967	0.109	0.137	0.152	0.234

Table 9– Test results

## **Appendix C**

### **Raw Data Collection**

# Field Test Reposts

## Test No.1

Date	11/19/2016
Time	7:30 AM
Suite	E10
Level	47 construction/52 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m3
Relative humidity	80%
Wind speed	W20 KPH

## Visual Observation

Discontinuity of weather stripping. Improper sealing at the top jamb of door frame panel. Discontinuity of exterior caulking at door frame and soffit interface. The backer rod was observable.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	8.5	9	9.8	10.5

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	9.5	12.5	14.8	16.2

Air leakage rate

Qd= EQ - Q (Scfm)	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Temperature corrected Flow Rate (Scfm)	1	3.5	5	5.7
Temperature corrected Flow Rate (L/s)	1.030	3.605	5.150	5.870
Standard air leakage (L/s/m²)	0.484	1.694	2.420	2.759
Standardized air leakage (Scfm/ft²)	0.117	0.410	0.585	0.667
Qd= EQ - Q (Scfm)	0.023	0.081	0.116	0.132



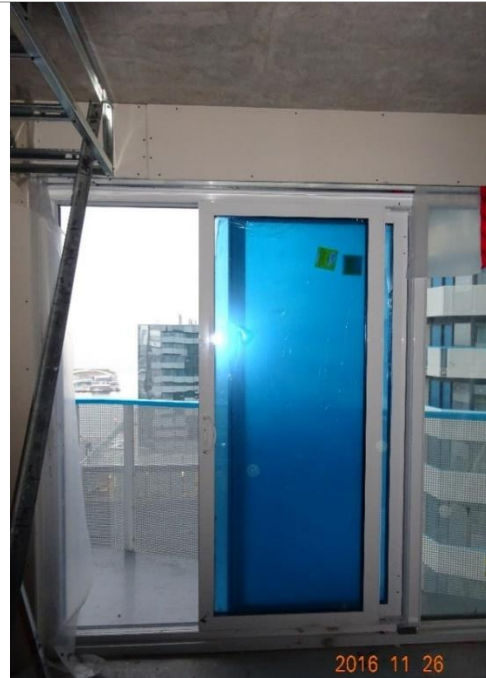
Interior view



Unit plan and location of the test unit



Exterior view



Interior view





Door track



Interior view of door head



Door track



Meeting stile at door head







Door track



Fixed frame panel joint and weather stripping



	
Door head track	Dust plug
	
Door head exterior interfaces	Door head exterior interfaces

## Discussion

As it is shown in the calculation above at the standard test pressure condition of 75 Pascal, air leakage will exceed the lab achieved results and reach to  $0.58 \text{ (L/s/m}^2\text{)}$ . Despite the higher rate of air leakage, the door has not failed as the air leakage rate does not exceed the allowed range.

The exterior interfaces joint and caulking may not be considered as part of the test specimen, but due to continuity of side frames to the concrete soffit above, if interior joint sealants has any failure, sliding door may show higher rates of air infiltration.

Discontinuity of weather stripping at door meeting stile may also contribute to slightly higher ranges of air leakage rate than the standard one.

## Test No.2

Date	11/19/2016
Time	9:00 AM
Suite	E05
Level	46 construction/51 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	W20 KPH

## Visual Observation

No specific deficiency observed at the time of review. Extra bead of sealant is applied at fixed frame corner joints.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow Q (Scfm)	10.5	10.6	12.2	13.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow EQ (Scfm)	10.1	13.9	16.5	18.8

Air leakage rate

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Qd= EQ - Q (Scfm)	-0.4	3.3	4.3	5
Temperature corrected Flow Rate (Scfm)	-0.412	2.884	4.429	5.150
Temperature corrected Flow Rate (L/s)	-0.194	1.355	2.081	2.420
Standard air leakage (L/s/m <sup>2</sup> )	-0.047	0.328	0.503	0.585
Standardized air leakage (Scfm/ft <sup>2</sup> )	-0.009	0.065	0.099	0.116



Interior view



Exterior view



Door sill track



Unit plan and location of the test unit



Door head track



Fixed frame panel joint and weather stripping

	
<p>Frame joint sealant</p>	<p>Dust plug</p>
	
<p>Exterior view of door meeting stile</p>	<p>Door head exterior interfaces</p>
	
<p>Meeting stile at door sill</p>	<p>Weather stripping at meeting stile</p>

### Discussion:

The visual inspection was showing that the door assembly is in a good shape. Extra sealant was observed, applied at fixed frame panel joints. The door has achieved the lab tested air tightness test result and performed well.

### Test No.3

Date	11/19/2016
Time	10:00 AM
Suite	E05
Level	43 construction/48 marketing

### Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

### Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	W20 KPH

### Visual Observation

No specific deficiency observed at the time of review

### Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow Q (Scfm)	8.8	14	15.1	16.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow EQ (Scfm)	9.8	14.1	16.8	19.7

Air leakage rate

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Qd= EQ - Q (Scfm)	1	0.1	1.7	3.1
Temperature corrected Flow Rate (Scfm)	1.030	0.103	1.751	2.987
Temperature corrected Flow Rate (L/s)	0.484	0.048	0.823	1.404
Standard air leakage (L/s/m <sup>2</sup> )	0.117	0.012	0.199	0.339
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.023	0.002	0.039	0.067





Exterior view



Interior view



Interior view



Fixed frame panel



door sill sliding track



door sill sliding track

	
Door head exterior interfaces	Dust plug
	
Fixed frame joint	Weather stripping

### Discussion:

As the air leakage rates are lower than the minimum lab achieved result, there may be an error during conducting field test such as reading higher extraneous air leakage rates due to improper installation of exterior chamber.

## Test No.4

Date	11/19/2016
Time	11:00 AM
Suite	E07
Level	20 construction/25 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	W20 KPH

## Visual Observation

No specific deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow Q (Scfm)	11.8	14.3	15.4	17.9

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow EQ (Scfm)	14	18.2	21.5	29.5

Air leakage rate

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Qd= EQ - Q (Scfm)	2.2	3.9	6.1	11.6
Temperature corrected Flow Rate (Scfm)	2.26	4.01	6.28	11.94
Temperature corrected Flow Rate (L/s)	1.06	1.88	2.95	5.61
Standard air leakage (L/s/m <sup>2</sup> )	0.25	0.45	0.71	1.35
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.05	0.09	0.14	0.26





Interior view



Exterior view



Interior view



Suite plan



Interior view



Interior view



Interior view



Interior view



Interior view



Interior view



Exterior view



Exterior view



	
Exterior View	Interior view
	
Interior view	Interior view
	
Interior view	Interior view

### Discussion:

Test sample exceeded laboratory test results. There was a gap between weather rubber stripping to glass pane.

## Test No.5

Date	11/19/2016
Time	1:00 PM
Suite	E10
Level	17 construction/22 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4a
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	WSW26 KPH

## Visual Observation

Door does not have any deficiency in the visual inspection.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow Q (Scfm)	9.8	10.8	12.9	13.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Air flow EQ (Scfm)	10	13.8	15.4	17.3

Air leakage rate

Pressure difference	0.1 (25 PA)	0.2 (50 PA)	0.3 (75 PA)	0.4 (100 PA)
Qd= EQ - Q (Scfm)	0.2	2	1.5	3.5
Temperature corrected Flow Rate (Scfm)	0.206	3.090	2.575	3.605
Temperature corrected Flow Rate (L/s)	0.097	1.452	1.210	1.694
Standard air leakage (L/s/m <sup>2</sup> )	0.023	0.351	0.293	0.410
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.005	0.069	0.058	0.081



Interior view



Exterior view



Door frames



Suite plan



Interior view of frame corners



Interior view of frame corners



	
Exterior view	Frame joints
	
Door track	Door hardware
	

## Discussion

Test specimen air leakage exceeded the laboratory test results at 75 pascals pressure difference.

