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Evaluating the Potential to Achieve Passive House with Structural Insulated Panels using a Case Study in Toronto, Canada

by

LORETA BRAZUKAS,

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Abstract

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Loreta Brazukas, Ryerson University

A home in Toronto recently re-constructed with Structural Insulated Panels (SIPs) was analyzed and an energy simulation using HOT2000 and PHPP was created based on the current state of the house. The simulations were used to determine compliance with the Canadian R-2000 standard and the Passive House standard. The building met the R-2000 standard in its current state. Further analysis was required in order to determine design changes that may be made to achieve Passive House. This research determined the applicability of SIPs to achieve these standards in the context of the subject home. Through the redesign of the building enclosure assemblies and the elimination of the thermal bridges through the envelope, the Passive House standard was achieved using a double wall stud SIP. A number of design changes were also required including better performing windows and HRV as well as the addition of glazing to the south façade and removal of glazing on other facades. These design changes were then applied to HOT2000 and it was found that the Passive House building achieved an energy savings of 60% compared to the R-2000 standard baseline.

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1. Introduction

1.1. Overview

Canada's residential housing stock was responsible for 16% of Canada's total energy consumption in 2007 (NRCan, 2010). There is an increasing concern regarding the reduction of energy use at the residential level. The new Ontario Building Code (including SB-10) and the National Energy Code of Canada are attempting to resolve some of these issues (Ministry of Municipal Affairs and Housing, 2011). One potential technology that has not been widely used that may contribute to the reduction in energy usage of residential homes is Structurally Insulated Panels (SIPs). The use of these panels in current construction practice is small and there is a need for more research to determine the benefits of using SIPs. The ability for residential construction to reach net Zero or Passive House standards is challenging with current construction practices in Canada's cold climate. In order to achieve low-energy performance goals in the future, there is a need to introduce new construction materials and building practices.

The thermal envelope of buildings is the first step in determining overall energy efficiency improvements to the building particularly with new construction efforts. The mechanical and electrical loads of the building can be reduced when improving the building enclosure first. The building enclosure should maximize thermal resistance as well as minimize the amount of air leakage through the envelope and increase thermal comfort. While optimizing the building enclosure, one commonly overlooked and energy intensive component is the amount of air leakage through the building envelope. The most common issue with reducing the air leakage in the building is due to poor craftsmanship and imperfect materials. One way to improve this is to use prefabricated walls that are designed and manufactured to fit perfectly together. SIPs provide a very unique construction in the building wall assemblies. They consist of 3 layers of materials as a unit and are built consistently due to the controlled manufacturing process. They will typically not allow any air movement within them which results in no convection occurring and so there are minimal condensation risks. The entire factory manufactured wall panel is airtight and leakage can only occur at the splines or other connections in the building.

As SIPs are produced in a controlled environment at a factory they are typically more consistent than walls installed onsite (Christian 2006). SIPs can replace exterior walls and roof components to one pre-manufactured modular construction solution. This effect onsite is that one product is now being purchased and installed instead of many separate products: structural studs, insulation, oriented strandboard. SIPs have been shown to be easy to install and without much more effort can significantly increase the air tightness of a building envelope (Christian 2006).

Obtaining Passive House certification requires an extremely tight envelope that is difficult to achieve with conventional construction practices. An EnerGuide for Houses residential housing audit found that across Canada the average air leakage rates for homes built as recently as 2005 (most recent data available) was 5 ACH at 50 Pa (Gamtessa, 2005). The majority of these homes were conventional wood stud framing. The requirement for Passive House Certification is 0.6 ACH at 50 Pa, which is a reduction in air leakage of 88%. The key benefit of using SIPs is that they are factory built and designed to fit together in an airtight way. They can be constructed easier and faster on site due to the fact that they have been pre-designed. They come pre-cut for the specific project. Also, due to the reduction in thermal bridging when using SIP products, the thermal comfort of the home increases.

The research approach in order to optimize residential building construction included analyzing a building that has been re-constructed with SIPs and then reviewing potential improvements that can be made. The research included collecting actual data onsite and then developing various energy models. Energy models consisted of Passive House Planning Package software and HOT2000. The models included a comparison between the home with SIPs and redesigning the home in order to achieve Passive House certification.

The results will show the effectiveness of using SIP materials to aid in energy efficiency improvements of the home. The research will quantify the benefits of SIP construction in terms of annual energy savings and with respect to the Canadian R-2000 standard and the Passive House standard.

1.2. Objective

The objective of the research is to investigate the energy performance of Structural Insulated Panels through the analysis of a case study that was recently re-constructed with SIPs. The goal of the simulation will be to determine the potential energy improvements that would be required to achieve Passive House standard. The research questions that will be answered through this research are:

- Can Structural Insulated Panels help in the achievement of Passive House?
- What specific minimum changes would be required to achieve Passive House standards for the case study home?
- How would the case study home (as designed to meet Passive House) then compare with average Canadian Homes and the R2000 standard?

1.3. Methodology

The methodology used in achieving the objective is as follows:

1. Research and understand current uses of structural insulated panels particularly in high performance buildings.
2. Review current market and uses of SIPs in Canada
3. Determine what materials are currently being used and which are available in the industry, with the goal of determining an optimum SIP
4. Case Study of SIP home in Toronto;
    a. Documentation review of drawings and design data
    b. Field measurements and data analysis including a site visit to the home,

   c. Blower door testing,
   d. Thermography scan,
   e. Utility consolidation and analysis.
5. Analyze the thermal properties of SIPs, including thermal bridge analysis of potential areas of concern and determining how to minimize thermal bridging effects, if any. The details investigated in this report include wall corners, wall interface foundation walls to SIP, roof connections and floor.
6. Simulation using HOT2000 and PHPP
7. Determine changes required in order to achieve Passive House
8. Analyze the results and performance of the new design and draw conclusions about the effectiveness of the SIP panel

1.4. Scope of Work and Limitations

The building that was analyzed is located in Toronto, Canada. The scope of this paper is to determine what type of SIPs could have been used for this building to achieve R-2000 and PH. The home was recently retrofitted by the owner with SIPs. The research will determine if the SIPs would be capable of achieving the stringent air tightness requirements of PH. The research was limited to the existing site location, orientation and floor plans.. Shading of the home was also analyzed in the Passive House model as this is a significant affect especially in the dense urban location of the home. The scope is limited to single family dwellings in Toronto climate.

The scope of this report is to primarily examine the thermal properties of SIPs, although other properties such as durability, moisture management and constructability were considered. These other properties are not the main focus of the report and a thorough analysis on these items was not made at this time.

1.5. Impact of Research

This research will identify areas where structural insulated panels can be improved and where they can be used to potentially achieve Passive House Standards. The research will also be comparing the home for both the PHPP calculation methodology as well as the HOT2000 calculation methodology developed in Canada.

2. Literature Review

2.1. Current Construction Practices with SIPs

Structural Insulated Panels are being used more frequently in construction in Canada (Borjen, 2008). Modular buildings and modular building products such as SIPs in general have been gaining popularity in the market place as they are more time efficient and produce consistent results. In order to achieve standardization of these products there needs to be more direction from regulatory bodies. Currently, regulatory bodies have not approved all SIPs for use in Canada. SIPs require more engineering design to be approved then other structural wall systems. For load bearing applications solid lumber studs must be used and for roofs, I-joists or solid lumber studs have been approved (NRCan, 2001). The use of solid lumber splines is beneficial to the structural strength of the wall system but decreases thermal resistance of the wall overall.

The development of standards for structural insulated panels in North America is still ongoing (Borjen, 2008). This is one of the fastest growing areas of building technology in housing construction (Borjen, 2008). The major reasons for this are the increased energy efficiency of SIP products as well as the ease and speed of construction. Many of the current manufacturers have proprietary designs and code reports. The basic elements of a prescriptive SIP standard have been included in the 2007 Supplement of the 2006 International Residential Code (IRC). A new ASTM standard will also be available for SIPs which would create a path for all manufacturers to ensure they meet the requirements of the US and Canadian Building Codes (SGC Horizon Building and Construction Group, 2012). These prescriptive measures have been limited to SIPs made with EPS cores and OSB facings. This now allows jurisdictions that have adopted this code an easier route to project approval by regulatory bodies. It seems that the main concern of regulatory bodies is structural behaviour of the panels themselves when loaded. To assist designers, design tables for a variety of SIPs are becoming available as a variety of SIPs have been tested.

2.2. Current and Past Research

The first occurrence of SIPs in the industry was in 1937 when the Forest Products Laboratory in Madison, Wisconsin assembled a demonstration house using “stress-skin panels” (Borjen, 2008). The use of SIPs has been slowly rising. In 2006 the amount of SIPs being used for the construction of new homes doubled from 1997 levels, with 1.8 million new homes in America (Borjen, 2008). There have been many studies showing that homes constructed using SIPs outperform traditional construction in terms of the thermal performance of the wall, comparing wood framed walls that achieve a thermal resistance of RSI-1.93 m^2K/W walls with SIPs that are 114 mm thick (Krarti, 2006). The value of SIP construction is due to the reduction in thermal bridging and therefore the increase of the total thermal resistance of the wall when compared to wood framed homes. A 89 mm SIP wall has an effective thermal resistance of RSI 2.5 m^2K/W whereas the same width of wall that has been wood framed has RSI 1.73 m^2K/W (Christian, 1995).

Habitat for Humanity has been using SIPs commonly in many of their new construction projects. A commonly cited case is the Near Zero Energy Home (ZEH) projects in Tennessee (Christian, 2006). All of the homes in this development have been built with SIPs among other energy efficient technologies and their energy use was closely monitored. There have been studies done by ORNL on the individual homes in the development providing suggestions for the next home to be built (Christian, 2006). In a comparison of four of the homes in which three of the homes were made with SIPs with an EPS core, the fourth one was made with SIPs that have a polyisocyanurate core. When comparing all of the homes to the base home that used standard two by four framed construction, the Building America benchmark house used 6512 kWh/year whereas the SIP home 4314 kwh/year (Christian 2006). The base home was the Building America Benchmark had 2x4 studs with fiberglass batt and OSB sheating and the roof had a thermal resistance of RSI-4.93 m^2K/W due to the fiberglass blown insulation, whereas, the other home had SIPs that were 114 mm for the walls and 203 mm for the roof. There were some additional mechanical differences as well;

the air conditioner of the SIP home was smaller than the baseline and slightly more efficient (SEER 12 vs 13.7). The SIP home also had an integrated hot water heater as opposed to an electric home. The study did not provide information regarding the energy savings due to the SIPs alone. The design of the home surpassed the energy requirements of the benchmark house model by 50%. Habitat for Humanity also found that when building two homes side by side – one constructed with SIP walls and roof and other with conventional wood stud framing and fiberglass insulation, the volunteers had a preference to use SIPs on the job site. This was due to the fact volunteers had very limited construction knowledge but since the installation of SIPs was easy and straightforward, they enjoyed helping to build them and were able to do it quicker (Christian 2006, Mullens 2006). For the habitat for humanity projects, it was found that the home built with SIPs was able to save two-thirds of the site framing labour for the walls and the roof (Mullens, 2006). However the SIP project did require the use of a crane onsite. The use of a crane onsite may prohibit projects construction with SIPs in remote areas and constricted areas where it would be more expensive and difficult to use a crane. Volunteers for the Habitat homes were also interviewed and largely believed that the effort to build the SIP home was significantly less than the conventionally framed one (Mullens, 2006). The production of SIPs also occurs in a factory-controlled environment that ensures quality and consistency of the panels to a level that is difficult to achieve when trying to assemble a wall in the natural environment. In addition to this, due to the speed of construction the assembly is not exposed to environmental factors for the length of time that a conventionally framed home could be. Construction waste was also significantly reduced; half as much wood scrap was produced for the SIP homes (Mullens, 2006). Additional research into framing techniques is required to determine more specific advantages of SIPs (Mullens 2006). Lessons learned from past ZEH built by Habitat for Humanity were recognized in future ZEH. ZEH5 was built with SIPs as well but the cathedral ceiling used SIPs which were 203 mm thick and had I-joist splines and an additional 50 mm of XPS outboard of the panel (ORNL, 2008)

There were many energy efficiency upgrades to achieve this savings but the use of SIPs was a major factor as the airtight and well-insulated home was able to downsize all mechanical equipment and make full use of the geothermal heat pump system. The study did not analyze the contributing factors to the energy savings individually. There is more research required to determine the exact effect that SIPs may have had on these energy savings.

Another study analyzed the energy consumption of a near zero energy home built in Utah over the period of one year. A parametric analysis showed that SIPs alone were responsible for 30% energy reduction in the home due to the increased insulation and airtightness of the home (Jannumahanthi, 2010). This study simulated a building using EnergyPlus and parametrically analyzed a variety of wall constructions; the building was constructed with 6" SIP external walls and 8"SIP roof (Jannumahanthi, 2010).

Many of the studies in current literature discuss the structural elements of the panels (Mousa, 2010, Taylor, 1997, Sennah, 2008). There are structural concerns associated with the use of SIPs, namely potential creep and debonding of the OSB on the panels themselves. There has been several failure mechanisms experienced with SIPs including debonding, buckling, wrinkling, core failure, flexural creep deflection.

The use of SIPs in climates that are moisture sensitive or flood prone areas is not recommended (Vaidya, 2010). Studies have been conducted on newer SIPs for these areas that have thermoplastic composite facesheets that provide more structure (Vaidya, 2010) where OSB facesheets have failed. There is some research devoted to the material selection used for SIP manufacturing, in order to greatly improve the product. Some of this research is being focused on lowering the density of boards to improve the stiffness to weight ratio (Kawasaki, 2006). However, to ensure proper moisture management within the boards it is important that the boards have a higher density then the insulation between them (Lstiburek, 2008).

2.3. Current Market

There are a growing number of SIP manufactures in Canada. SIPs have been used in Canada in some capacity since the 1950s. Habitat for Humanity also commonly uses them in construction due to the ease of installation and the overall time savings on the site. Habitat for Humanity also tracks energy consumption for many of their buildings and they have seen a 50% annual energy use reduction in these homes with SIPs relative to the rest of their portfolio (Christian 2006). The manufacturers of SIP panels are testing them regularly for compliance with Canadian Construction Materials Center (CCMC). There are many new types of SIPs available on the market today with different materials and connections. The introduction of the use of SIPs in residential construction has been slow but growing. Prestige Panel is introducing newer panels using polyisocyanurate and magnesium oxide panels (Prestige Panel, 2011). The Endeavour Center is also providing SIPs made out of strawbale and plywood (Endeavour Center, 2011). These newer products will need time to penetrate the market. Contractors in Canada have been regularly building with SIPs for the past 20 years. The most common insulation material is EPS although polyisocyanurate is frequently used by the manufactures to increase their sales. SIPs can be more cost effective than spray foam that has been foamed on site as it may be mass. They are also more consistent as there is minimal variation in density of the insulation as it is manufactured in a factory setting. There are two main types of SIPs for construction. One type is panels that have been precut such as Plastifab (Plastifab, 2011) which come exactly as designed for the particular building. The other type is panels such as Thermapan (Thermapan, 2011) which are factory manufactured to be of the same size so they are always in stock and therefore are more accessible. This type of panel requires more work on site as they have to be measured and cut and installed directly on site. Some contractors do prefer panels that are cut to size onsite as it also allows the constructors of the building more flexibility in adjusting the design to meet the site conditions when there is an unexpected issue on site that was not designed for. Although this provides for more flexibility with the use of the panels, it can also cause workmanship error. The main issue for SIP acceptance by regulatory bodies is a structural one, however, fire safety concerns also exist with EPS panels as EPS turns to liquid and then gas when heated. The use of SIPs typically requires cranes which might deter home owners from using them.

2.4. Summary

Although SIPs are being used more prevalently in North America, there is a need for additional research to determine the specific energy savings potential that may be attributed to SIPs. This may increase the use of SIPs in the marketplace in the future. Passive House certification has been achieved with SIPs although minimal research is available for assessing SIPs for Passive House certification. There is also a need to streamline the regulatory process for SIP designs from regulatory bodies in order to gain a wider acceptance of this technology. As the building codes get more stringent and focused on energy efficiency measures, SIPs will likely be used even more.

3. Case Study: Description of Baseline Conditions

3.1. Site Observations

The case study is based on a single family detached two-storey household located in downtown east Toronto. A young couple with a child is currently occupying the building.

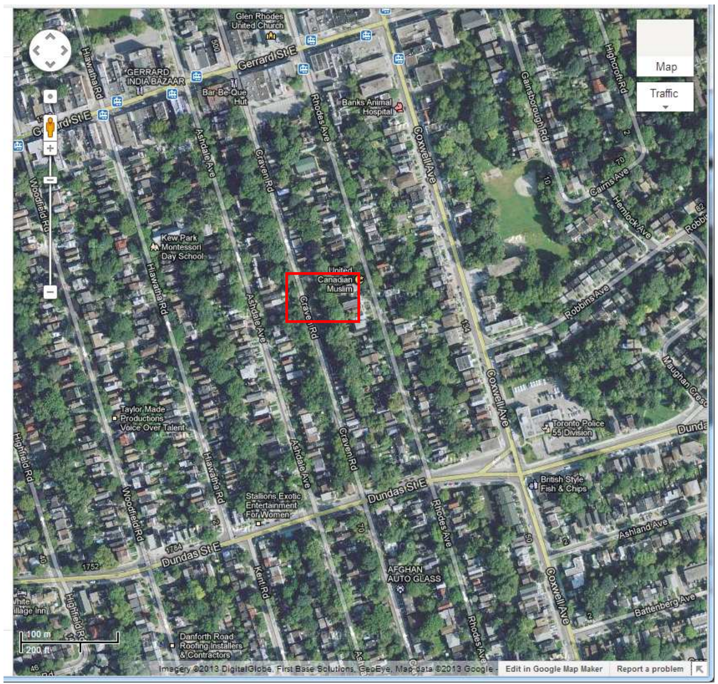


Figure 1: Location of Case Study Home

The home is located in a dense urban environment. The building is shaded by other homes on the north and south facades. General weather data for the City of Toronto was used for all simulations. The building was recently completely rebuilt with SIP walls and roof, new windows and doors were installed, all mechanical equipment was also updated in the building.