## Test No.6

Date	11/19/2016
Time	1:30 PM
Suite	E06
Level	14 construction/19 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	WSW26 KPH

## Visual Observation

No deficiency observed at the time of review. Localized discontinuous sealant at frame joints.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	7.2	9.4	10.2	11.4

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	10.8	13.8	14.6	16.7

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	3.6	4.4	4.4	5.3
Temperature corrected Flow Rate (Scfm)	3.70	4.53	4.53	5.45
Temperature corrected Flow Rate (L/s)	1.74	2.13	2.13	2.56
Standard air leakage (L/s/m <sup>2</sup> )	0.42	0.51	0.51	0.62
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.08	0.10	0.10	0.12



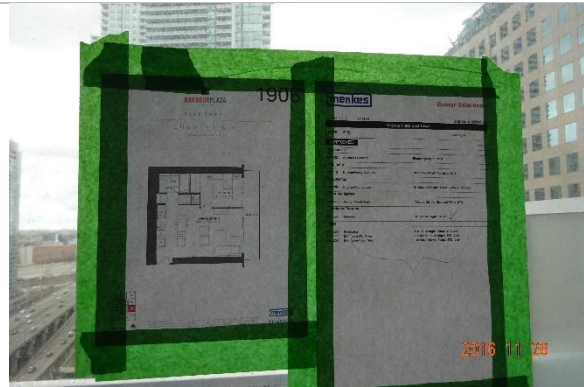
Interior view



Exterior view



Frame joints



Suite plan



Interior view



Frame joints





Door track



Door track



Frame joints



Frame joints



Frame joints



Door sill

	
Glass to frame joint	Door hardware
	
Door sill track	Dust plug area

## Discussion

Despite of localized discontinuity at frame joints sealants, air leakage rate is approximately equal to laboratory test results. The exterior frame join sealants are secondary air leakage lines of defense.

## Test No.7

Date	11/19/2016
Time	2:00 PM
Suite	E07
Level	14 construction/19 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	12°C
Temperature outside	10°C
Density of air at test site	1.24 Kg/m <sup>3</sup>
Relative humidity	80%
Wind speed	WSW26 KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	8.9	11.4	12.5	13.9

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	11.8	16.3	18.9	21.7

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	2.9	4.9	6.4	7.8
Temperature corrected Flow Rate (Scfm)	2.987	5.047	6.591	8.033
Temperature corrected Flow Rate (L/s)	1.404	2.372	3.098	3.776
Standard air leakage (L/s/m <sup>2</sup> )	0.339	0.573	0.749	0.913
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.067	0.113	0.148	0.180





Interior view



Exterior view



Exterior view



Suite plan



Frame joints



Frame joints



Frame joints



Frame joints






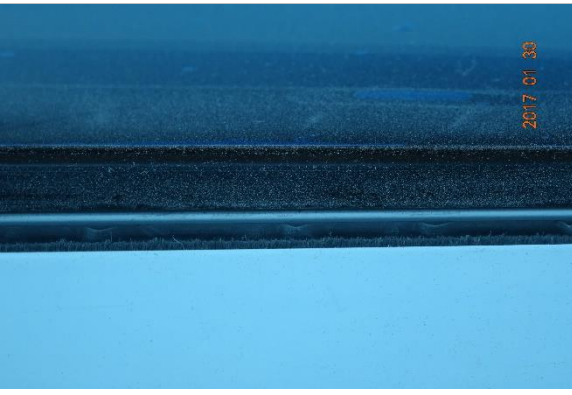


Door sill



Door sill



	
Door track	Head track
	
Frame joints	Frame joints
	
Frame joints	Glazing to frame joints

## Discussion

This test specimen is exceeding laboratory test results. Exterior soffit to door frame sealants are not properly done and could contribute to overall air leakage in case of any interior door secant failures.

## Test No.8

Date	12/01/2016
Time	10:27 AM
Suite	E03
Level	64 construction/69 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a or 1b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	7°C
Temperature outside	5°C (Feels like -3 °C)
Density of air at test site	1.307Kg/m <sup>3</sup>
Relative humidity	70%
Wind speed	WSW 38 KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

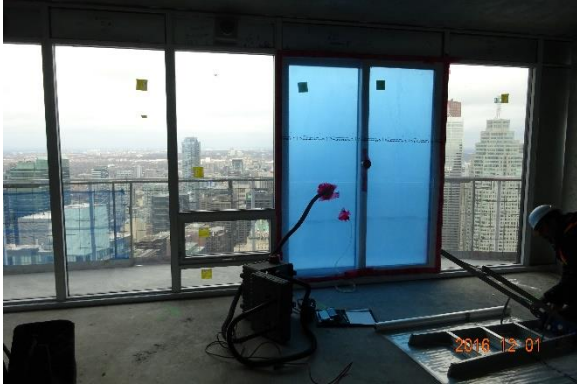
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	12.2	13.5	14.7	16.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	12.3	19.8	21.4	22.8

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	2.9	4.9	6.4	7.8
Temperature corrected Flow Rate (Scfm)	0.109	6.839	7.273	6.513
Temperature corrected Flow Rate (L/s)	0.051	3.214	3.418	3.061
Standard air leakage (L/s/m <sup>2</sup> )	0.012	0.729	0.775	0.694
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.002	0.144	0.153	0.137



Interior view



Exterior view



Interior view



Interior view of bulk head



Interior view



Frame joints



	
<p>Frame joints</p>	<p>Door hardware</p>
	
<p>Interior view of door sill to concrete slab</p>	<p>Exteriro view of soffit to door frame</p>

## Discussion

Test sample air leakage rate exceeded laboratory air leakage test result.

## Test No.9

Date	12/01/2016
Time	11:27 AM
Suite	E07
Level	64 construction/69 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	7°C
Temperature outside	5°C (Feels like -3 °C)
Density of air at test site	1.307Kg/m <sup>3</sup>
Relative humidity	70%
Wind speed	WSW 38 KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	7.2	9.2	10.8	11.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	9.1	12.6	15.3	16.2

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	2.1	3.4	4.5	4.2
Temperature corrected Flow Rate (Scfm)	2.063	3.691	4.885	4.776
Temperature corrected Flow Rate (L/s)	0.969	1.735	2.296	2.245
Standard air leakage (L/s/m <sup>2</sup> )	0.220	0.393	0.521	0.509
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.050	0.089	0.118	0.115



Interior view



Exterior view

## Discussion

Test sample air leakage slightly exceeded air leakage laboratory test result.

## Test No.10

Date	12/01/2016
Time	12:32 PM
Suite	E03
Level	58 construction/63 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a or 1b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	7°C
Temperature outside	6°C (Feels like -2 °C)
Density of air at test site	1.307Kg/m <sup>3</sup>
Relative humidity	70%
Wind speed	W 24 KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

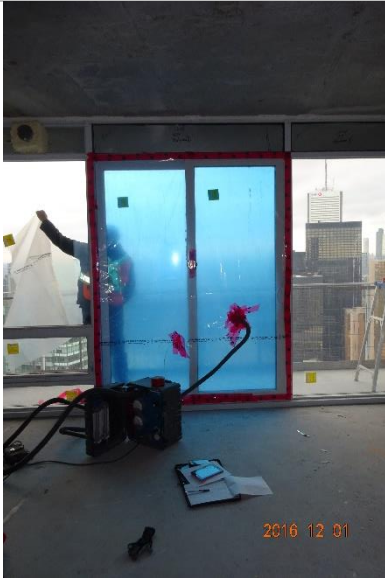
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (Scfm)	9.8	10.5	12.2	14.7

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (Scfm)	10.3	14.8	15.5	20.9

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.5	4.3	3.3	6.2
Temperature corrected Flow Rate (Scfm)	0.543	4.668	3.582	6.730
Temperature corrected Flow Rate (L/s)	0.255	2.194	1.684	3.163
Standard air leakage (L/s/m <sup>2</sup> )	0.058	0.497	0.382	0.717
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.013	0.113	0.087	0.163



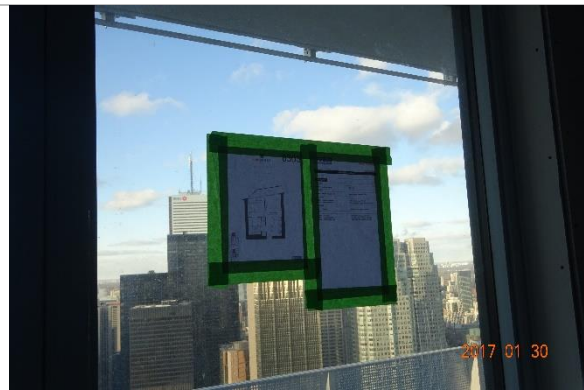
Interior view



Exterior view



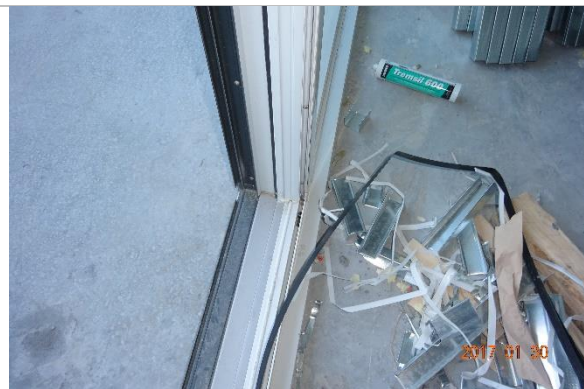
Bulk head



Unit plan



Frame joints



Door sill frame and track



	
Door hardware	Frame joints
	
Exterior frame to soffit joints	Glazing to frame joints

## Discussion

Test sample air leakage result is below laboratory air leakage result at 75 pascal pressure difference.

## Test No.11

Date	12/01/2016
Time	1:14 PM
Suite	E09
Level	54construction/59 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	6°C (Feels like -2 °C)
Density of air at test site	1.307Kg/m <sup>3</sup>
Relative humidity	70%
Wind speed	W 24 KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

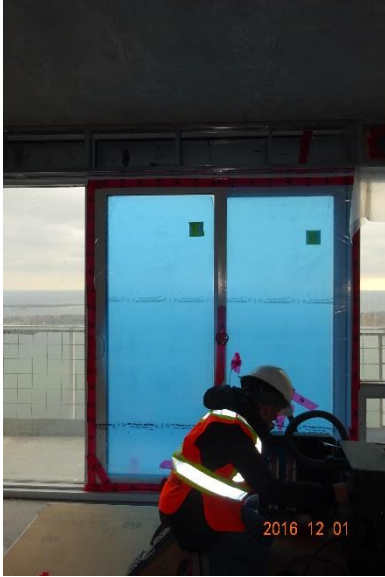
Pressure Difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.1	9.4	11.9	12.4

Extraneous air flow rate at nonstandard condition

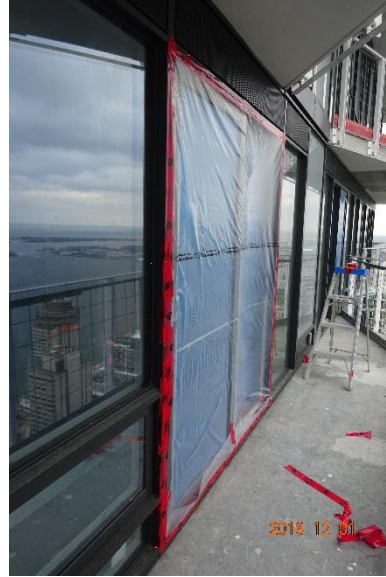
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	8.8	14.7	16.8	19.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	0.760	5.458	5.319	7.273
Temperature corrected Flow Rate (L/s)	0.357	2.565	2.500	3.418
Standard air leakage (L/s/m <sup>2</sup> )	0.086	0.620	0.604	0.827
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.021	0.150	0.146	0.200



Interior view



Exterior view

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.



## Test No.12

Date	12/01/2016
Time	3:23 PM
Suite	E07
Level	10construction/15 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	6°C (Feels like -2 °C)
Density of air at test site	1.307Kg/m <sup>3</sup>
Relative humidity	70%
Wind speed	W 24 KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.7	9.7	11.8	12.6

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	11.8	14.9	17.1	19.4

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	3.1	5.2	5.3	5.8
Temperature corrected Flow Rate (Scfm)	3.365	5.355	5.753	7.382
Temperature corrected Flow Rate (L/s)	1.582	2.517	2.704	3.469
Standard air leakage (L/s/m <sup>2</sup> )	0.382	0.609	0.654	0.839
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.092	0.147	0.158	0.203



Interior view



Unit plan



Exterior view



Frame joints



Door track



Glass to frame joint

	
<p>Door head</p>	<p>Door jamb</p>
	
<p>Door head</p>	<p>Door hardware</p>
	
<p>Frame joint</p>	<p>Door sill</p>



Dust plug



Door frame to concrete soffit



Exterior view



Door sill



Door meeting stile



Door meeting stile



	
<p>Frame joint</p>	<p>Dust plug</p>
	
<p>Weather stripping</p>	<p>Weather stripping</p>
	
<p>Frame joint sealant</p>	<p>Door track joint</p>

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.13

Date	12/01/2016
Time	4:15 PM
Suite	E06
Level	11construction/16 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	6°C (Feels like -2 °C)
Density of air at test site	1.307Kg/m3
Relative humidity	70%
Wind speed	W 24 KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	7.8	9.8	10.3	11.3

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	20.5	23.8	27.1	30.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	13.786	14.419	18.237	20.408
Temperature corrected Flow Rate (L/s)	6.480	6.777	8.571	9.592
Standard air leakage (L/s/m <sup>2</sup> )	1.567	1.639	2.073	2.319
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.379	0.396	0.501	0.561



Frame joints



Frame joint



Glass to frame



Door track



Door track



Meeting stile



	
<p>Frame and track joints</p>	<p>Weather stripping</p>
	
<p>Frame and track joints</p>	<p>Frame and track joints</p>
	
<p>Door rubber sealant</p>	<p>Door frame to concrete slab</p>

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

This test is excluded from test results analysis due to out-performance.



## Test No.14

Date	12/03/2016
Time	8:54 AM
Suite	E09
Level	53 construction/58 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	4a
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	2°C
Density of air at test site	1.28 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 11 KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

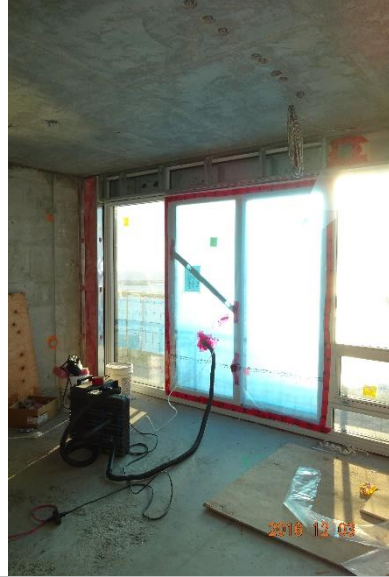
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	10.9	11	12.3	13.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	11.4	14.6	16.3	18.4

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	0.53	3.82	4.25	4.89
Temperature corrected Flow Rate (L/s)	0.25	1.79	1.99	2.29
Standard air leakage (L/s/m <sup>2</sup> )	0.06	0.43	0.48	0.55
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.01	0.10	0.11	0.13



Interior view

## Discussion

Test sample air leakage result is below laboratory air leakage result at 75 pascal pressure difference.