3.1.1. Building Enclosure

The panels that were selected for the case study building discussed in this report are from Plastifab (aka Insulspan) because the homeowner recognized them as one of the major Canadian SIP manufacturers and they were interested to be involved with research (Gray, 2011). These panels came predesigned for this specific building, as it was a retrofit so the exact type of panels required was known. Pastifab was also able to provide the homeowner with engineer stamped drawings, which made the building code approval process more streamlined (Gray, 2011).

The shell of the case study home was completely assembled in a single week (Gray, 2011). The first floor only took a day to assemble and the second floor and roof took the rest of the week that included some trouble scheduling due to inclement weather (Gray, 2011). The number of labour hours required to install the SIPs was a solid week with two people working full-time. The roof panels were more challenging to install than the wall panels as they are larger in size and more difficult to erect. The design process with the manufacturer occurred over a month before the design was finalized and the panels were delivered 5 weeks later (Gray, 2011). The homeowner was also able to install all of the panels by himself being without a strong background in construction (Gray, 2011). This is encouraging to ensure that this type of construction becomes more widespread in the residential building industry.

The construction of the main wall assemblies is Structural Insulated Panels (SIP) as manufactured by Insulspan. All detailed information for the SIPs was taken directly from the Insulspan drawings for the case study home (July 2010) and technical SIP details (Insulspan, 2013). First and second floor walls are 165 mm panels. The roof consists of a 260 mm panel. The panels comprised two sheets of 13.5 mm OSB on either side of expanded polystyrene. The splines for the building were single pieces of lumber, whereas the splines of the roof assembly were double pieces of lumber. All of the SIP details have been included in Appendix C (Insulspan, 2013). The panels including the spline were modeled in THERM and PHPP and the thermal resistance determined was included in the HOT2000 model. The effective thermal resistance from the PHPP model of the walls was RSI-4.31 W/m^{2}K and the main roof was RSI-6.83 W/m^{2}K.

Figure 2: The home after construction (September 2013)

Basement walls are generally 203.2 mm concrete block from footings to grade (approximately 1.22 m), then 203.2 mm of poured concrete above for approximately 600 mm utilized to increase the previously existing height of the basement. There is 50 mm of spray foam on the basement walls and 88.9 mm in the header space. The back part of the basement extends beyond the rest of the house. The ceiling space in this back part of the basement is insulated with 127 mm of spray foam. The basement floor consists of four inches of existing concrete slab with 76.2 mm of EPS underneath it. There is no additional insulation to create a thermal break between the basement wall and the basement floor. However, the floor and the wall slabs of concrete do not touch, as there is only 10 mm gap with dimpleboard. The drawings of the home have been included in Appendix A.

All of the windows are double glazed with an argon fill and composite frames (fiberglass and wood). There are two glass patio doors at the back of the building on is on the ground floor and the other at the second floor balcony with the same glazing properties as the windows.

The window and patio door manufacturer is Marvin Windows and Doors under their "Integrity" brand. The specifications can be found in the Wood-Ultrex catalog (Marvin, 2009).

The front door is manufactured by Thermatru Doors and is the Fiber-Classic Oak 2100 is Aluminum clad exterior, wood textured fiberglass with an English walnut stain and a polyurethane foam core. The door is Energy Star rated and has a thermal resistance of RSI 2.73 Km^2/W.

The skylight is made by Velux and is Energy Star rated. It's their hand-cranked operable model. The glazing for the skylight is also an insulted double pane unit with argon gas fill as indicated in the window schedule.

There was also a roof hatch that was marked "Lexcan" and is 76 mm by 76 mm. It has been sealed off by the building owner and as such excluded from the energy analysis.

3.1.2. Lighting

The majority of the lighting fixtures in the home are incandescent. A lighting survey was conducted during the site visit and the light fixtures were documented in the following table.

Table 1: Lighting Audit Summary

Location	Area (m^2)	Number of Fixtures	Lamp Wattage	Total Wattage	LPD (W/m^2)
Front Entrance	1.1	1	60	60	53.8
Kitchen / Dining	16.6	2	40	640	38.5
		8	50		
		2	50		
		1	60		
Bedroom	11.4	1	60	60	5.2
Washroom	5.3	3	60	180	33.7
2nd Bedroom	12.6	1	60	60	4.8
Corridor	2.9	1	60	60	20.5
Basement	41.5	1	100	152	3.7
		2	26		

The light fixture in the second floor corridor is seldom used as there is a skylight located directly above that space that fully illuminates the entire area. The value included in the energy model for these lighting fixtures assumed a daily use of 3 hours for all fixtures. The daily light use average used was back-calculated from the lighting survey done at the home and the default assumptions that were made for determining compliance with the R-2000 standard. The lighting assumptions do not affect the total energy use of the HOT-2000 model by a significant amount. If the lighting assumed is halved then the total energy for the building changes by 0.76%. The same lighting assumptions were then used in the Passive House model.

3.1.3. Plumbing Fixtures

There are two washrooms located in the home. The washroom in the basement contains one toilet, which consumes 6 liters of water per flush, and one faucet, which consumes 8.3 liters of water per minute. The main washroom is located on the second floor of the home and contains one toilet fixture, which consumes 6 litres per flush, two lavatory faucets which consume 8.3 liters per minute and one showerhead which consumes 9.5 liters per minute.

3.1.4. Equipment and Appliances

The home is heated by a furnace that is manufactured by Carrier (Performance 96, model: 58UVB060-14). It has a total heating capacity of 60,000 BTU/h and a thermal efficiency of 95% (Energy Star, 2013).

A Heat Recovery Ventilator (HRV) provides ventilation air for the home. The HRV is manufactured by Carrier (model HRV CCSV) the specification sheet for the product is located in Appendix A. This product has been certified by the Heating Ventilation Institute. The unit can be balanced to supply 3 to 48 L/s to the home. Based on the mechanical drawings, it provides 46 L/s, the same exhaust rate was assumed to maintain balance. The energy recovery efficiency of the HRV in cooling mode was estimated to be 25%, however the owners seldom use the HRV during summer as natural ventilation is preferred when available. It is not in use during the shoulder seasons when only natural ventilation is being used in the home through operable windows. The HRV is set to low when the air conditioning is on in the summer months (when the temperature is greater than 25^{o}C). This was included in the simulation as temperature controlled ventilation.

There are two other exhaust fans that were included in the simulation, a bathroom fan (Broan 684N with a capacity of 42.4 L/s) and the kitchen fan (Broan 650 with a capacity of 23.6 L/s). The laundry exhaust was not installed at the time of the audit and as such was not included in the model.

The domestic hot water is heated by a 151 liter Superflue (model: 8G4ONVH-ES-02) at a slightly lower temperature than for which it is designed. The natural gas heater is capable of providing 33,000 Btu/hr and is rated at 113 L/hr at 55°C. The Energy Factor of this unit is 0.67 as provided by the manufacturer (JohnWood, 2013).

The residents seldom use the air conditioning unit, as all of the windows are operable. The unit installed is the Carrier Air Conditioning Comfort 16 puron AC with an EER of 13.00 and a SEER of 16.0. The total cooling capacity of the unit is 18,000 Btu/h.

The kitchen contains a microwave with a built in recirculating range hood over the stove. The microwave is a Samsung (model: SMH9107). The stove itself is Energy Star certified and is rated to consume 565 kWh/year. The refrigerator is also Energy Star certified and is rated to consume 445 kWh/year. The clothes washer is located on the second floor of the home and is a Kenmore Ecocycle. There is no drier in the home.

3.2. Air Infiltration

A depressurization test was conducted using a blower door to determine the air tightness of the home. The test was conducted in accordance with CAN/CGSB-149.10-M86, Determination of the airtightness of building envelopes by the fan depressurization method. It was found to be 0.727 ACH at 50 Pa. At the end of the test the blower was used to maximize a pressure differential in the home and a walkthrough of the entire house was completed. Common areas of leakage were investigated during the test. The areas of air leakage that were identified during this test included:

- Crack in concrete in basement washroom
- Basement header where the ground floor intersects
- Weather stripping at patio door at rear of home
- Electrical outlet beside exterior door
- Electrical fixture box in both of the second floor bedrooms

The results of the blower door tested were entered directly into the HOT2000 model during the test.

3.3. Thermographic Scan

An infrared thermographic scan was conducted for the building to determine any other significant areas of thermal bridging. The exterior scan of the building occurred on the evening of March 7, 2012 in order to establish a significant temperature difference between the interior and the exterior of the building. The interior of the building was maintained at 22^{o}C whereas the exterior was 4^{o}C providing a temperature difference of 18^{o}C. A minimum temperature difference of 10^{o}C is required in order to see the effects of thermal bridging and air leakage.

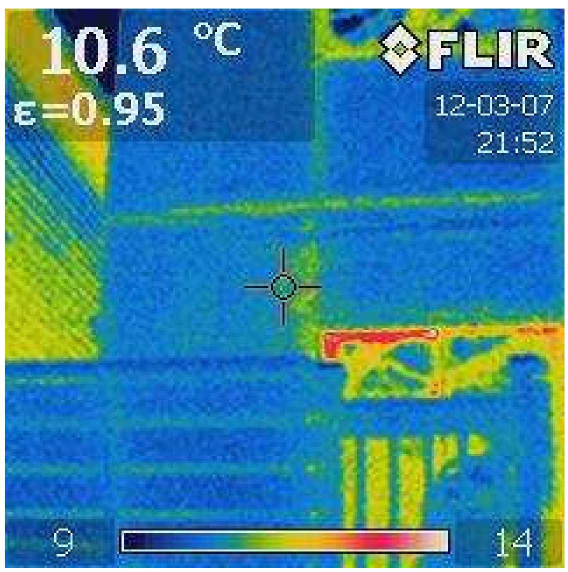


Figure 3: Exterior thermographic scan of east (rear) elevation

Figure 5 indicates that the temperature difference at the surface of the center of the wall panel and the spline only 1^{o}C, this narrow temperature difference ensures that the entire surface of the wall only experiences slight fluctuations.

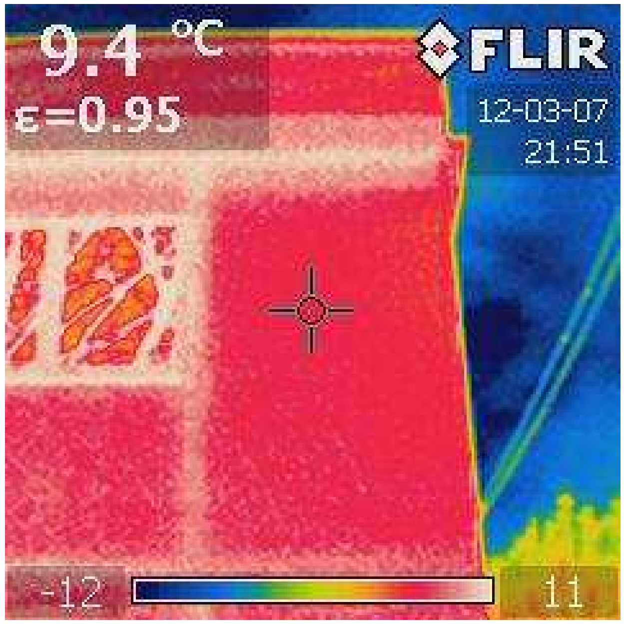


Figure 4: Exterior thermal scan of wall and roof connection

The temperature difference between the wall panel and the roof connection is 5°C. This temperature difference is slightly more than the temperature difference of the splines in the wall panels. These are areas of the wall assembly where solid lumber intersects the insulation plane.

The value of the thermographic scans allowed us to identify where potential thermal bridges may be located throughout the home. The potential thermal bridges that were located and discussed such as the roof/wall connection and the splines were modeled later modeled in THERM to calculate the psi factor.

The thermographic scan did not reveal any areas of potential air leakage, which often occurs near the window frames and other penetrations. The analysis of the infrared images reveals that the only thermal bridging occurs near the splines of the panels and connections with the roof. The temperature difference between the center of the SIP and the spline appears to only be a one to two degree difference at most, which is a small difference overall.

3.4. Utility Rates

The current Toronto Hydro electricity rates (Regular Price Plan Tiered Pricing) were used in the simulation and Enbridge (Residential Rate 1) natural gas rates. The utility bills for the building were provided.

4. Case Study Simulations

4.1. HOT2000

4.1.1. HOT2000 Software

The R-2000 standard governed by the Natural Resource Canada's Office of Energy Efficiency promotes the use of cost effective and energy efficient building practices and technologies (NRCan, 2010). HOT2000 Software is provided by NRCan to evaluate compliance with the R-2000 standard (NRCan, 2010). The software provides a simple platform to analyze the annual consumption end uses of a residential home. Since the software is designed to be easy to use with many defaults for the R-2000 program, it does not provide a lot of flexibility for the types of inputs.

4.1.2. HOT2000 Simulations

The Case Study home was modeled in HOT2000 using both General mode and R-2000 mode. All of the building areas were take from the drawings located in Appendix A. The thermal resistance of the building enclosure was entered as a user specified value. The windows were modeled in HOT2000 using the default material library. The floor headers were modeled in the THERM as defined in Insulspan drawings for the case study home (dated July, 2010).

The 2nd floor plate is actually hung inside the walls. This location of the thermal envelope was analyzed to determine if there was a thermal bridge. The temperature gradient across the header is shown below.

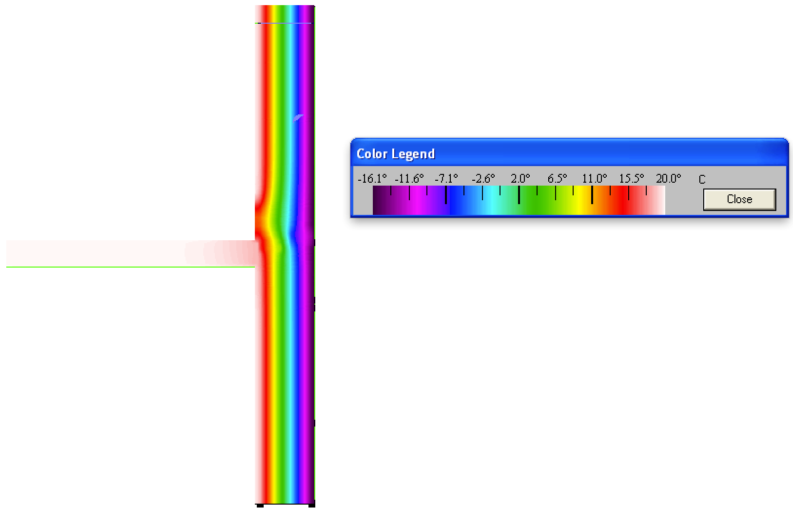


Figure 5: Second floor header

The Utility Rates for the building were provided and used to calibrate the energy model.

4.1.3. HOT2000 Results and Discussion

The R-2000 Standard is based on the Space Heating and Hot Water Energy for the building. The home uses approximately 10,590 kWh for space heating and domestic hot water in an average year. The R-2000 reference building would use 15,100 kWh per year. Therefore, the building was found to be 30% above the R-2000 target. The R-2000 Report for this building is found in Appendix D.

The end use breakdown of the simulation is shown in Figure 6.

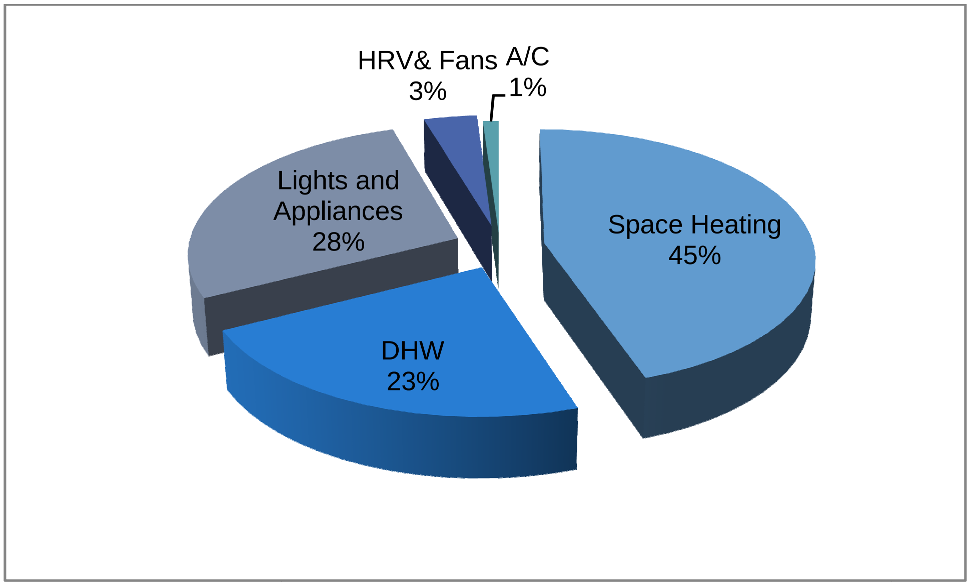


Figure 6: HOT2000 building end use breakdown

From the end use table, it is apparent that the majority of the energy used in the home is space heating as well as lighting. The national average residential home energy end use distribution is located in the following Table.