## Test No.15

Date	12/03/2016
Time	9:30 AM
Suite	E07
Level	53 construction/58 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	2°C
Density of air at test site	1.28 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 11 KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.3	9.2	12.8	13.2

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	11.8	16.9	20.2	24.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	3.72	8.18	7.86	11.58
Temperature corrected Flow Rate (L/s)	1.74	3.84	3.69	5.44
Standard air leakage (L/s/m <sup>2</sup> )	0.42	0.93	0.89	1.31
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.10	0.22	0.21	0.31



Interior view

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.16

Date	12/03/2016
Time	10:10 AM
Suite	E06
Level	53 construction/58 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	5°C
Temperature outside	4°C
Density of air at test site	1.27 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WNW 25KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

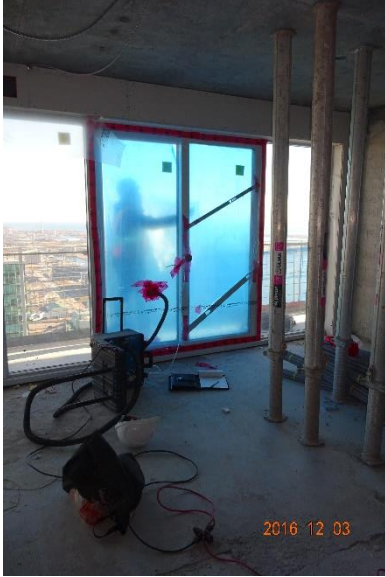
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	6.2	6.9	1.15	9

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	10.1	14.05	17.5	21.3

Air leakage rate

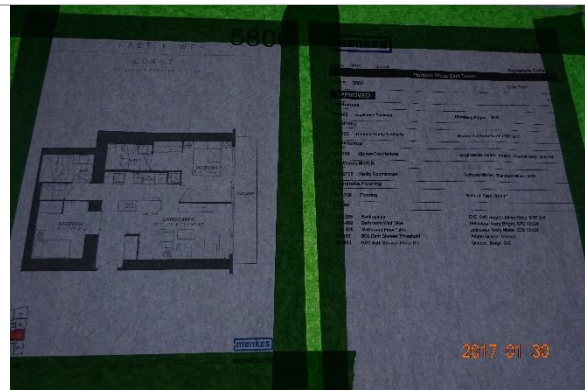
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	4.146	7.601	17.382	13.076
Temperature corrected Flow Rate (L/s)	1.949	3.573	8.170	6.146
Standard air leakage (L/s/m <sup>2</sup> )	0.471	0.864	1.975	1.486
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.114	0.209	0.478	0.359



Interior view



Door sill



Unit plan



Door head frames



Door sill frames



Door track and frame



Frame and track joints



Track joint



Dust plug and door track



Door sill



Door hardware

	
Door head frame joint	Bulk head view

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

This test is excluded from test results analysis due to out-performance.



## Test No.17

Date	12/03/2016
Time	10:30 AM
Suite	E04
Level	50 construction/55 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	7°C
Temperature outside	4°C
Density of air at test site	1.27 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WNW 25KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition




Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.4	9.1	10.1	12.2

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	15.1	18	19.3	22.4

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	7.12	9.46	9.78	10.84
Temperature corrected Flow Rate (L/s)	3.34	4.44	4.59	5.09
Standard air leakage (L/s/m <sup>2</sup> )	0.80	1.07	1.11	1.23
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.19	0.26	0.26	0.29

	
Frame joint	Unit plan
	
Interior view	Door head joint

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.18

Date	12/03/2016
Time	11:00 AM
Suite	E10
Level	50 construction/55 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	8°C
Temperature outside	5°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WNW 25KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	7.6	8.9	10.5	12

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	8.9	12.5	15.4	17.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	1.3	5.3	4.9	5.1
Temperature corrected Flow Rate (Scfm)	1.382	3.827	5.209	5.422
Temperature corrected Flow Rate (L/s)	0.650	1.799	2.448	2.548
Standard air leakage (L/s/m <sup>2</sup> )	0.157	0.435	0.592	0.616
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.038	0.105	0.143	0.149



Interior view

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.19

Date	12/03/2016
Time	11:30 AM
Suite	E10
Level	38 construction/43 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a or 1b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	8°C
Temperature outside	5°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 22 Kph

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

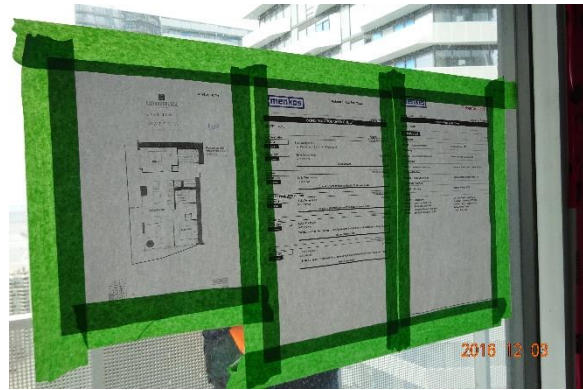
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.9	12.2	14.05	16.2

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	9	12.5	14.4	16.4

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.1	0.3	0.35	0.2
Temperature corrected Flow Rate (Scfm)	0.10	0.31	0.37	0.21
Temperature corrected Flow Rate (L/s)	0.05	0.15	0.17	0.10
Standard air leakage (L/s/m <sup>2</sup> )	0.01	0.03	0.04	0.024
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.003	0.009	0.01	0.006



## Discussion

Test sample air leakage result is way below laboratory air leakage result at 75 pascal pressure difference. This test is excluded from test results analysis due to out-performance.

## Test No.20

Date	12/03/2016
Time	01:00 PM
Suite	E4
Level	35 construction/40 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	1a
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	10°C
Temperature outside	7°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 22 Kph

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	6.8	8.5	10.5	11.9

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	8.2	11.2	14	16.2

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	1.4	2.7	3.5	4.1
Temperature corrected Flow Rate (Scfm)	1.488	2.870	3.721	4.571
Temperature corrected Flow Rate (L/s)	0.700	1.349	1.749	2.149
Standard air leakage (L/s/m <sup>2</sup> )	0.169	0.326	0.423	0.520
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.041	0.079	0.102	0.126



## Discussion

Test sample air leakage result is below laboratory air leakage result at 75 pascal pressure difference.



## Test No.21

Date	12/03/2016
Time	01:00 PM
Suite	E05
Level	35 construction/40 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	10°C
Temperature outside	7°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WNW 20KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.5	11.2	11.4	13.2

Extraneous air flow rate at nonstandard condition

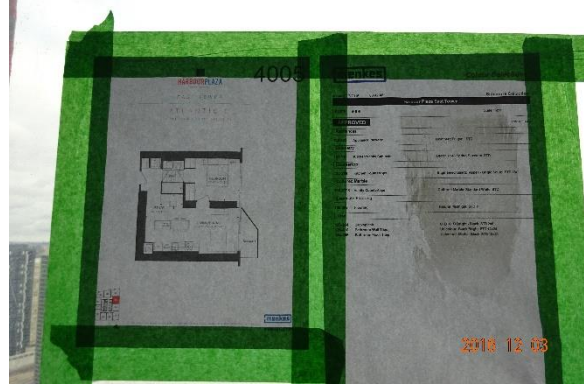
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	7.9	13.3	16.4	19.9

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	-0.638	2.233	5.316	7.123
Temperature corrected Flow Rate (L/s)	-0.300	1.049	2.498	3.348
Standard air leakage (L/s/m <sup>2</sup> )	-0.072	0.254	0.604	0.809
Standardized air leakage (Scfm/ft <sup>2</sup> )	-0.018	0.061	0.146	0.196



Interior view



Unit plan

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.22

Date	12/03/2016
Time	02:14 PM
Suite	E07
Level	26 construction/31 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	10°C
Temperature outside	7°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 24KHP

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	7.8	8.7	8.9	11.3

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	11.3	14	15.4	17.5

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	3.5	5.3	6.3	6.2
Temperature corrected Flow Rate (Scfm)	3.721	5.635	6.910	6.591
Temperature corrected Flow Rate (L/s)	1.749	2.648	3.248	3.098
Standard air leakage (L/s/m <sup>2</sup> )	0.423	0.640	0.785	0.749
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.102	0.155	0.190	0.181



Interior view



Unit plan

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.23

Date	12/03/2016
Time	02:46 PM
Suite	E05
Level	26 construction/31 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	5b
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	8°C
Temperature outside	7°C
Density of air at test site	1.269 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	NW 18KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.5	12.2	15.3	20.4

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	13.2	18.3	22.3	24.9

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	4.7	6.1	7	4.5
Temperature corrected Flow Rate (Scfm)	4.997	6.485	7.442	4.784
Temperature corrected Flow Rate (L/s)	2.348	3.048	3.498	2.249
Standard air leakage (L/s/m <sup>2</sup> )	0.568	0.737	0.846	0.544
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.137	0.178	0.204	0.131



Interior view



Unit plan

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.24

Date	12/16/2016
Time	08:30 AM
Suite	E07
Level	36 construction/41 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	
Temperature outside	(-7) °C - Feels (-17) °C
Density of air at test site	1.379 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	W31KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

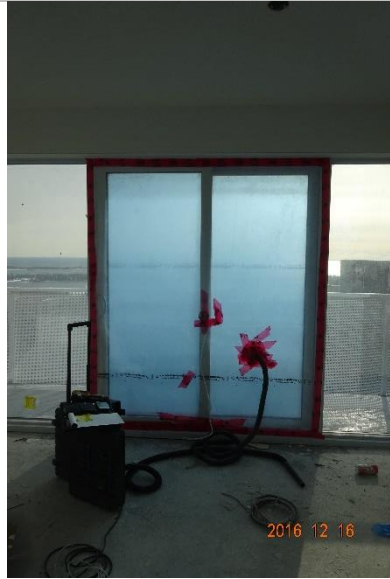
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	7.8	11	14.1	15.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	8.9	12.4	14.9	16.9

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	1.1	1.4	0.8	1.1
Temperature corrected Flow Rate (Scfm)	1.260	1.603	0.916	1.260
Temperature corrected Flow Rate (L/s)	0.592	0.754	0.431	0.592
Standard air leakage (L/s/m <sup>2</sup> )	0.143	0.182	0.104	0.143
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.035	0.044	0.025	0.035



Interior view



Unit plan

## Discussion

Test sample air leakage result is way below laboratory air leakage result at 75 pascal pressure difference.

This test is excluded from test results analysis due to out-performance.



## Test No.25

Date	12/16/2016
Time	10:00 AM
Suite	E05
Level	36 construction/41 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	
Temperature outside	(-7) °C - Feels (-17) °C
Density of air at test site	1.379 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	W31KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

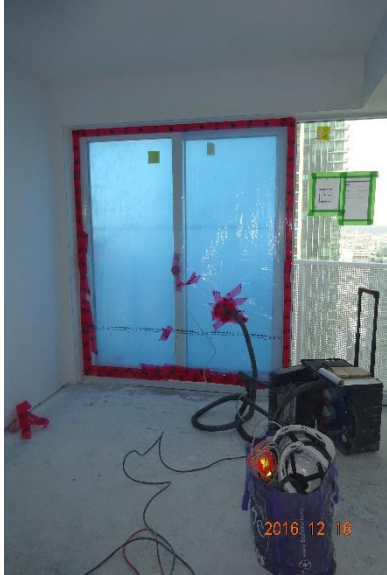

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Air flow Q (scfm)</b>	7.8	8.9	10.1	12.7

Extraneous air flow rate at nonstandard condition

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Air flow EQ (scfm)</b>	8.1	9.2	11.1	12.2

Air leakage rate

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Qd= EQ - Q (Scfm)</b>	0.3	0.3	1.1	0.5
<b>Temperature corrected Flow Rate (Scfm)</b>	0.344	0.344	1.145	-0.573
<b>Temperature corrected Flow Rate (L/s)</b>	0.161	0.161	0.538	-0.269
<b>Standard air leakage (L/s/m<sup>2</sup>)</b>	0.039	0.039	0.130	-0.065
<b>Standardized air leakage (Scfm/ft<sup>2</sup>)</b>	0.009	0.009	0.031	-0.016

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<p>Interior view</p>	<p>Unit plan</p>

## Discussion

Test sample air leakage result is below laboratory air leakage result at 75 pascal pressure difference.

This test is excluded from test results analysis due to out-performance.

## Test No.26

Date	12/16/2016
Time	12:17 PM
Suite	E06
Level	23 construction/27 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	
Temperature outside	(-5) °C - Feels (-14) °C
Density of air at test site	1.36 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WSW29KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow q (scfm)	11.2	15.3	17.8	19.9

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow eq (scfm)	14.2	19.4	21.9	26.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	3.389	4.631	4.631	7.003
Temperature corrected Flow Rate (L/s)	1.593	2.177	2.177	3.292
Standard air leakage (L/s/m <sup>2</sup> )	0.385	0.526	0.526	0.796
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.093	0.127	0.127	0.192