Table 2: Energy End Use Distribution

<table>
<tr><th></th><th>National Average</th><th>HOT2000 Simulation</th></tr>
<tr><td>Space Heating</td><td>66.20%</td><td>45%</td></tr>
<tr><td>Water Heating</td><td>15.41 %</td><td>23%</td></tr>
<tr><td>Appliances</td><td>12.06%</td><td rowspan="2">28%</td></tr>
<tr><td>Lighting</td><td>4.37%</td></tr>
<tr><td>Space Cooling</td><td>1.97%</td><td><1%</td></tr>
</table>

The data in the table for national average end uses is from the NRCan Survey of Household Enegy Use. The Case Study is consuming a smaller portion of the total energy for space heating when compared to the average. As such, the domestic hot water, lighting and appliances are consuming more. The space heating percentage of the building is lower than the national average because of the increased thermal resistance of the building envelope components, minimized infiltration, heat recovery of ventilation air and has a very efficient furnace the space heating. The result of the reduction in the space heating component has cause the appliance and lighting percentage to increase.

The air conditioner is on roughly 600 hours for this case study home. This is the amount o f time that the temperature in Toronto reaches beyond 25^{o}C. The air conditioning unit as described in the previous section has a capacity of 18,000 Btu and a SEER of 16. The total demand of the unit is 1,125 W, it is also a two stage unit. Assuming the second stage is required when the outdoor air temperature was over 30^{o}C. which would mean the energy consumption of the unit over the year is a maximum of 250 kWh. The total energy for the building was 13,964 ekWh, therefore the maximum air conditioning percentage would be 1.8% of the total.

The cooling load for the building can also be estimated by reviewing the electrical load for the building. Figure 7 represents the monthly kWh consumption for the building, as can be seen from the Figure the base load of the building is approximately 325 kWh/month. The electricity consumption does increase in the summer months for a total of 175 kWh. This value is less than the previously calculated maximum value of 250 kWh. The assumed 175 kWh of cooling would represent 1.2% of the total annual building energy consumption.

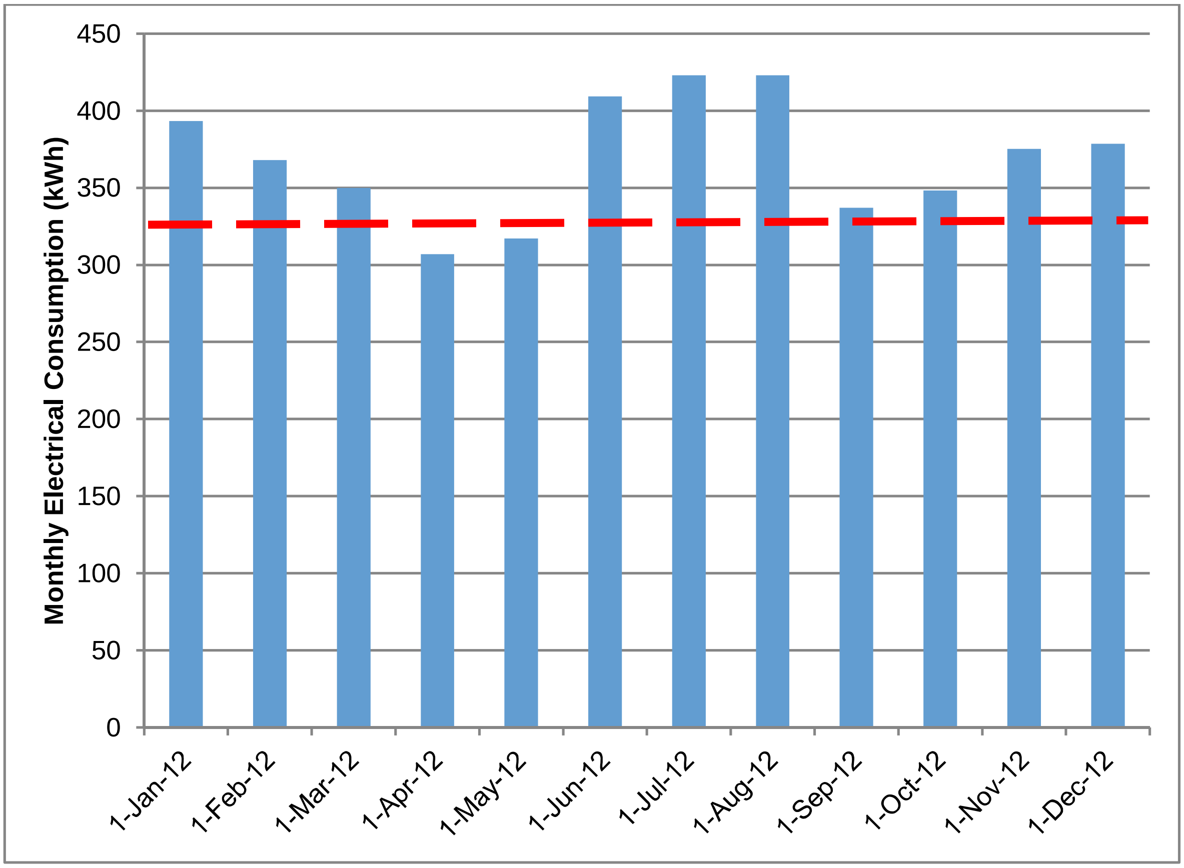


Figure 7: Monthly Electrical Consumption for the Case Study home

The HOT2000 simulation results were also compared to the utilities for the home. The following graphs represent this comparison for natural gas and electricity, respectively.

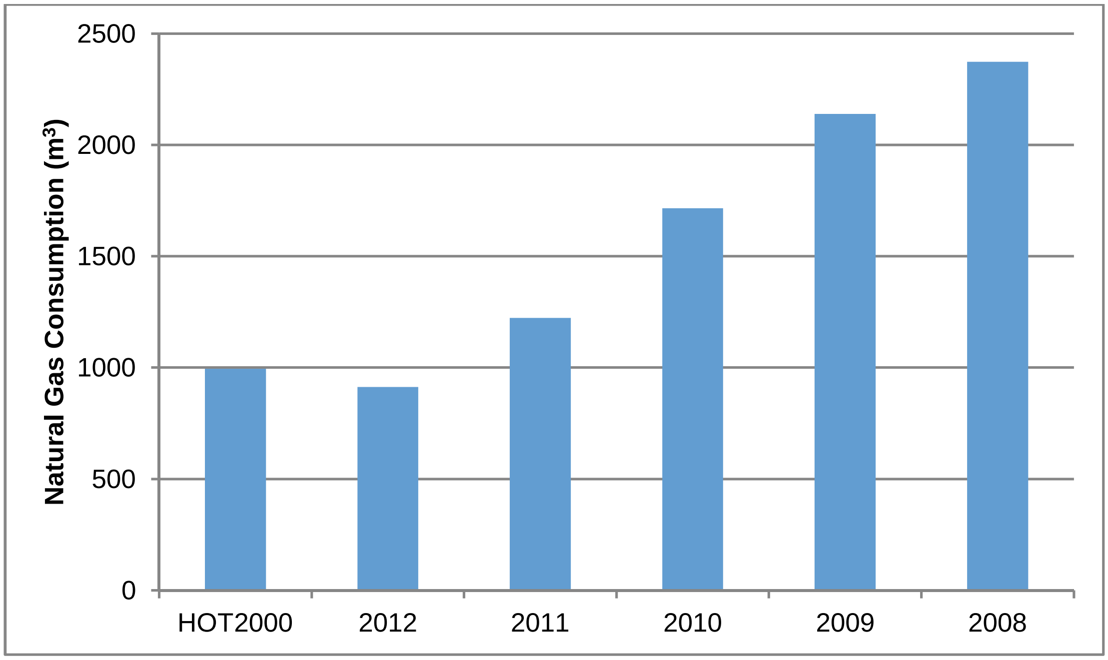


Figure 8: Annual Natural Gas Consumption vs Simulated

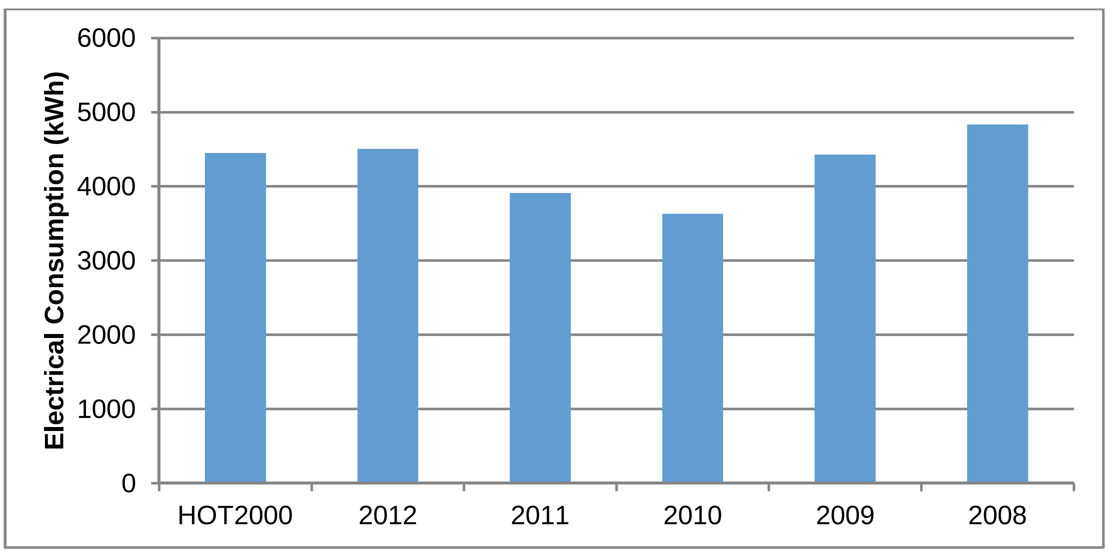


Figure 9: Annual Electrical Consumption vs Simulated

The natural gas consumption for the year 2012 the HOT2000 energy simulation was within 8% of the simulated value for the previous year. For electrical consumption was within 2%

of the simulation. The simulation was however calibrated with the utility bills. The building was completed rebuilt in 2010 and as can be seen in Figure 7 the natural gas consumption reduced dramatically. The electrical consumption has remained steady throughout the years.

The lighting in the building is mainly incandescent and the lighting power densities in all of the spaces of the home could be decreased with more efficient fixtures. If all of the fixtures were updated to similar LED type fixtures, the lighting demand savings would be 75%. This would mean the overall energy savings of 12% for the home. The domestic hot water portion of the energy use is also high, although the water heater is very efficient compared to potential alternatives. The hot water flow fixtures (shower, lavatory) are not low-flow industry standard fixtures but have very typical building code rates. A low flow showerhead and lavatories would help decrease the energy use of this area. The space heating is the greatest energy end use for this building. The space heating system is an energy efficient system and as such the energy use is primarily due to the thermal envelope. The thermal envelope will be discussed in greater detail in the next chapter of this report. The greatest energy end use is space heating (45% of total energy). There are two sources of heating in this building: the furnace and the HRV. Although the simulation output does not indicate what fraction of heat could be captured by the HRV and the amount of supplemental heating that was required from the furnace.

4.2. Linear Thermal Bridge Analysis

4.2.1. THERM Software

THERM is a two dimensional heat flow software tool developed by Lawrence Berkley National Laboratories. It is also the tool that is used by the National Fenestration Rating Council to determine thermal transmittance of glazing systems.

The thermal bridge calculations in this section have been done in accordance with the requirements to achieve Passive House Certification (PHPP, 2007). A thermal bridge is defined as a location in the building enclosure where the linear thermal bridge heat loss coefficient is greater than 0.01 W/mK (PHPP, 2007). THERM is used to determine the overall thermal transmittance through the section and PHPP software is used for individual components.

4.2.2. Thermal Bridge Simulations

The Passive House Planning Package (2007) requires the consideration of any thermal bridges that have a great thermal bridge heat loss coefficient. The thermal bridge coefficient is a one-dimensional coefficient determined by a two-dimensional heat flow calculation determined by the difference in heat flow through each of the two contributing members. A thermal bridge occurs where the insulation is not continuous; these are often transition areas from one assembly to another. These areas of the building that require further modeling in THERM in order to be accounted for in PHPP. The following table summarizes the Thermal Bridges that were included in the PHPP calculation. They were modeled in PHPP as well as in THERM to determine the linear thermal bridge heat loss coefficient, any element with a coefficient less than 0.01 W/mK has to be included in the PHPP calculation sheet. There were four areas of concern identified in the case study home: the basement wall connection to the basement floor, corners between two wall panels, the connection of the wall to the roof and the second floor of the building.

In order to calculate the results in the table above the following boundary conditions were used as described by PHPP 2007:

- Exterior Rainscreen: -16.3^{o}C, 12.5 W/m^{2}K
- Interior Corner: 20^{o}C, 5 W/m^{2}K
- Interior Wall: 20^{o}C, 8.33 W/m^{2}K
- Interior Ceiling: 20^{o}C, 9.09 W/m^{2}K
- Interior Floor: 20^{o}C, 5.88 W/m^{2}K
- Ground: 5^{o}C, 1000 W/m^{2}K (infinite)
- Adiabatic – default in THERM

All results had an error of less than 5% and 20 iterations; U-value tags were applied to the interior of the building envelope components. The interior temperature was assumed to be 20^{o}C for the model as required by PHPP. The resulting linear thermal bridge heat loss coefficients are

Thermal Bridge Description	Thermal Bridge Type	Calculated PSI factor (W/mK)
Basement wall to basement floor connection	Perimeter	- 0.335
Corner	Ambient	- 0.129
Roof and Wall Connection	Perimeter	- 0.103
2nd floor	Perimeter	- 0.064

summarized in the following Table.

Table 3: Potential Thermal Bridges

The results of the thermal bridging analysis indicate that the individual components of the building are constructed in such a way that there are no thermal bridges. The thermal bridge at the second floor of the house is not considered a thermal bridge by PHPP standards because the total thermal conductance of the member is not that different from the thermal conductance of the individual members. However, it is the closest to a thermal bridge when compared to the rest of the potential thermal bridge areas. This was considered to be a thermal bridge in the case of the PHPP design of the home as the floor board had a greater affect on the total thermal conductance of that area.

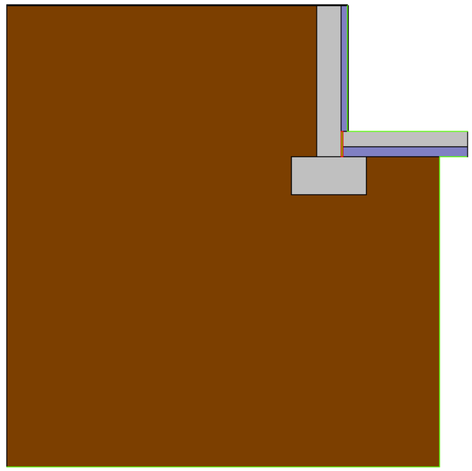


Figure 10: Thermal Analysis at Foundation

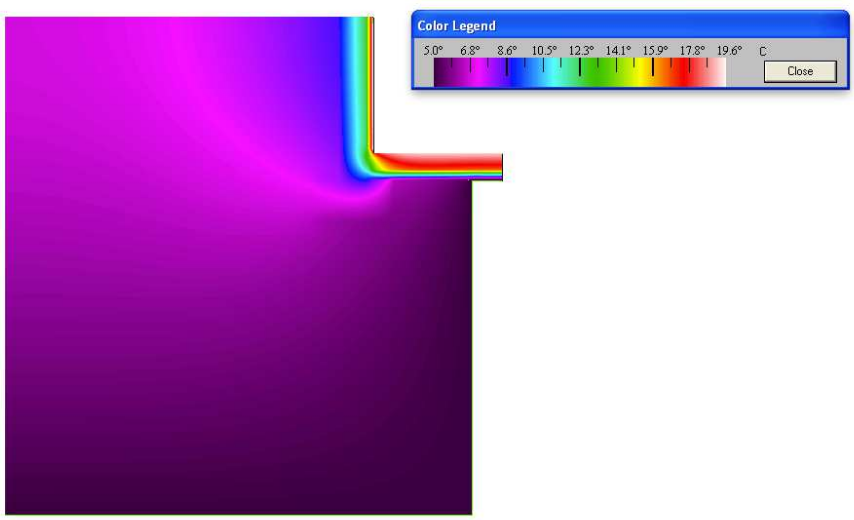


Figure 11: Thermal Analysis at Foundation

The example shown in Figure 7 and 8 is the THERM simulation of the basement wall and foundation. This would appear to be a thermal bridge from Figure 7 as there is no thermal break between the wall and the floor except for a 10 mm space for dimpleboard. However, due to the thermal resistance of both the wall and the floor, there is not enough of a different between the individual thermal resistances of the assemblies and the total thermal resistance to be considered a thermal bridge. If the thermal resistance of either of these elements were increased then the likelihood of a thermal bridge in this location would be greater.

4.3. Passive House Planning Package

4.3.1. Passive House Planning Package Software

The Passive House Planning Package software that was used for this simulation was released by the Passive House Institute in 2007 (PHPP 2007). A more current version of the standard has been released by the Passive House Insitute in 2012; however, the new software was not available at the time of this analysis. It is a Microsoft Excel based calculation program. This is a design approach that has been used successfully in Germany since the 1990s (PHPP 2007). The requirements for a Passive House are to create a space that requires so little heating that it can be provided by the ventilation air alone with the use of a HRV. The goal is to only distribute fresh air throughout the home reducing fan energy. The super-insulated building envelope will prevent heat loss. Additionally, an extremely tight envelope will prevent infiltration of cold air and thus further reducing the heating load. The shape and orientation of the building are also designed to maximize solar gains to reduce the heat load within the building. The focus of Passive House is the reduction in the heating energy, which is the largest energy demand end use in colder climates such as Toronto. The intent of the Passive House is first to optimize the building envelope to reduce energy loses through the envelope. The goal is to supply the entire heating requirement using only the ventilation system. The intent is to not need a mechanical heating system at all, however, many Passive Houses still have some supplemental heating systems for extreme weather cases. Exhaust air leaving the building transfers energy to outdoor air entering the building thus minimizing additional heating requirements. In the Canadian climate, additional heating through the use of a mechanical system is necessary. There is a Passive House requirement for cooling and to ensure the building is not being overheated.

The specific criteria that are required in order to achieve the Passive House Certification is that the specific space heating demand of a building must be less than 15 kWh/m^{2}yr, the house must achieve a tested air tightness of 0.6 ACH at 50 Pa and the entire specific primary energy demand must be less than 120 kWh/m^{2}year which includes domestic electricity estimates (PHPP 2007). Cooling energy is also considered in the certification process however the certification of the house typically does not depend on it.

4.3.2. Passive House Planning Package Results and Discussion

Passive House Planning Package (PHPP) version 2007 was used for the calculations. The specific heating demand for the case study home was investigated. The following worksheets were completed in PHPP: verification, climate, areas, refdims, r-values, ground, windows, shading, winentry, wintype, ventilation. The baseline building model was located in Toronto, Ontario.

Table 4: PHPP Default Assumptions

	PHPP Assumption	Actual Case Study
Layout Temperature = 20^{o}C	20	Winter = 20, summer = 25
Internal heat sources = 2.1 W/m^2	76W	-
Occupancy 35m2/person	1	2.5 people
DHW = 25 L/person/day	25	-
Airflow 20-30 m^3/hr/person,	30m^3/hr = 17.65 cfm	95 cfm
ACH=0.3	0.3 = 57 cfm	85 cfm

The calculation method used for this project was the monthly method as the annual heating load was higher than 8 kWh/m^2 per year. The PHPP defaults were not used in the model where the actual case study values were known. The goal of the simulation was to determine the performance of home relative to the PHPP standard.

The assumptions that were made in the HOT2000 model as described in Section 3 were also included in the PHPP calculation.

The results of the analysis indicate:

- Specific annual space heat demand = 117 kWh/m^2yr
- Air leakage test results 0.7 h^{-1}
- Specific primary energy demand = 219 kWh/m^2yr
- Space heating load = 40 kWh/m^2hr

The building in its current configuration as described above did not meet the Passive House standard. A significant effect of the specific space heating demand was the fact that the south and north façade had minimal glazing which was also shaded by adjacent buildings. The next step of the analysis was to determine the energy measures required in order to achieve Passive House certification, which requires a specific space heat demand of 15 kW/m^2yr. The details of this redesign follow in Section 5.

5. Analysis of SIPs

There are many different combinations of SIPs that can contribute to the improvement of current wall assemblies and practices. This section will look at different materials for the insulation and structural boards of the panels as well as the thermal bridges. The new design of the SIPs for the PHPP model will aim to eliminate thermal bridges completely from building envelope construction.

5.1. Material Selection

There are many different types of materials that SIPs can be manufactured with as will be discussed in this Section. The insulation for SIPs has to be carefully selected for increased structural performance and it needs to adhere well to the structural boards of the panels. In order to select the most appropriate materials the goal of maximizing thermal performance while decreasing the width of the panel to maintain its structure. The following table lists the different types of insulation (values taken from NRCan) that can be considered for SIPs (NRCan).

Table 5: Summary of Potential SIP insulations

	RSI/25.44 mm [K·m²/W·mm]	R/in [h·ft²·°F/Btu·in]
Polyisocynurate foam	0.88	R-5
Extruded polystyrene (XPS)	0.88	R-5
Polyurethane foam (closed cell)	1.06	R-6
Polyurethane foam (open cell)	0.63	R-3.6
Expanded polystyrene foam	0.7	R-4
Icynene (MD-R-200) spray foam	0.65	R-3.7
Cellulose	0.63	R-3.6

Strawbale	0.26	R-1.45

Expanded polystyrene (EPS) foam was used in the current construction of the SIP panel for the case study home. It is also the most commonly used insulation in SIPs that are available in the current market. EPS has been used in the market for over 50 years, it is widely available, easy to modify onsite and not as expensive as some of the newer materials.

The most natural and the least carbon content of the materials listed above is the strawbale SIP that would be the best material from a sustainability perspective. However, since this project is located in a dense Toronto neighborhood, the thickness of the panel will be need to be minimized in order to maximize interior space. SIPs made with strawbales are currently being manufactured in Canada. They comprise typical-use plywood skins and they need plaster to provide support which is typically 1" thick (Chris Magwood, 2013) and can achieve R30-R40 for a typical strawbale 14" thick. Unfortunately, due to the weight of the strawbales they can only be used as walls and are too heavy for roofing. It is the most sustainable of all of the materials considered as it has extremely low embodied energy. It is a waste product of the agricultural industry and requires very little processing, only needing some mechanical energy to form the straw into bales (Bronsema, 2010). It is also very abundant locally (southern Ontario). The construction is all natural without the use of any manufactured chemicals. Straw properties are 133 kg/m3 and 0.061 W/mK, more permeable plasters are recommended for moisture drying potential. Solar absorptance of earth plaster is greater than the solar absorptance of cement plaster, since the main goal is to reduce the heating load of the home, earth plaster would be favoured. It has been found that the earth plaster wall performed better than the cement plaster one, however the strawbales should be rain-sheltered due to potential moisture damage from rain events (Bronsema 2010). One of the major benefits of using strawbale SIPs is that they maybe designed with virtually no splines, this means that there is absolutely no thermal bridging between each panel. This is also due to the thickness required for them. For the requirements of this project and the achievement of Passive House, the strawbale wall that would be required would be around 50 inches (4 feet) thick which is not feasible for the location.

Figure 12: Strawbale SIP production (Chris Magwood, 2013)

Phase Change Materials (PCM) have also been used in the design of newer SIPs. A SIP containing 20% PCM was able to reduce the peak heat flux reductions by 62% and the average additional reduction in heat transfer was 38% (Medina, 2007). The addition of a PCM to the SIP would allow the wall to attain a better thermal capacity than a conventional SIP as more energy can be stored and released through the PCM. This allows for the effect of a trombe wall without the massive size a trombe wall would need. This would be more ideal for a denser environment such as in the City of Toronto. This passive technique would also increase thermal comfort and reduce peak capacities of mechanical equipment. PCMs have been incorporated into wall boards and construction blocks in the past, the best performing wall board contained 25-30% PCM by weight (Medina, 2007). Basically a PCM pipe is inserted throughout the insulation material of the SIP.

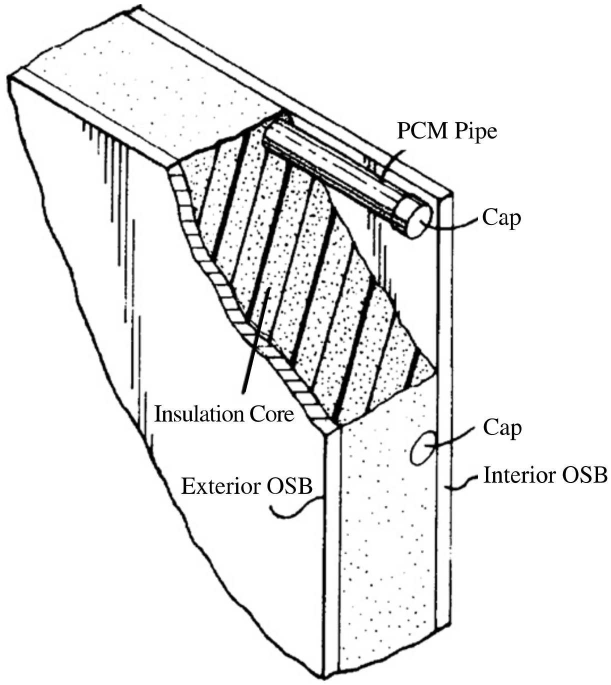


Figure 13: PCM SIP cross section (Medina 2007)

A 1hr shift in peak flux was observed in a wall with 20% PCM compared to one without (Medina, 2007).

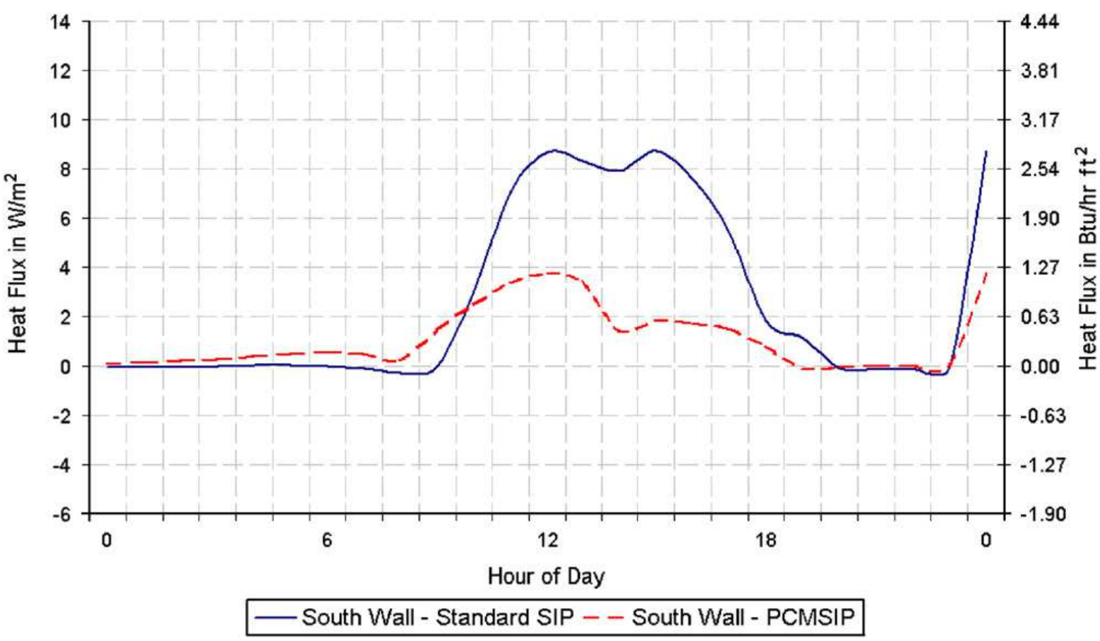


Figure 14: Wall heat fluxes for SIP and SIP containing 20% PCM (Medina 2007)

In testing onsite there was a perceived difference created by the PCM in the SIP, however, this technology is very new and not well tested. This could be an area of research that may be investigated in greater detail in the future, however there was not enough data to include this technology for the purposes of this report.

In addition to the insulated material there are many materials that can be used for the outer panels of a SIP. The current home has OSB outer boards that are the most common along with plywood boards. Newer materials that are being used in the construction of SIPs include cement bonded particle board, insulative sheathing, sheet rock, concrete, sheet metal, magnesium oxide boards, fiber-reinforced plastic. Some of these products have a much greater insulative properties that reduce the condensation potential of the boards, which is especially important on the exterior side of the panel where condensation may occur.

The requirement for the thickness of boards is indicated by the structural integrity of the overall SIP. In order to maximize the thermal properties of the entire panel, the insulation should be maximized whereas as the board that has a higher thermal conductance would need to be minimized. Since the structural integrity of the boards is not analyzed in this report, only the thermal conductivities of the different materials will be considered.

Insulated Concrete Forms (ICF) were not considered for this analysis as they have a larger carbon footprint then using more natural materials such as wood frame construction, also since this is a residential project they would be too expensive for the size of the project. ICFs are very similar to SIPs in that they have a structural component at both ends and insulation in the center. They are considered by some to be the next generation of SIPs. They are structurally stronger than SIPs and as such used in buildings that are greater than

2 storeys. SIPs are not recommended for taller buildings and as such they are not commonly used in the commercial sector.

Modular and prefabricated wall assemblies should be strong enough to resist loads not only during the life of the building but throughout transportation and installation, the structural experiments confirm the use of this composite wall system in the residential market. Magnesium oxide board used in SIP construction has one of the lowest thermal conductivities of all of the outer boards considered of 0.047 W/mK, compared to OSB which has a thermal conductivity that is almost double this at 0.104 W/mK (Manalo. 2013).

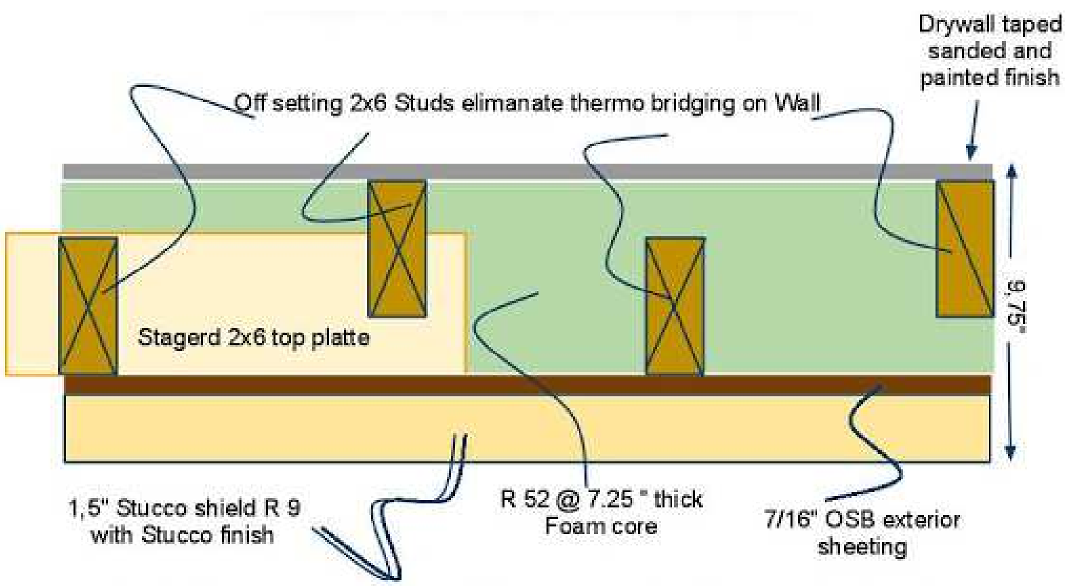


Figure 15: Wall cross section of a staggered double stud wall by (Raycore 2013)

The double stud wall was modeled in contrast to a double SIP wall, similar to one used in the Equilibrium House design, which was a double layer of prefabricated Emercor SIPs. The second SIP panel does not have a second OSB layer but building paper that was installed onsite using cantilever screws (CMHC 2010):

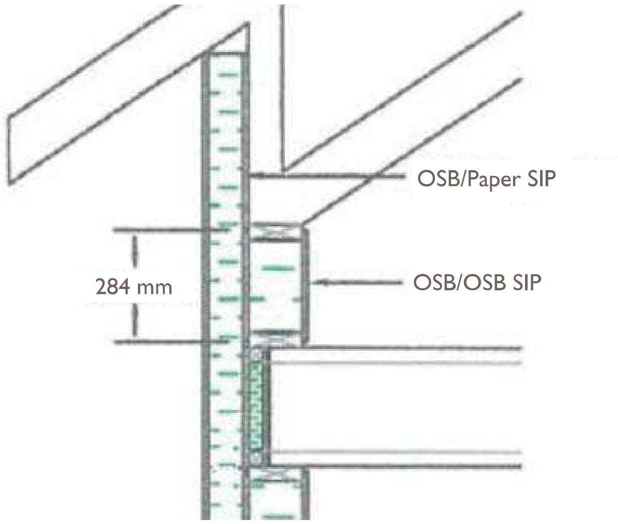


Figure 16: Double stud wall cross section (CMHC 2010)

Cross section of double SIP wall showing roof and second floor connections (CMHC 2010). The particular second floor assembly shown above is a thermal bridge this area and this is typically the hardest to remove a thermal bridge from as will be discussed in the thermal bridge section. The double SIP wall significantly reduced the energy consumption of the home, however the builder found the construction of the home challenging, the outside panels were slightly warped by the time the builder was ready to install them and did not fit perfectly together (CMHC 2010).

Table 6: Annual Heating Requirements for various wall types (CMHC 2010)

Wall Type	**Estimated Annual Heating Requirements**
38 mm x 140 mm stud wall (2 in. x 6 in.), RSI-2.9 (R-16.5)	10,300 kWh
Single 114 mm (4½ in.) SIP, RSI-4.9 (R-28)	7,330 kWh
Single 165 mm (6½ in.) SIP, RSI-7.7 (R-44)	6,290 kWh
Double SIPs, RSI-12.7 (R-72)	5,260 kWh

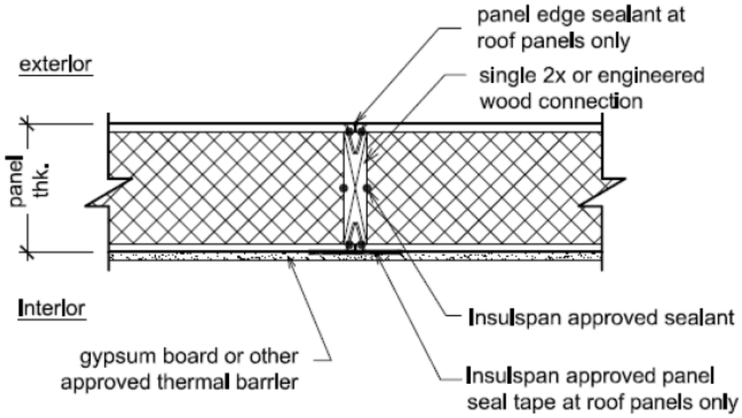
As a result of this CMHC study, a double SIP manufactured panel was analyzed for the purposes of this report. A manufactured double SIP wall would have the same insulative properties but would require less assembly onsite and less potential for warping. For the purposes of this report a manufactured with double stud walls, polyisocyanurate and MgO panels will be used in the design of the wall and roof assembly.