Smoke pencil test



Smoke pencil test



Smoke pencil test



Smoke pencil test





Smoke pencil test



Smoke pencil test



Smoke pencil test



Smoke pencil test



Frame joit



Frame joint



Door head frame and track



Frame joint



Door corner



Door hardware



Window frame to soffit



Exterior view





Door sill track



Door head track



Exterior view



Door tack



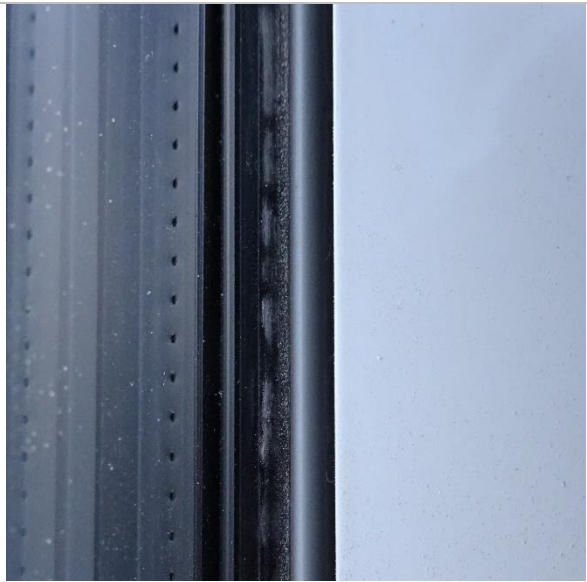
Frame joint





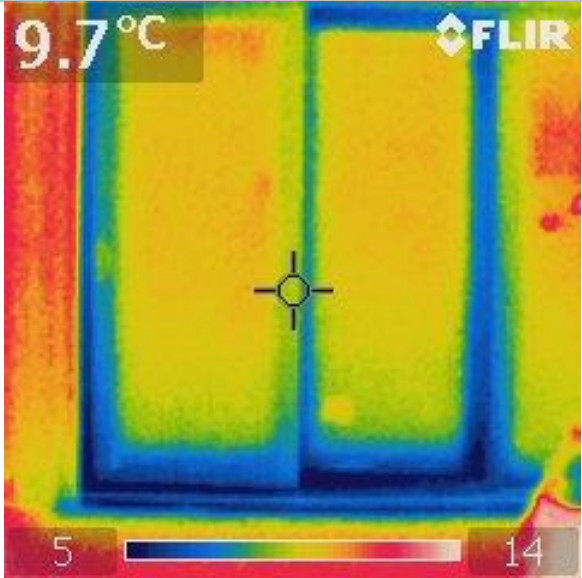
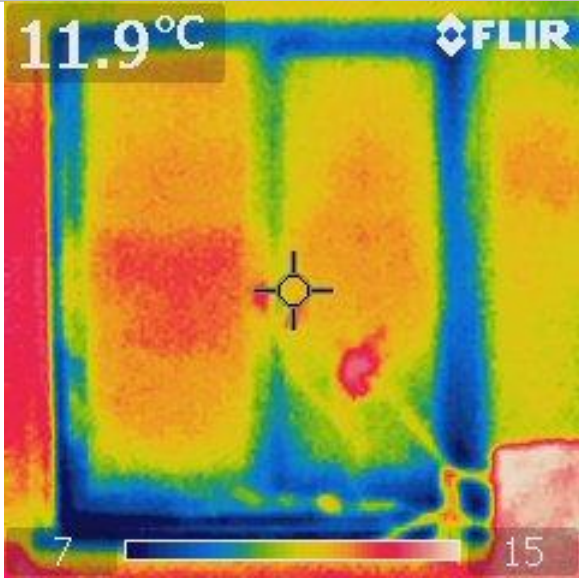
Sash joint