5.2. Thermal Bridges

SIP construction minimizes thermal bridging; however it is important to note that detailed construction drawings are required to ensure thermal bridges are minimized at every point of connection. The following section will look at options for minimizing thermal bridges at all panel to panel connection points including: splines, corners, walls to foundation, floor joists, and roof connections. The Passive House design will require building envelope assemblies that are much thicker and have higher thermal resistance, thermal bridging will be a greater affect for these assemblies then in the case study home.

The splines are the most recurring potential thermal bridge connection within SIP construction as they are the most prevalent throughout the building and affect the thermal resistance of the whole wall of the SIP. There are many different materials that are available to reduce the thermal bridging at the splines. The use of fiber-reinforced plastics, insulating lumber other types of mechanical locks between panels have helped to reduce the amount of thermal bridging that occurs due to splines. The case study building uses regular 2x4 lumber for the splines. The use of the solid lumber was required due to Canadian structural regulations (NRCan, 2001). However, Insulspan offers a different type of spline that would have been is more effective at reducing the thermal bridging between panels. This is calculated in the following Table.

Table 7: Spline Comparison from Insulspan (Insulspan 2011)

<table>
<tr><td rowspan="2">Lumber Spline (RSI-5 m²K/W and psi factor of 0.025 W/mK)</td><td>
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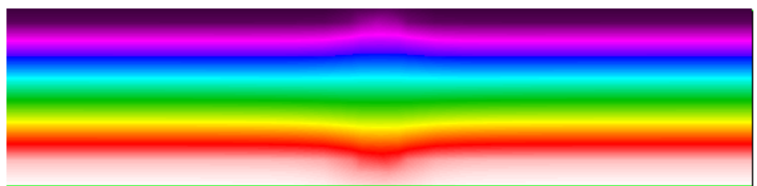
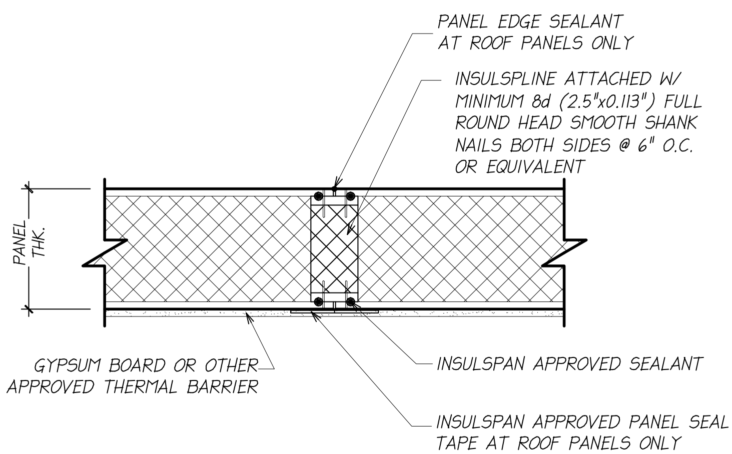
<tr><td></td></tr>
<tr><td rowspan="2">OSB Spline (RSI – 5.6 m²K/W and psi factor of 0.009 W/mK)</td><td>
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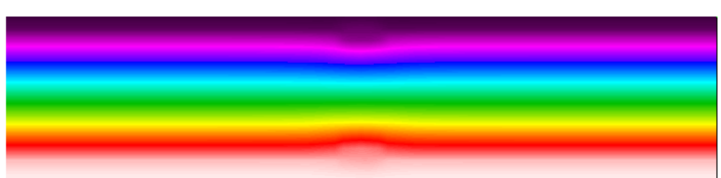
<tr><td></td></tr>
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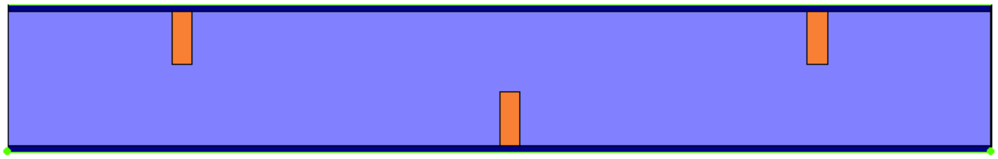
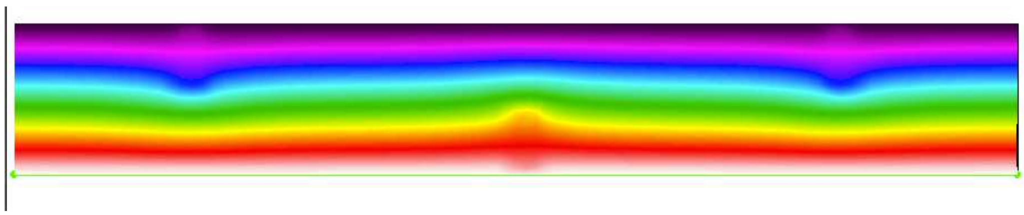
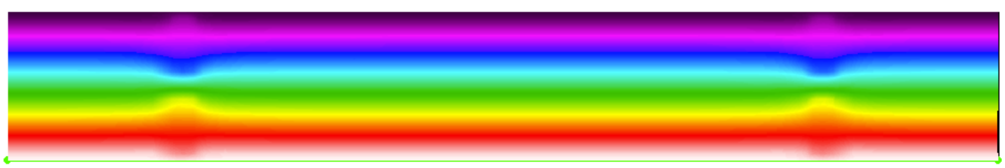
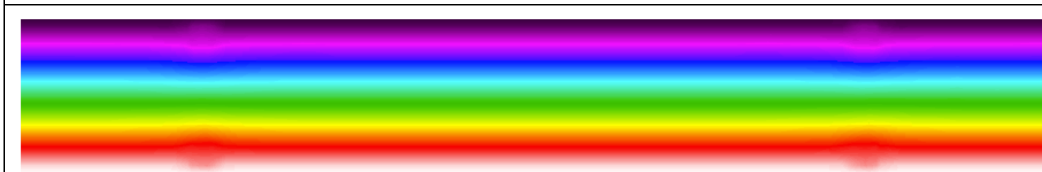
The solid lumber spline has a calculated thermal bridge heat loss coefficient value of 0.025 W/mK which would be considered a thermal bridge by PHPP standard. The OSB spline has a calculated psi factor 0.009 W/mK which would not be considered a thermal bridge by PHPP standards. Although the OSB Spline offered by Insulspan, it does not meet Canadian Structural requirement

The first spline in the Table above was the one that was installed in the case study home, the second is another option that was available for the home. All panels from Insulspan are available in these two options. These are the two most common splines that can be designed with SIPs and are also available with other common manufacturers. As seen in the Table above the OSB spline reduces the amount of thermal distortion and is consequently a higher overall RSI value. The goal of the new design would be to completely reduce thermal bridging this would include not using lumber across the entire panel.

The thermal resistance requirements for PHPP would also require a wall size that was much greater than the current walls size. Since this wall size would be so much greater there are more options with respect to the configurations of the splines. Three different types of configurations of studs were compared to determine the best one. Two types of double stud walls were compared. The double stud walls included one with offset studs and one with studs that were inline with each other. The third type of wall that was analyzed was designed with I-joist studs. The use of I-joist studs is also a common practice in Passive House constructions. The thickness of the wall was determined by the wall Rvalue requirements for the achievement of Passive House. The result of the thermal analysis for these walls is shown in the following table.

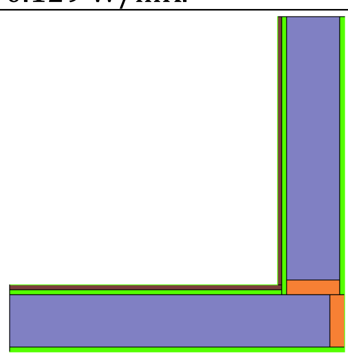
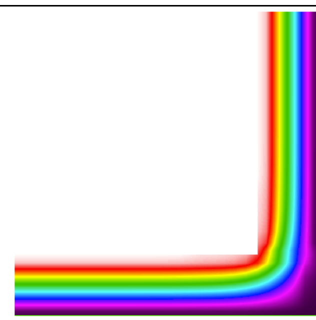
Table 8: Comparison of Passive House walls

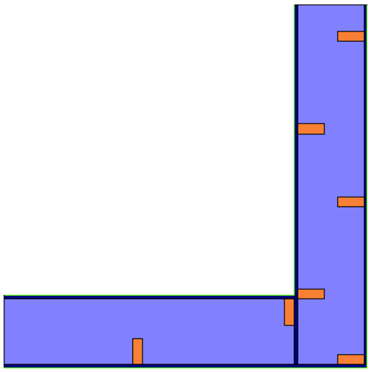
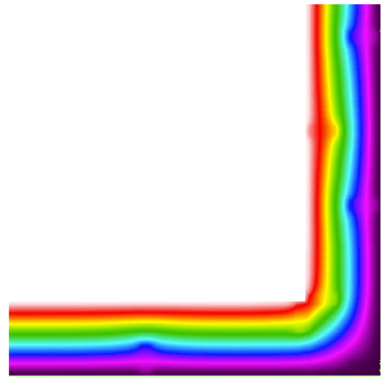
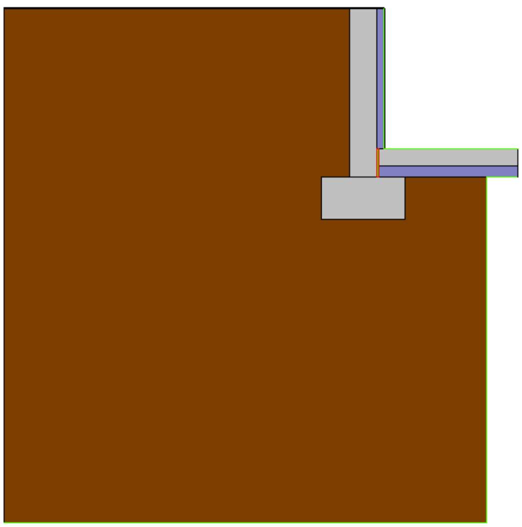
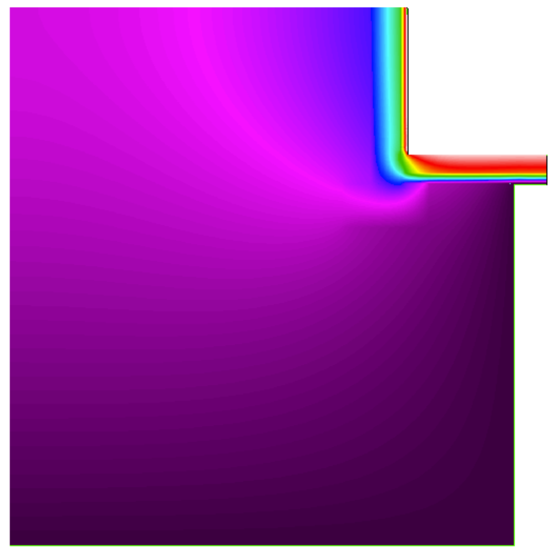
Double Stud Wall (offset studs) RSI-11.1	
	
Double Stud Wall (inline studs) RSI-10.8	
	
I-joist Studs R-11.0	
	

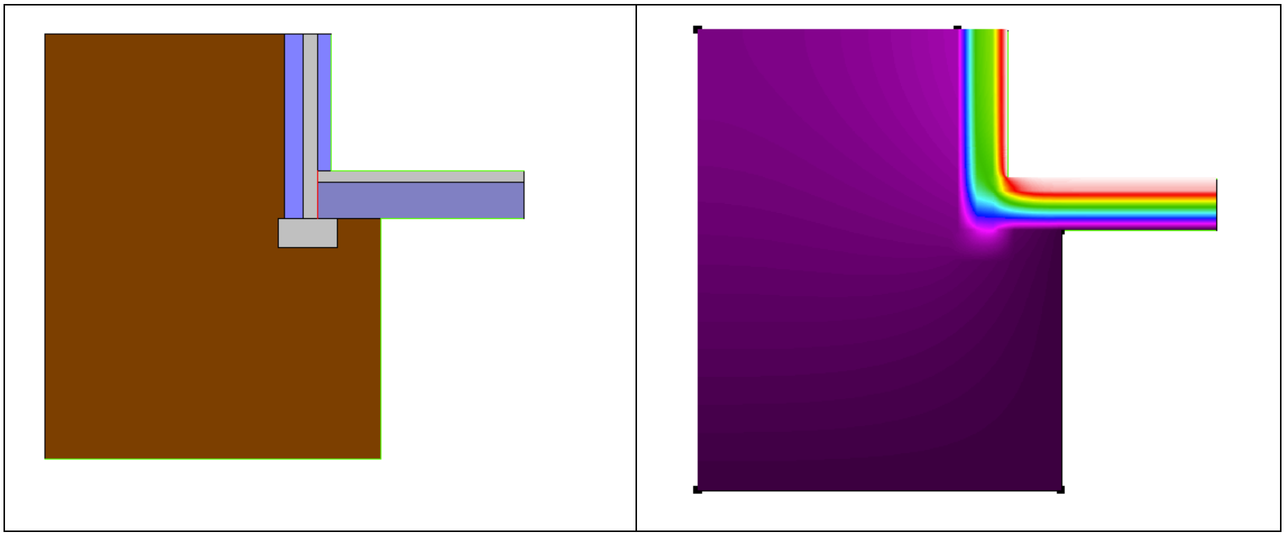
The Table above includes the thermal resistance values calculated for each of the three wall types. All three of the walls were the exact same thickness (280 mm) and the same materials. The only difference between each of the wall types is the type of connection between the two structural panels. The thermal resistance is the greatest in the wall type with offset wooden studs.

Further thermal simulations were completed to determine the thermal bridging locations at building assembly interfaces. The details of all of the current areas of thermal bridging in the building were examined. The thermal bridges were calculated according to the linear thermal bridge coefficient (psi factor) calculation as outlined by the Passive House Institute (PHPP, 2007).

Table 9: Potential Thermal Bridge Simulations

<table>
<tr><td colspan="2">Corner of Case Study home, linear thermal bridge heat loss coefficient was calculated to be -0.129 W/mK.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Corner of new PHPP, linear thermal bridge heat loss coefficient was calculated to be -0.008 W/mK.</td></tr>
</table>

	
Foundation of Case Study, linear thermal bridge heat loss coefficient was calculated to be – 0.336 W/mK.	
	
Foundation of new Passive House, linear thermal bridge heat loss coefficient was calculated to be – 0.139 W/mK.	



The analysis indicated in the Table above was completed for all of the identified potential locations where thermal bridging may occur in both case study and new Passive House designs. The results indicate that all of the thermal bridge coefficients are less than 0.01 W/mK and as such indicate that these are not actual thermal bridges.

The thermal bridge is worse in the Passive House design of the building as opposed to the Case Study due to the increase in thermal resistance of the all assemblies that the Passive House design requires. The thermal resistance of the individual components increases a greater amount and the thermal resistance of the whole area increases relatively less, so that the thermal resistances are more similar than when they were for the Case Study home. In the Case Study home the Uvalue of the thermal bridge area is more similar to the Uvalue of the components unlike the Passive House design. As the thermal resistance of the building envelopes increases the area of the potential thermal bridge will more closely reflect the thermal resistance of the individual components. Also since the thickness of the components has increased the difference in the length between the individual members and the whole area has increased.

The temperature profiles seen in the Table above indicate that there is a consistent temperature across the building assemblies. This reduction in thermal bridging will also create a much more comfortable home for the building owners.

5.3. Recommended SIP design

The recommended SIP design for increased thermal resistance was selected based on the analysis above. Considering the dense urban environment of the case study home, the amount of thermal resistance to panel thickness is maximized. The preferred insulation that was selected was polyisocyanurate due to its high thermal performance. The structural boards that were selected were orientated strand board containing Magnesium Oxide as this would further increase the thermal performance of the panels when compared to plywood or OSB without compromising the structure stability of the panels themselves.

The vapour permeance of the selected MgO panels was measured to be 53 ng/Pa-s-m^2 (Prestige Panel, 2011). This is very similar to Insulated Fiber Cement Boards measured to be 43 ng/Pa-s-m^2 and OSB panels that were measured to be 58 ng/Pa-s-m^2. The selected polyisocyanurate insulation will be increased in order to have a vapour permeance which is more than the outer boards. SIPs can also be built with a variety of different types of cladding. The cladding selected for the SIP should be able to deal with bulk moisture (such as rain) in order to protect the SIP underneath.

The exact thickness of the SIPs was established by the thermal resistance requirements to meet the Passive House standards using PHPP software. The SIP design would have to include a double stud wall in order to reach the thermal resistance requirements and also help to reduce thermal bridging in the overall design.

The recommended SIP design included the upgrades listed in the following table.

Table 10: RSI Increases for new SIP design

Component	Case Study	Passive House design	Percent	Percent

	RSI value	Total Thickness (mm)	RSI value	Total Thickness (mm)	**Increase in Thermal Resistance**	**Increase in Wall Thickness**
SIP Wall	4.31	178	12.02	315	64%	44%
SIP Roof	6.83	274	19.33	523	65%	48%
Basement Wall	3.02	254	14.07	483	79%	47%
Basement Floor	2.97	203	9.52	432	69%	53%

The total thickness of the panels listed in the table above is the outer dimensions, from sheathing to sheathing. It was found that in this analysis the thermal conductance had to be 0.05 W/m^2K to achieve the standard. The increase of the resistivity of the material itself meant that the panel thickness did not have to increase as much to meet the same increase in total panel resistance. The increase in the thickness of the walls of the home reduces the interior volume of the new design. This means that there is less volume for the surface area of the home.

This design also includes the complete elimination of thermal bridges through the detailed design process and new materials used.

5.3.1. Recommendations for HOT2000 Upgrades

The energy end use breakdown provides information that can be used to determine which areas of the building are consuming the most energy. The energy end use breakdown when compared to the national average indicates potential areas of improvement. The main areas of energy efficient recommendations for this home will be lighting, plumbing fixtures and the building enclosure.