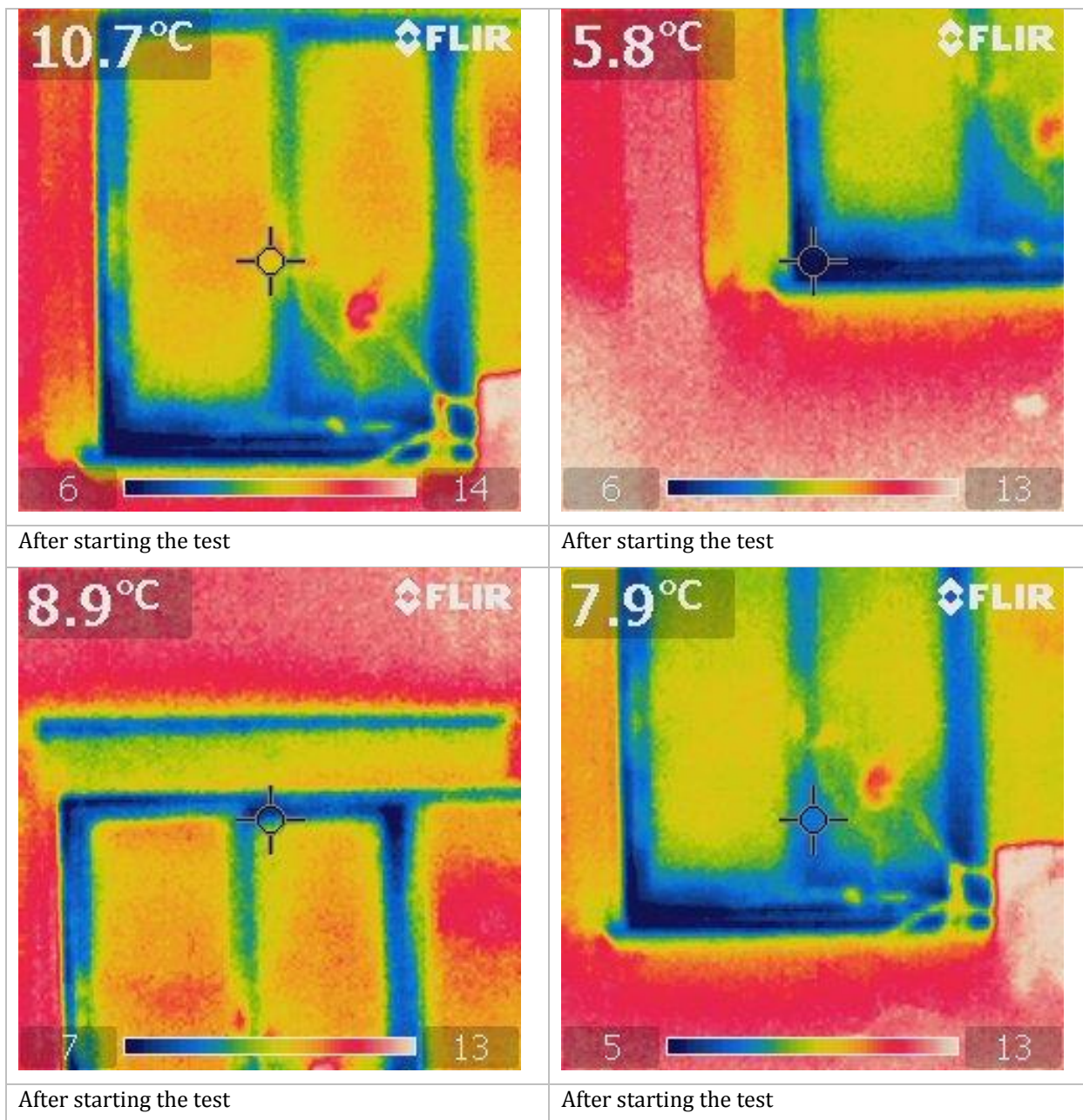
Sash corner joint

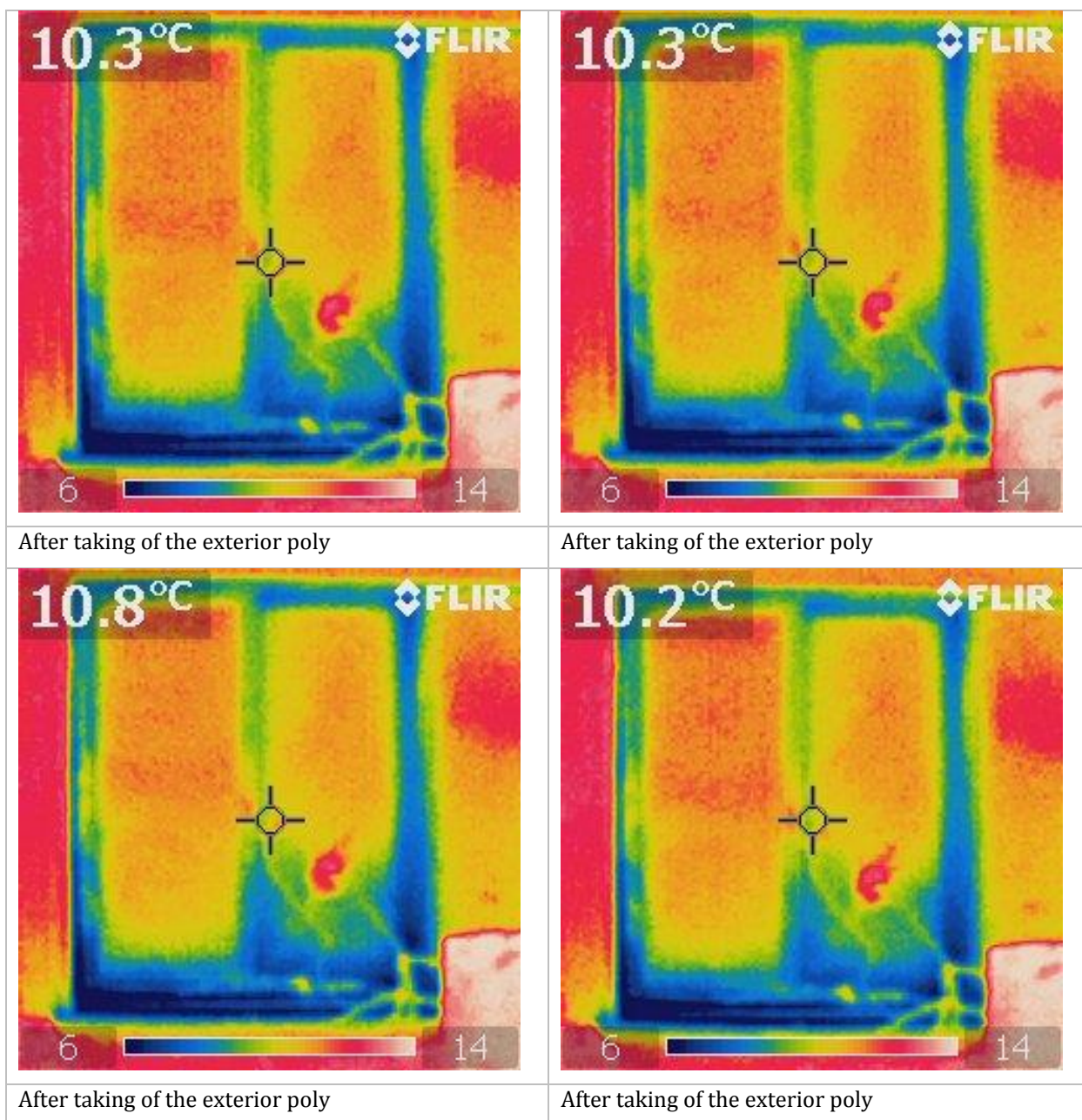


Glass to sash joint

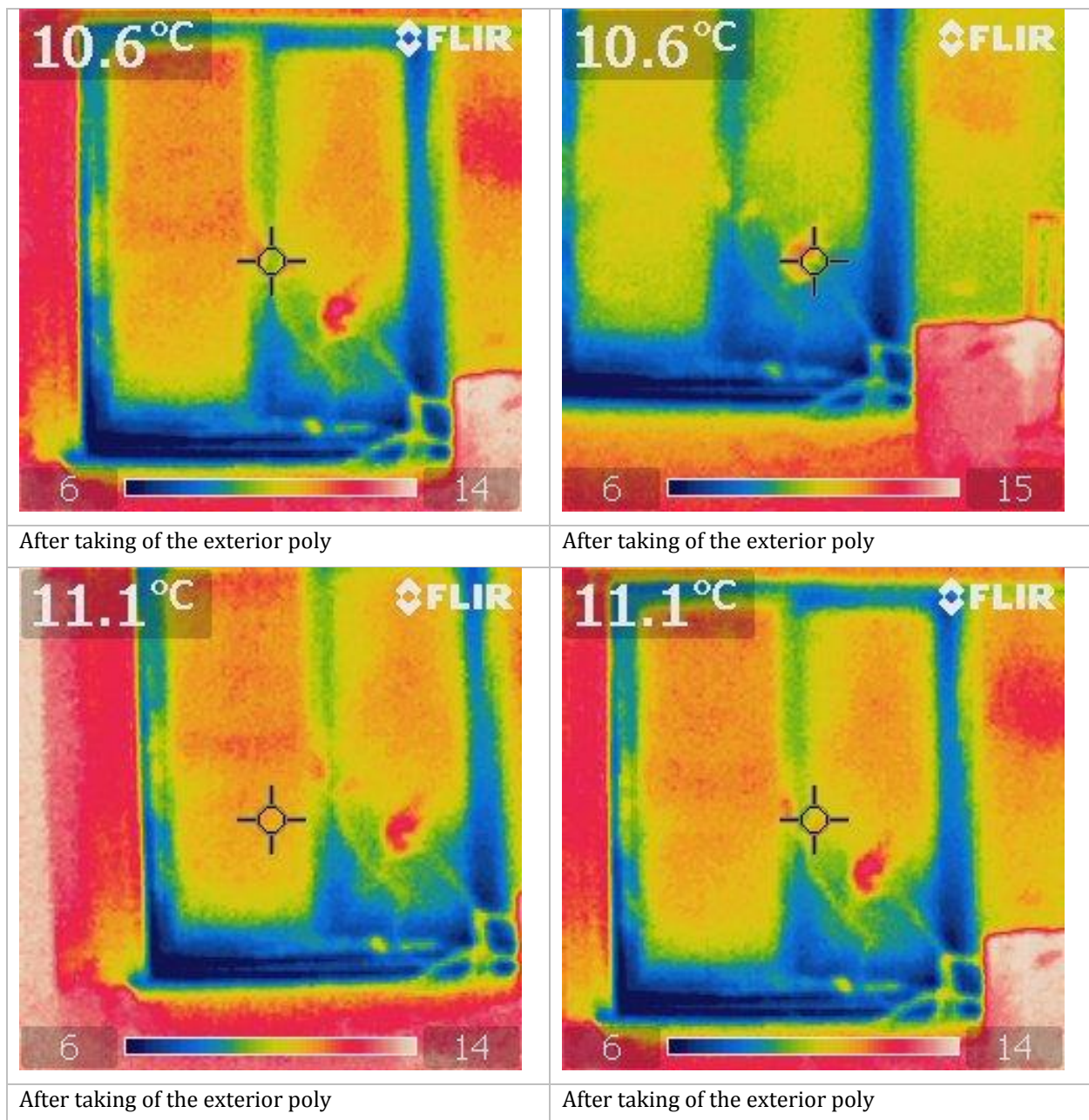
	
Sash corner	Glass to sash joint
Termography capturing	
	
Before test	After starting the test











## Discussion

Test sample air leakage result is slightly above laboratory air leakage result at 75 pascal pressure difference. This test is excluded from test results analysis due to out-performance.

## Test No.27

Date	12/16/2016
Time	01:40 PM
Suite	E07
Level	23 construction/27 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	
Temperature outside	(-5) °C - Feels (-14) °C
Density of air at test site	1.35 Kg/m <sup>3</sup>
Relative humidity	50%
Wind speed	WSW24KPH

## Visual Observation

No deficiency observed at the time of review.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	9.9	11.2	12.9	14.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	10.2	15.1	19.8	22.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.3	3.9	6.9	7.3
Temperature corrected Flow Rate (Scfm)	0.339	4.405	7.794	8.246
Temperature corrected Flow Rate (L/s)	0.159	2.070	3.663	3.876
Standard air leakage (L/s/m <sup>2</sup> )	0.039	0.501	0.886	0.937
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.009	0.121	0.214	0.227



Interior view



Unit plan

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.



## Test No.28

Date	12/16/2016
Time	02:50 PM
Suite	E05
Level	23 construction/27 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	
Temperature outside	(-5) °C - Feels (-14) °C
Density of air at test site	1.35 Kg/m3
Relative humidity	
Wind speed	WSW24KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	11.8	13.5	15.4	16.8

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	15.2	21.1	24.4	25

Air leakage rate

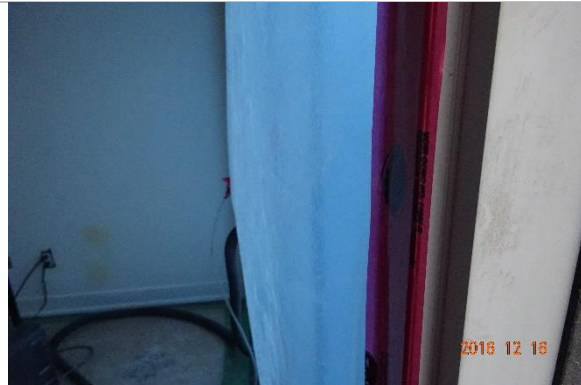
Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	3.4	7.6	9	9
Temperature corrected Flow Rate (Scfm)	3.841	8.585	10.166	9.262
Temperature corrected Flow Rate (L/s)	1.805	4.035	4.778	4.353
Standard air leakage (L/s/m <sup>2</sup> )	0.436	0.976	1.155	1.053
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.106	0.236	0.279	0.255



Interior view



Interior view



Interior view



Smoke pencil test



Smoke pencil test



Smoke pencil test



Meeting stile



Sash joint




Sash joint



Interior view



Interior view

	
Exterior view	Weather stripping
	
Door sill	Door head
	
Glass to frame joints	

## Discussion

Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.

## Test No.29

Date	12/28/2016
Time	10:00 AM
Suite	E07
Level	49 construction/54 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	Very Hot
Temperature outside	(0) °C - Feels (-8)
Density of air at test site	1.33 Kg/m <sup>3</sup>
Relative humidity	
Wind speed	W25KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	3.8	7.9	9.8	12.1

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	3.8	7.2	10.5	13.1

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0	0.6	0.7	1.0
Temperature corrected Flow Rate (Scfm)	0.000	-0.773	0.773	1.105
Temperature corrected Flow Rate (L/s)	0.000	-0.363	0.363	0.519
Standard air leakage (L/s/m <sup>2</sup> )	0.000	-0.088	0.088	0.126
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.000	-0.021	0.021	0.030





Interior view



Door hardware



Unit plan



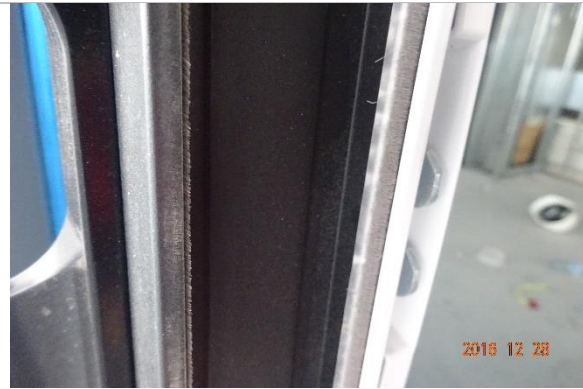
Door hardware



Smoke pencil test



Weather stripping



Weather stripping



Door sill





Door sill



Dust plug



Exterior view

	
Door frame to concrete soffit	Bulk head

## Discussion

Interior view Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference. This test is excluded from test results analysis due to out-performance.



## Test No.30

Date	12/28/2016
Time	12:10 PM
Suite	E04
Level	49 construction/54 marketing

## Sample Descriptions

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	Very Hot
Temperature outside	(0) °C - Feels (-8)
Density of air at test site	1.33 Kg/m <sup>3</sup>
Relative humidity	
Wind speed	W25KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow q (scfm)	7.1	12.2	17.2	19.7

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow eq (scfm)	4	12.7	15.2	19.8

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (SCFM)	0.7	5.3	4.9	6.7
Temperature corrected qdst (scfm)	0.543	4.668	3.582	6.730
Temperature corrected qdst (l/s)	0.255	2.194	1.684	3.163
Standard air leakage (l/s/m <sup>2</sup> )	0.058	0.497	0.382	0.717
Standardized air leakage (scfm/ft <sup>2</sup> )	0.013	0.113	0.087	0.163



Interior view



Unit plan



Door head



Door head



Frame joint



Door sill sash joint

	
Smoke pencil test	Smoke pencil test
	
Door frame to soffit joint	Door sill
	
Frame joint	Dust plug

## Discussion

Interior view Test sample air leakage result is below laboratory air leakage result at 75 pascal pressure difference. This test is excluded from test results analysis due to out-performance.

## Test No.31

Date	12/28/2016
Time	02:00 PM
Suite	E04
Level	48 construction/53 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	Very Hot
Temperature outside	(0) °C - Feels (-8)
Density of air at test site	1.33 Kg/m <sup>3</sup>
Relative humidity	
Wind speed	W25KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Air flow Q (scfm)</b>		7.2	7.5	8.7

Extraneous air flow rate at nonstandard condition

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Air flow EQ (scfm)</b>	8.1	11.8	14.7	15.9

Air leakage rate

<b>Pressure difference</b>	<b>0.1 (25 pa)</b>	<b>0.2 (50 pa)</b>	<b>0.3 (75 pa)</b>	<b>0.4 (100 pa)</b>
<b>Qd= EQ - Q (Scfm)</b>		4.6	7.2	7.2
<b>Temperature corrected Flow Rate (Scfm)</b>		5.081	7.953	7.953
<b>Temperature corrected Flow Rate (L/s)</b>		2.388	3.738	3.738
<b>Standard air leakage (L/s/m<sup>2</sup>)</b>		0.577	0.904	0.904
<b>Standardized air leakage (Scfm/ft<sup>2</sup>)</b>		0.140	0.219	0.219





Door frame joint



Unit plan



Frame joint



Door head



Frame joint



Door sill

	
Frame joint sealant	Door track
	
Dust plug	Dust plug and weather stripping
	
Exterior door frame to soffit	Abandoned screw holes

## Discussion

Interior view Test sample air leakage result is above laboratory air leakage result at 75 pascal

## Test No.32

Date	12/28/2016
Time	03:30 PM
Suite	E04
Level	54 construction/59 marketing

## Sample Description

Model	Double glazed, Argon gas filled
Door type	6 mm ESR42 Temp (PURCH) / 1" Black spacer/6 mm CLR Temp (PURCH)
Assembly Type	
Size	2260 mm x1830 mm
Operation type	Sliding door

## Ambient Test Condition

Temperature inside	-1° C
Temperature outside	(-1)°C - Feels (-8)°C
Density of air at test site	1.33 Kg/m3
Relative humidity	
Wind speed	W25KPH

## Visual Observation

No deficiency observed in the sample.

## Readings

Air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow Q (scfm)	8.2	12.3	14.8	16.2

Extraneous air flow rate at nonstandard condition

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Air flow EQ (scfm)	11.8	16.8	19.8	23.9

Air leakage rate

Pressure difference	0.1 (25 pa)	0.2 (50 pa)	0.3 (75 pa)	0.4 (100 pa)
Qd= EQ - Q (Scfm)	0.7	5.3	4.9	6.7
Temperature corrected Flow Rate (Scfm)	3.977	4.971	5.523	8.506
Temperature corrected Flow Rate (L/s)	1.869	2.336	2.596	3.998
Standard air leakage (L/s/m <sup>2</sup> )	0.452	0.565	0.628	0.967
Standardized air leakage (Scfm/ft <sup>2</sup> )	0.109	0.137	0.152	0.234





Exterior view



Interior view



Frame joint



Sash joint



Sash joint



Door sill

	
<p>Interior view</p>	<p>Door meeting stile</p>
	
<p>Door meeting stile</p>	<p>Interior view</p>
	
<p>Smoke pencil test</p>	<p>Smoke pencil test</p>

## Discussion

Interior view Test sample air leakage result is above laboratory air leakage result at 75 pascal pressure difference.