A compliance table from SB-12 is shown below to summarize how the home compares to the local code and how it can be improved. The home was built before this code had been implemented; the table shows how it compares to new buildings that would be built today.

The goal of an R-2000 home is to be more efficient than standard construction. The following table shows the value of the current components in the case study home and the potential upgrades to the new SB-12 Requirements of the Ontario Building Code (Ministry of Municipal Affairs and Housing, 2011).

Table 11: SB-12 requirements compared to Case Study

Component	Compliance Package Best Suggestions	Case Study
Ceiling Without Attic Space Minimum RSI Value	5.46	6.83
Wall Above Grade Minimum RSI Value	4.75	4.31
Basement Walls Minimum RSI	3.87	3
Below Grade Slab Minimum RSI Value	1.76	2.98
Windows and Glass Doors, Maximum U value	1.6	1.597
Skylight, Maximum U value	2.8	1.6
Space Heating AFUE	94%	95%
HRV Minimum Efficiency	70%	59%
Domestic Hot Water Heater EF	0.67	0.67

The home meets the majority of the OBC SB-12 prescriptive requirements. The main building component that could be improved is the heat recovery effectiveness followed by the above grade wall thermal resistance. Since the building in it's current state is achieving the R-2000 standard, these requirements will not be incorporated into the design.

5.3.2. Passive House Planning Package Results Recommendations

PHPP has provided recommendations to enable building designers to achieve Passive House Standards (PHPP 2007).

Table 12: PHPP Recommended Improvements

PHPP Recommendation	Case Study	Improvement
Exterior building elements must have a U-value below	Roof – 0.146 W/(m^{2}K) Walls – 0.232 W/(m^{2}K)	Roof – 0.052 W/(m^{2}K) Walls – 0.083 W/(m^{2}K)

0.15 W/(m²K)	Basement – 0.330 W/(m²K) Foundation – 0.335 W/(m²K)	Basement – 0.07 W/(m²K) Foundation – 0.105 W/(m²K)
Air leakage must not exceed 0.6h-1 at 50 Pa	0.7 h^{-1} at 50 Pa	0.5h^{-1} at 50 Pa
Glazing: Uvalues below 0.8 W/m2K	1.53 W/(m²K)	1.022 – 0.908 W/(m²K)
Glazing: total solar heat gain transmittance > 50%	0.37	0.55-0.61
Ventilation heat recovery greater than 75%	59%	90%
Ventilation Fan Power less than 0.4 Wh/m³	0.471Wh/m³	2.33 Wh/m³
DHW – min heat losses	Tank meets NRCan, EF=0.83	Tank meets requirements and not changed.
Highly efficient electrical appliances	Most appliances are energy star rated	Appliances are not changed

The suggested values for the improvement were taken from the Passive House Planning Package (2007) and potential values in the software itself. The software provides a database of products to choose from when designing a home. The availability of these products in area was not reviewed as part of this study. The goal of this analysis is to reduce the specific space heating demand of the building from 117 kW/m²yr to 15 kW/m²yr. The first step in achieving this reduction is to minimize heat loses through the building envelope. A number of case studies that had achieved the Passive House standard from the literature review were considered when determining the appropriate changes that would need to be made to the house. A similar certified Passive House is the Smith House. Although the house was not built with SIPs, the climate is similar to Toronto. Toronto has approximately 4000 Heating Degree Days and Urbana, Illinois has 4600 Heating Degree Days. As such the required thermal properties of the home would be similar as well. The Smith House was built in Urbana, Illinois and had 350 mm of EPS underneath the foundation slab and an additional 152 mm of insulation on the exterior of the wall (Stecher, 2008). The other specifications of the home are summarized in the following table.

Table 13: PHPP Specifications of a similar home

Location	Urbana, IL
Area	105 m^2 (1,200 square feet), with loft
Foundation	Concrete-block frost wall
Foundation perimeter insulation	152 mm (6 inches) of expanded polystyrene
Under-slab insulation	356 mm (14 inches) of expanded polystyrene
Wall framing	Wall framing Vertical 305 mm (12-inch) Wooden I-Joists
Wall insulation	305 mm (12 inches) blown-in fiberglass plus 102 mm (4 inches) of exterior rigid polystyrene
Roof framing	406 mm (16-inch) wooden I-Joists with vent channels above the sheathing
Roof insulation	406 mm (16 inches) of blown-in fiberglass
Windows	EPS insulated fiberglass frames, triple-pane, argon-filled, low-e glazing
Ventilation system	90% sensible efficiency heat-recovery ventilator (HRV)
Heating system	1000 Watt (3400 btu/h) electric resistance element in the HRV
Domestic hot water system	Tankless electric water heater

This house achieved Passive House standards with a specific space heating requirement of 8 kWh/m^2 per year. The windows also had coatings with different SHGC depending on the orientation. The greatest SHGC windows were strategically placed on the south end of the building. In operation the average base electrical load for the house was 265 kWh per month (for the year 2005).

The recommended thermal envelope of the home was summarized in Table 9. The use of similar case study home was used in determining appropriate measures that can help to achieve Passive House. After the building envelope was optimized the requirement was then to improve the heat recovery of the ventilation air. A double core heat recovery unit was required in order to achieve the required 90% heat recovery effectiveness. The air now has to be pushed through two cores that greatly increased the fan power of the unit. All of these improvements were modeled in PHPP.

6. Results

6.1. Model Improvements

In addition to upgrading the SIP design to that discussed in Chapter 5, the mechanical systems were also upgraded. A new HRV would have to be installed to improve the heat recovery of the ventilation air. The Lifebreath Model 300 DCS has been selected for this home as it has a double core system for maximum heat recovery and is readily available in North America. This unit has a sensible heat recovery effectiveness of 90% (Energy Star, 2011). This unit does not come with an ECM motor although that may be requested when ordering or available in the near future. This unit consumes approximately 1.63 W/cfm. However, with an ECM motor it could be rated as low as 0.675 W/cfm (Energy Star 2011). This product does not seem to be available with an ECM motor currently and as such the fan rating of the PSC motor was included in the design. Currently the building only has one heat recovery ventilator in the basement of the building. There is a washroom located on the top floor of the building with direct exhaust; it is recommended that this washroom also has a heat recovery ventilator.

Additional measures were required to achieve Passive House. The air tightness was adjusted in both models to meet the Passive House requirement of 0.6 ACH at 50 Pa. The home originally met the R-2000 requirement of 1.5 ACH at 50Pa. The lighting in the case study building is currently all incandescent fixtures that consume much more energy than required and LED lighting throughout would help reduce that electrical load by 25.2%.

The windows were updated to triple glazed with high solar heat gain and argon filled, the window frames were also updated to include a super-spacer with a thermal transmittance of 0.681 W/m^{2}K. This product is a certified by the Passive House Institute and retrieved from the Passive House Product Database. However as the Passive House standard becomes more prevalent in Canada it would be assumed that similar products might be manufactured here in the near future.

The house is located in a dense neighbourhood in Toronto. The houses on either side of the case study home (north and south) are approximately 1 m away. The house to the north is 1 storey and vertically 3.8 m in height. However, there is no glazing on the north façade of the home. The house to the south is a taller two storey home, is 5.4 m. The effect of shading on a new PHPP design prevented the building from achieving Passive House. A Passive House depends on an exposed solar façade in order to gain heating. This building has another building directly adjacent to it, which blocks all of the solar gains. The removal of the shading that was included in the baseline design affected the specific space heating in the PHPP model by less than 5%. In the Passive House design, the glazing on the south side of the building is reduced to 9% of the actual size due to the home beside it. However, the removal of shading the Passive House design affected the heating demand by 70%. This is not a feasible method of achieving Passive House as it would require the demolition of the neighbouring home. The home was able to achieve the Passive House specific space heat demand requirement 14.06 kW/m^2yr. The specific space heating demand without considering shading effects on the home is 43 kW/m^2yr. In order the achieve the Passive House standard the home must have clear undisrupted access to the south sun.

The final measure required to reach the Passive House specific space heating requirement was to increase the amount of glazing on the south façade and reduce glazing on all of the other facades. The skylight was completely removed. Removing the skylight not only improves thermal performance of the building but it would also reduce the air leakage as this is one of the most common areas of air leakage. The glazing on the south façade had to increase to almost 43% of the wall area.

The size of the house is also a barrier in the achievement of Passive House. The requirement to increase the thickness of the walls in order to decrease thermal losses has caused the actual heated floor area of the building to decrease. This reduction in floor area impedes the achievement of a lower Specific Space Heating Demand. Passive House uses a metric for homes that is per floor area as opposed to total heating. This allows homes to be compared on a relative basis as opposed to an absolute basis. If absolute values were used then a smaller home would be rewarded for using less energy overall.The effect of the basement was also found to have a great influence on the Specific Space Heating Value. Typically Passive Houses do not have a "liveable" basement as most North American homes do. The case study home has a conditioned basement and this effect increases the specific space heating demand by 30%. A summary of all of the PHPP models and cases is shown in the following Table.

Table 14: Specific Space Heating Value of PHPP Simulations

Simulated Case	Specific Space Heating Demand (kWh/m^{2}yr)
Case Study Home	**117.2**
Passive House Design	**42.86**
Passive House Design without shading	**14.06**
Passive House Design without shading and basement	**9.82**

The PHPP model was used to determine the measures required to reach Passive House standard. In order to achieve Passive House the building must not have shading on the solar façade. These changes were then incorporated in the HOT2000 model to calculate annual energy usage compared to the R2000 standard.

6.2. Comparison of Models

The changes that were made to the Case Study home to achieve a Passive House compliant design were done in the PHPP simulation software first. These updates were then used to update the HOT2000 model. The new Passive House design was able to exceed the R-2000 energy target by 60%. This was primarily due to the significant increase in the thermal resistance of the building envelope. The changes in the window glazing and the type of glazing were also significant factors.

Table 15: R-2000 Results

Model	Annual Heating Consumption and DHW (ekWh)	R-2000 Energy Target (ekWh)	Percentage Difference
Case Study	10,591	15,100	30%
Passive House Design	5,717	15,100	62%

An interesting outcome while comparing the models was how the difference in window size affects the results. In the Passive House model the increase in window size is required to ensure that there is enough solar heat gain through the windows. It should be noted that the mechanical systems were autosized by HOT2000 for the updated Passive House design, this is because the equipment will need to be downsized due to the reduction in heating loads.

6.3. Analysis of Results

The updates included in the HOT2000 model (disregarding the required increase in window area size) achieved a total energy savings of 25.8%. This home would still not be close to achieving Net Zero and more mechanical and electrical changes to the building would be required in order to achieve a near net zero energy target.

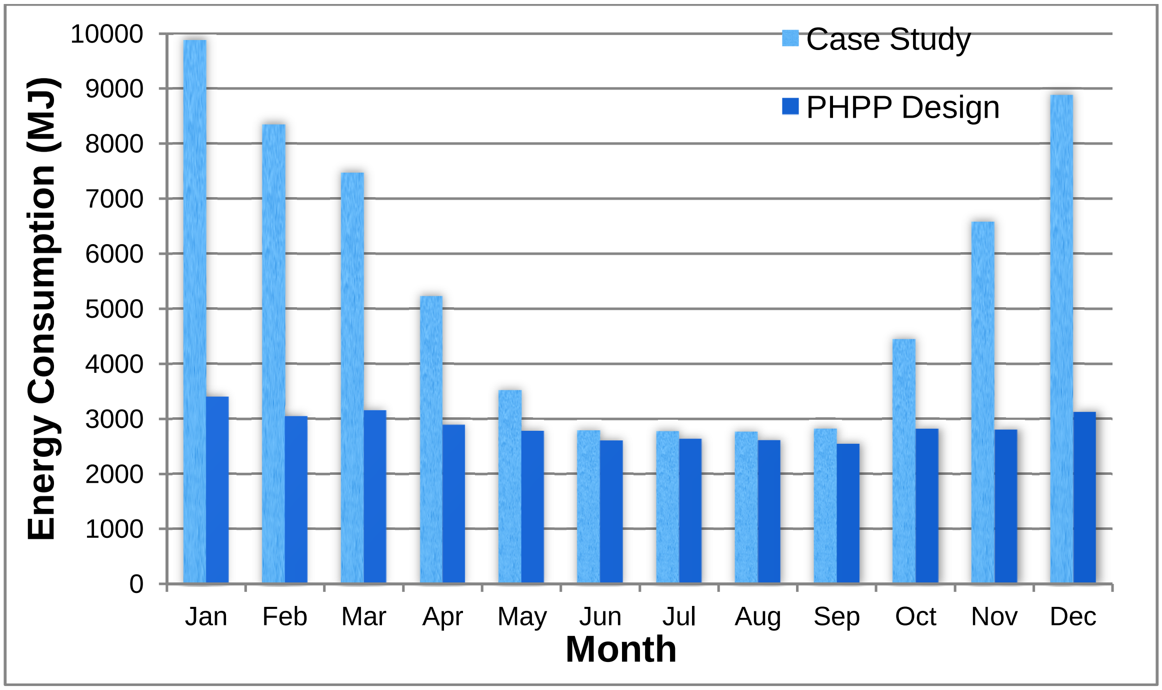


Figure 17: Total Monthly Energy Load (MJ) of Case Study and Passive House design

Overall, the Passive House Design was 47.5% more energy efficient than the Case Study Design. The Passive House design actually did not require any heating during the months of April to November. Some heating was required in the winter months, although it was significantly less than the Case Study amount. For example, the Case Study had required 6740 MJ of heating in January. This was reduced to 360 MJ of heating in the Passive House Design, a reduction of 95%. This new design is closer to being an actual Passive House which would require no heating at all. The Passive House standard is a standard that has originated in Germany and does not reflect Canadian building practices.

The Passive House standard is best suited for new construction designs where the goal of the construction is to achieve certification. This Passive House Design had required removing and increasing specific window sizes that would not be practical in a retrofit project. The building orientation is extremely important to achieving the specific space heating demand using Passive House design principles. This Passive House design required that the windows on the south façade be increased. The building would not achieve Passive

House due to the location of the building and its proximity to its neighbor. The south façade would be completely shaded in actuality. The building of a Passive House would require a large exposed south façade that is capable of achieving solar gains. Since, the current case study building is directly beside another home there is no way to achieve the solar gains required. The Passive House Standard is a standard that drives the industry to design buildings to higher standards in general.

7. Recommendations

There is a need for more research regarding potential materials that can be used in the manufacture of SIPs. This research should include more information for phase change materials and how they can be used. If more literature were available on the use of PCMs in SIPs then this project would also have considered them. The home that was built with SIPs should be monitored in order to have a more accurately calibrated model for comparison with the Passive House building to see exactly how the design updates affect the resulting energy consumption of the home.

This research should be extended to include a moisture analysis of various types of SIPs. Greater benefits of SIPs may be realized by using lower conductivity foam insulations and exploring different types of materials. More research is required on the applicability of the Passive House standard to the Canadian climate and if the requirements of the standard are practical for dense urban areas such as Toronto.

8. Conclusions

The results of this analysis indicate that the use of Structural Insulated Panels is beneficial to the achievement of Passive House certification. Throughout the literature analysis it has been noted that in many of the other case studies with SIPs the main benefit of them has been an increased air tightness that is not as easily achieved through conventional construction practices. The building could not achieve the Passive House standard with only the implementation of SIPs, the window glazing performance needed to increase to three pane glazing with super insulating spacers in the frames, the HRV also needed to be upgraded to a version with a greater heat recovery effectiveness. One of the greatest changes was the addition of glazing to the south façade and the reduction of shading to ensure solar gains. The thermal bridging analysis also identified that when the building enclosure had thermal resistance values that were lower the occurrence of thermal bridging was less. Passive House certification is achievable in Toronto and using Structural Insulated Panels will help to achieve Passive House Standards. The new Passive House design suggested for the home was also found to be 60% better than the R-2000 reference building.

References

Allan Manalo, *Structural behaviour of a prefabricated composite wall system made from rigid polyurethane foam and Magnesium Oxide board*, Construction and Building Materials, Volume 41, April 2013, Pages 642-653, ISSN 0950-0618, 10.1016/j.conbuildmat.2012.12.058. Accessed: http://www.sciencedirect.com/science/article/pii/S0950061813000147

Aste, N., Angelotti, A., & Buzzetti, M. (2009). The influence of the external walls thermal inertia on the energy performance of well insulated buildings. *Energy and Buildings, 41*(11), 1181-7.

Canadian General Standards Board (1986), Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method, CAN/CGSB-149.10-M86

Christain, J., and Kosny, J. (1995). "Thermal performance and wall ratings." paper on ORNL: http://www.ornl.gov/sci/roofs+walls/articles/wallratings/index.html

Christian (2011) High Performance Homes That Use 50% Less Than the DOE Building America Benchmark Building. http://www.sips.org/wp-content/uploads/2011/01/zeh-vs-benchmark-1-26-11-final-1.pdf

Christian, J. E., Richards, L., Childs, P., Atchley, J., & Moon, H. (2006). Energy efficiency, SIPS, geothermal, and solar PV used in near zero-energy house. ASHRAE Transactions, 112, 275-284. Retrieved from http://ezproxy.lib.ryerson.ca/login?url=http://search.proquest.com/docview/192583087?accountid=13631

CMHC 2010 - Equilibrium Housing Insight Avalon Discovery 3: Double Structural Insulated Panel: http://www.cmhc-schl.gc.ca/odpub/pdf/66966.pdf?fr=1337021264898

Fan, Mizi et al. Nature and Behaviour of cement bonded particleboard: structure, physical property and movement. Journal of Material Science September 2006, Volume 41, Issue 17, pp 5666-5678.

Gagnon, M. A., & Adams, R. D. (1999). Marketing profile of the U.S. structural insulated panel industry. *Forest Products Journal, 49*(7), 31-35.

Gray, Steven (2011) Interview regarding case study home.

Jannumahanthi, M. (2010). *Comprehensive energy analysis of a near zero energy home.* ProQuest Dissertations and Theses, 68. Retrieved from http://ezproxy.lib.ryerson.ca/login?url=http://search.proquest.com/docview/821467458?accountid=13631. (821467458).

Kawasaki, T., & Kawai, S. (2006). Thermal insulation properties of wood-based sandwich panel for use as structural insulated walls and floors. *Journal of Wood Science, 52*(1), 75-83.

Kermani, A. (2006). Performance of structural insulated panels. *Proceedings of the Institution of Civil Engineers.Structures and Buildings*, *159*, 13-19.

Krarti, Moncef; Hildreth, Tom Comparative thermal analysis of structural insulated panels and wood frame walls for residential buildings *International Solar Energy Conference*, p 659-669, 2007, *Proceedings of the ASME International Solar Energy Conference, ISEC2006*

Lstiburek, Joseph (2008). "Builder's Guide to Structural Insulated Panels (SIPs) for all Climates". Building Science Press.

Lee, S., Kim, S., Kim, S., Park, Y., & Park, J. (2006). Experimental research on performance of the solar heat gain (SHG) insulation panel. *Building and Environment, 41*(3), 336-342.

Marvin (2009) Integrity Wood-Ultrex Series Published by Marvin Windows and Doors. Accessed: http://www.integritywindows.com

Medina, M. A., King, J. B., & Zhang, M. (2008). On the heat transfer rate reduction of structural insulated panels (SIPs) outfitted with phase change materials (PCMs). *Energy, 33*(4), 667-678.

Ministry of Municipal Affairs and Housing (2011) Supplementary Standard SB-12 Energy Efficiency of Housing, revised December 5, 2011. MR-11-S-17

Mousa, M. A., & Uddin, N. (2010). Debonding of composites structural insulated sandwich panels. *Journal of Reinforced Plastics and Composites, 29*(22), 3380-3391.

Mullens, M. A., & Arif, M. (2006). Structural insulated panels: Impact on the residential construction process. *Journal of Construction Engineering and Management, 132*(7), 786-794.

NRCan (2010) HOT2000 Procedures Manual Revision 4: March 2010 - HOT2000 Version 10.5.

NRCan http://oee.nrcan.gc.ca/sites/oee.nrcan.gc.ca/files/files/residential/personal/documents/Chapter3_e.pdf

NRCan 2010 Energy Use Data Handbook. Energy Publications, Office of Energy Efficiency, Natural Resources of Canada. accessed via: http://oee.nrcan.gc.ca/publications/statistics/handbook09/pdf/handbook09.pdf

NRCan (2010). Survey of Household Energy Use 2007: Detailed Statistics. Accessed: http://oee.nrcan.gc.ca/publications/statistics/sheu07/pdf/sheu07.pdf

Insulspan (2013) SIP Details: Insulspan Technical Information. Accessed: http://www.insulspan.com/product_specs/sip_details.aspx

Gamtessa, Samuel (2006). Trends in Retrofit Activity in the EnerGuide for Houses Program. CREEDAC-2006-RP-08. Accessed: http://www.cbeedac.com/publications/documents/EGHreport2006-rp08.pdf

NRCan (2001). Evaluation Report CCMC 13016-R: Insulspan Structural Insulated Panel System. Accessed: http://www.nrc-cnrc.gc.ca/ccmc/registry/pdf/13016_e.pdf

Raycore (2013). Toronto Passive House Uses Ray-Core Sips to Achieve R16 Wall http://www.raycore.com/blog/passive-house-toronto-raycore-sips/

SGC Horizon Building and Construction Group (2012). New standard for structural insulated panels under development. (2012). *Building Design & Construction,* Retrieved from http://ezproxy.lib.ryerson.ca/login?url=http://search.proquest.com/docview/1281967893?accountid=13631

Sadineni, Suresh et al. Passive building energy savings: A review of building envelope components. Renewable and Sustainable Energy Reviews 15 (2011) 3617-3631.

Sennah, K., Butt, A., & Taraba, E. (2008). Development of structural insulated sandwich timber panels with foam-core spline connections for roof construction. *Annual Conference of the Canadian Society for Civil Engineering 2008 - "Partnership for Innovation", June 10, 2008 - June 13, 3* 1542-1551.

Sennah, K., & Mohamed, M. (2010). Experimental study on insulated foam-timber sandwich panels as basement walls in residential construction. *Annual Conference of the Canadian Society for Civil Engineering 2010, CSCE 2010, June 9, 2010 - June 12, 2* 951-960.

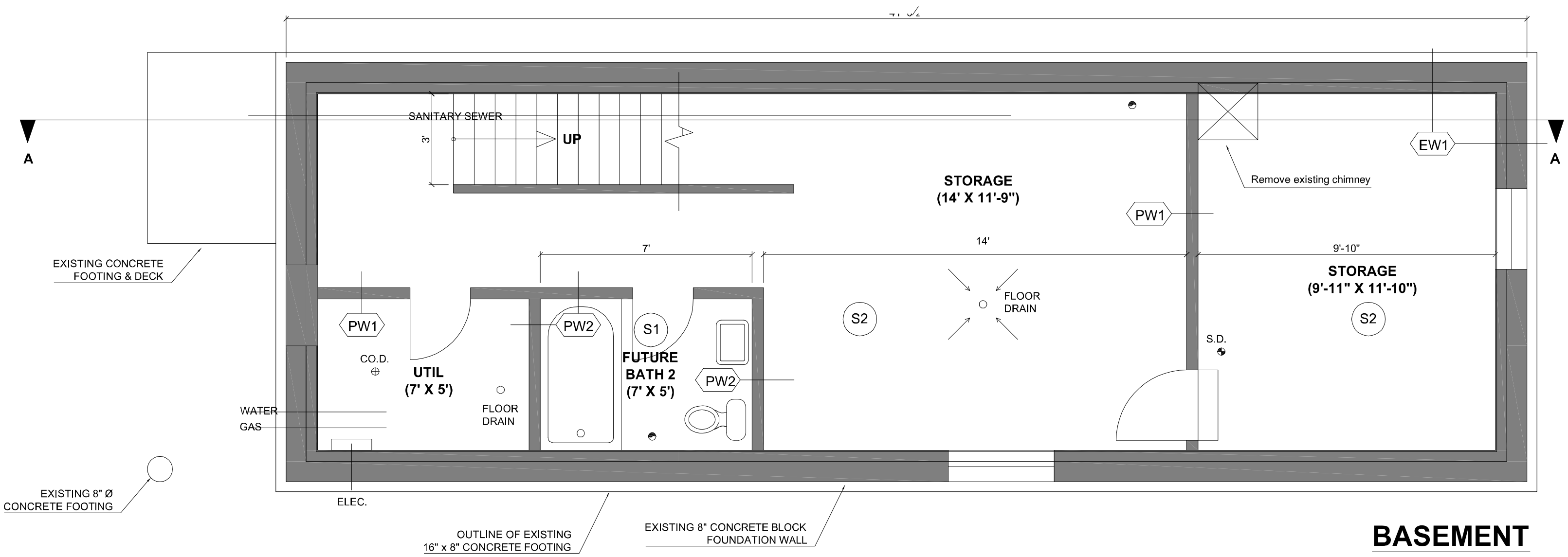
Taylor, S. B., Manbeck, H. B., Janowiak, J. J., & Hiltunen, D. R. (1997). Modeling structural insulated panel (SIP) flexural creep deflection. *Journal of Structural Engineering New York, N.Y., 123*(12), 1658-1665.

Ueno, Kohta (2010). Residential Exterior Wall Superinsulation Retrofit Details and Analysis. ASHRAE 2010. Accessed: http://www.buildingscience.com/documents/reports/rr-1012-residential-exterior-wall-superinsulation-retrofit

Vaidya, A., Uddin, N., Vaidya, U., Serrano, J., & Husman, G. (2007). Thermoplastic composite structural insulated panels (CSIPS) for building construction. *SAMPE '07: M and P - from Coast to Coast and Around the World, June 3, 2007 - June 7, , 52* SAMPE Baltimore/Washington Chapter.

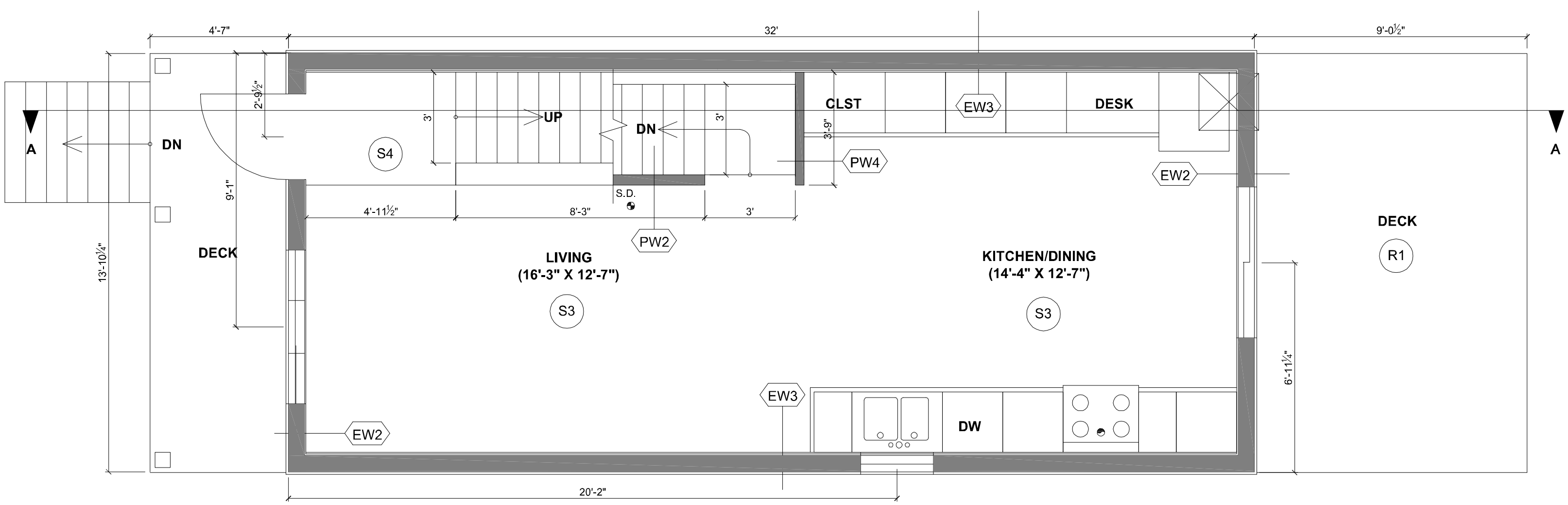
Yeh, B., Williamson, T., & Keith, E. (2008). Development of structural insulated panel standards. *2008 Structures Congress - Structures Congress 2008: Crossing the Borders, April 24, 2008 - April 26, 314*

Appendix A: Case Study Drawings



BASEMENT

SCALE 1/4" = 1'-0"



GROUND FLOOR

SCALE 1/4" = 1'-0"

General Notes

No.	Revision/Issue	Date
5	For SIPs Design 1	18-07-2010
4	Termites	13-07-2010
3	For Permit R1	11-06-2010
2	For Permit	10-05-2010
1	For PAL Review	20-11-2009

[redacted]

FLOOR PLANS

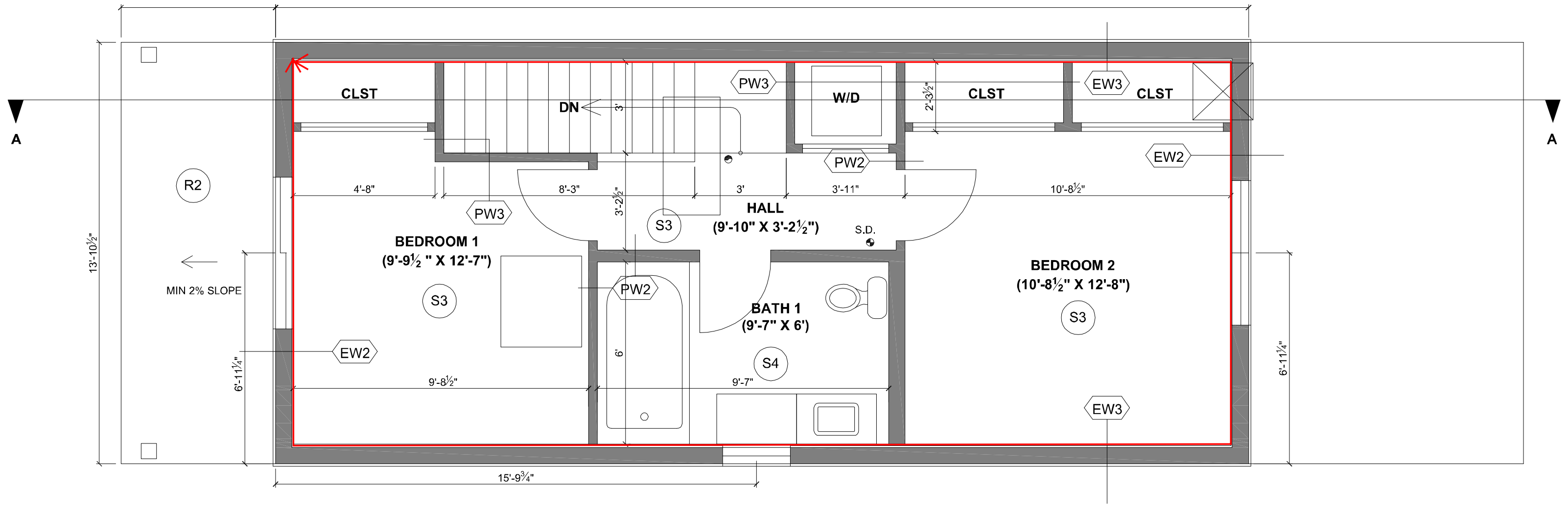
Project [redacted]

Date

Scale

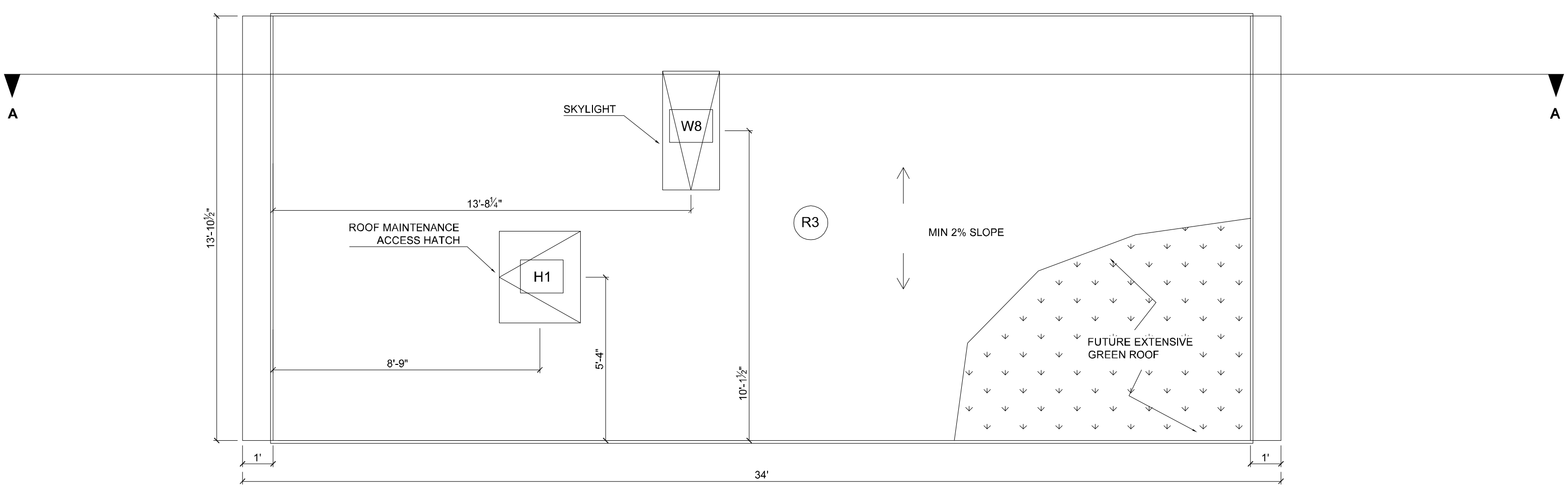
Sheet

A-1



PROPOSED SECOND FLOOR

SCALE 1/4" = 1'-0"



PROPOSED ROOF

SCALE 1/4" = 1'-0"

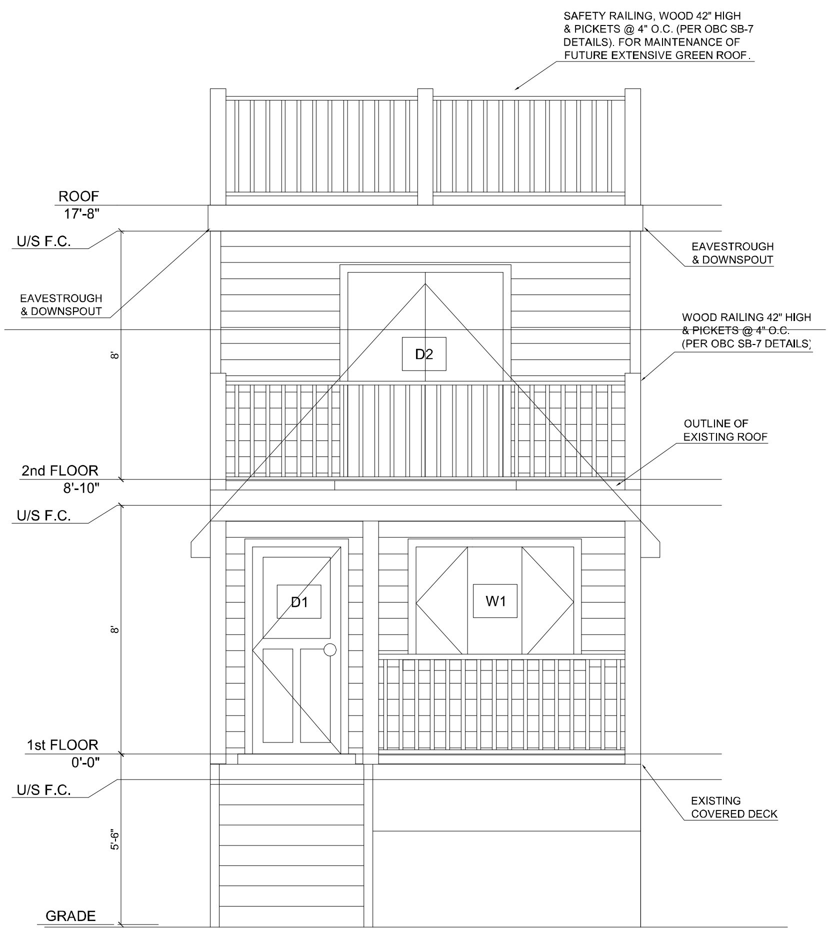
General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	19-07-2010
3	For Permit R1	11-06-2010
2	For Permit	19-05-2010
1	For PAL Review	20-11-2009

[redacted]

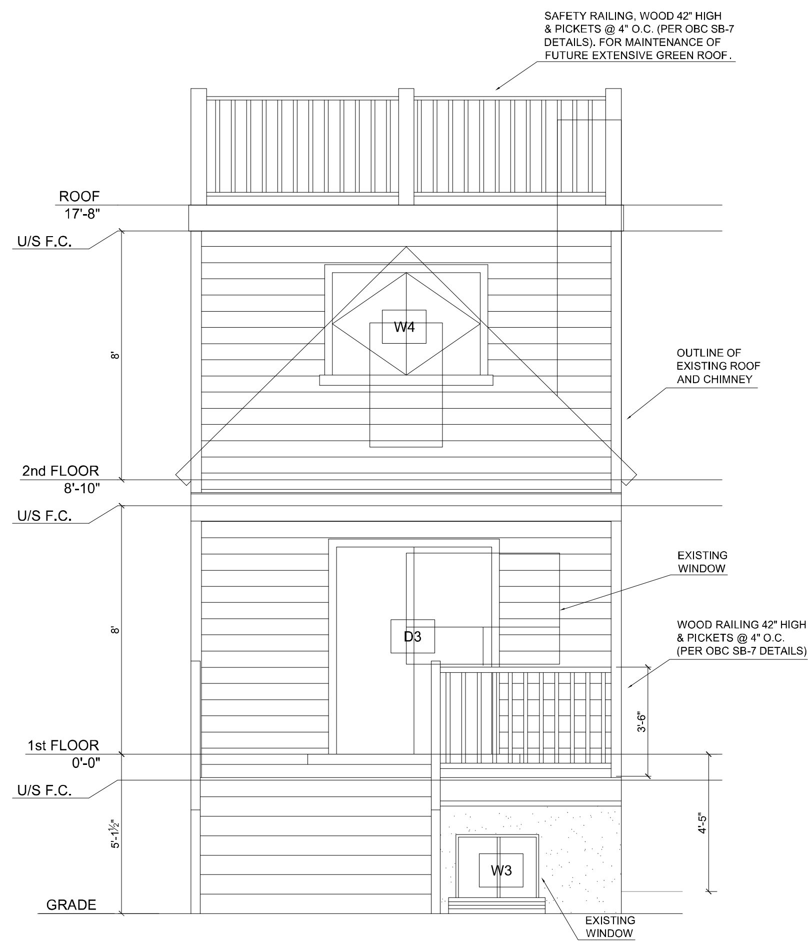
FLOOR & ROOF PLANS

Project [redacted]
Date
Scale
Sheet
A-2



EAST ELEVATION

SCALE 1/4" = 1'-0"



WEST ELEVATION

SCALE 1/4" = 1'-0"

General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	19-07-2010
3	For Permit R1	11-06-2010
2	For Permit	19-05-2010
1	For PAL Review	20-11-2009

[redacted]

ELEVATIONS

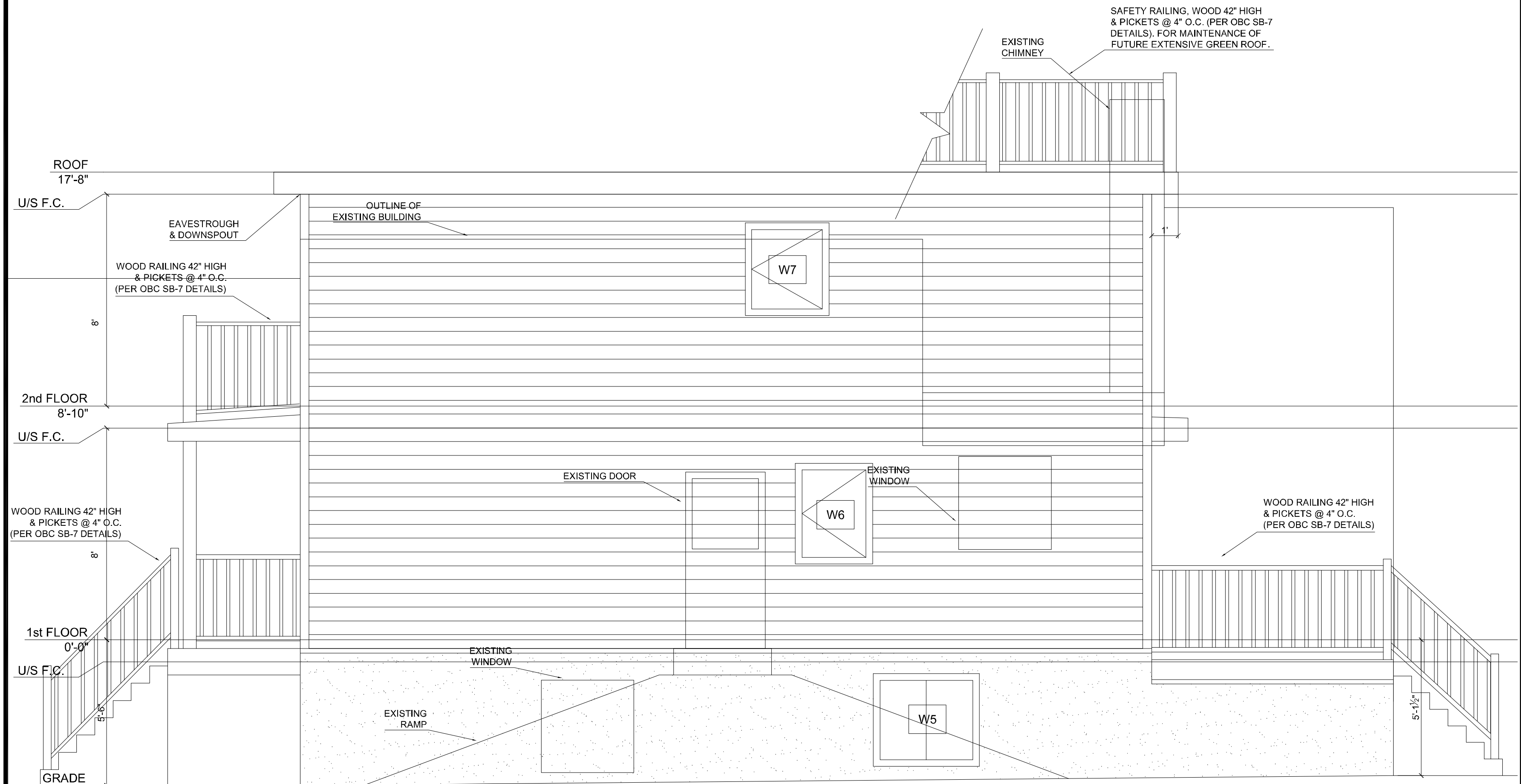
[redacted]

Date

Scale

Sheet

A-3



GLAZED AREA
EXISTING 31 SF
NEW 27 SF

SOUTH ELEVATION

SCALE 1/4" = 1'-0'

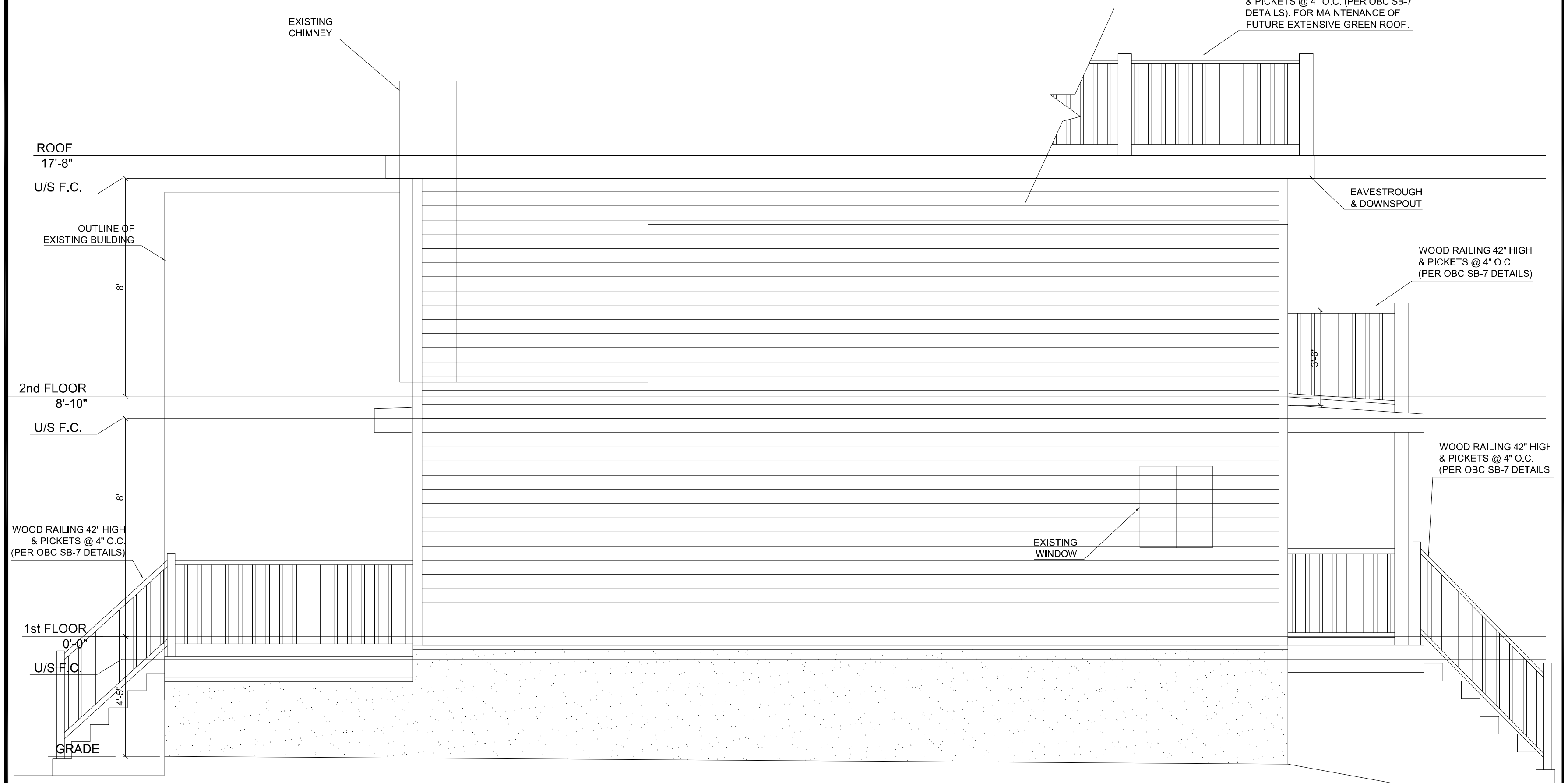
General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	18-07-2010
3	For Permit R1	11-06-2010
2	For Permit	10-05-2010
1	For PAL Review	20-11-2009

[redacted]

ELEVATION

Project [redacted]
Date
Scale
Sheet
A-4



GLAZED AREA
EXISTING 8 SF
NEW 0 SF

NORTH ELEVATION

SCALE 1/4" = 1'-0"

General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	18-07-2010
3	For Permit R1	11-06-2010
2	For Permit	10-05-2010
1	For PAL Review	20-11-2009

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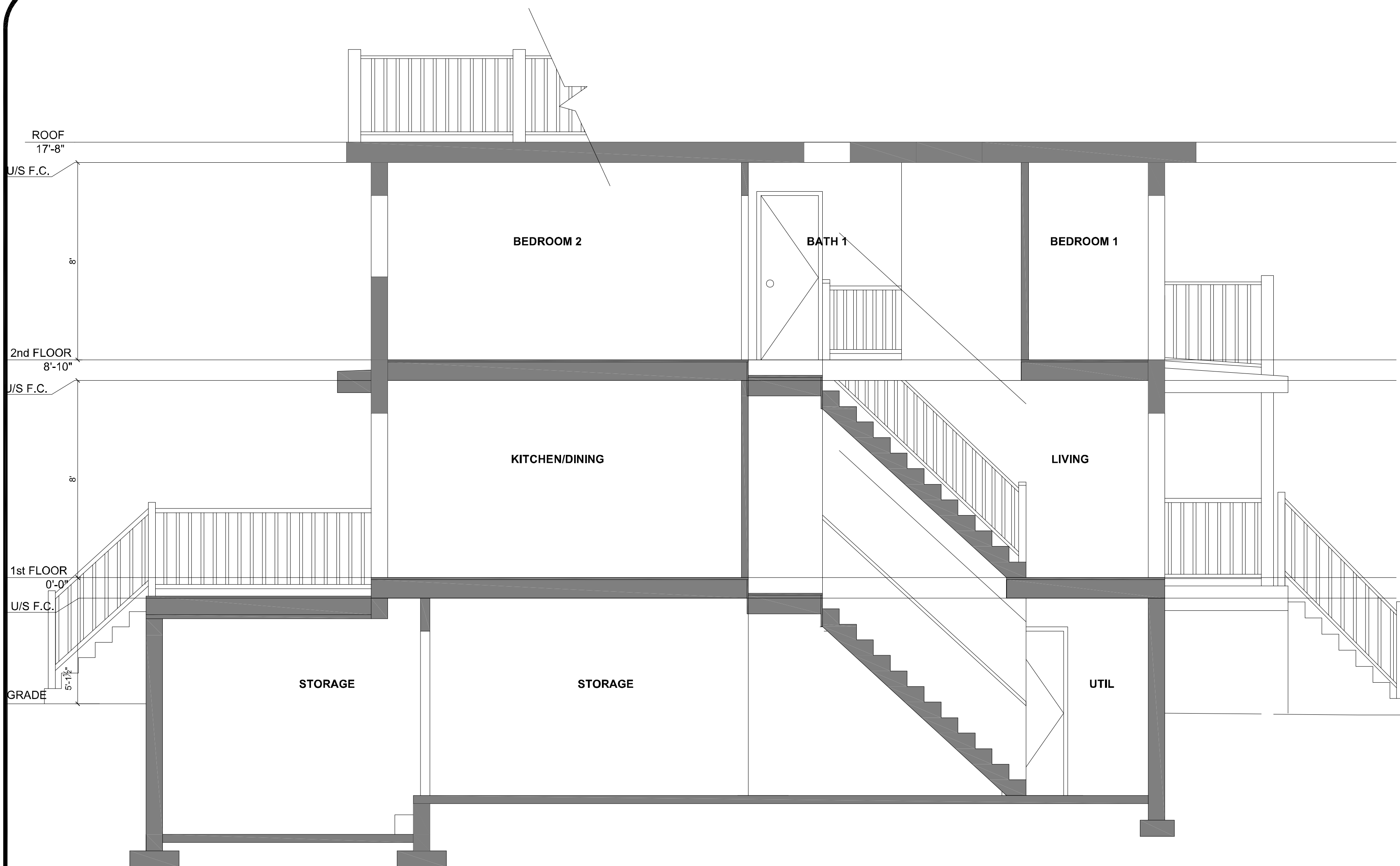
ELEVATION

Project [redacted]
Date
Scale
Sheet
A-5



SECTION

SCALE 1/4" = 1'-0"

General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	18-07-2010
3	For Permit R1	11-06-2010
2	For Permit	10-05-2010
1	For PAL Review	20-11-2009

[redacted]

SECTION

Project [redacted]

Date

Scale

Sheet

A-6

ASSEMBLIES:

FLOORS:

S1 **Basement Floor 1**
- 12" X 12" ceramic tile
- thinset mortar bed
- 4" existing concrete slab

S2 **Basement Floor 2**
- engineered hardwood flooring
- aerated OSB subfloor
- 4" existing concrete slab

S3 **Floor 1**
- engineered hardwood flooring
- 3/4" T&G plywood sheathing
- 2 X 10 joists at 16" O.C.
- 1/2" GWB, painted finish

S4 **Floor 2**
- 12" X 12" ceramic tile
- thinset mortar bed
- 3/4" T&G plywood sheathing
- 2 X 10 joists at 16" O.C.
- 1/2" GWB, painted finish

LEGEND:

S.D. smoke detector

CO.D. carbon monoxide detector

exhaust fan

EXTERIOR WALLS:

EW1 **Exterior Wall 1**
- Cement parging
- 8" concrete block (existing - repair or replace deteriorated elements)
- 2 X 4 metal stud framing, offset 1/2" from block wall (cavity filled with R15 mineral wool batt insulation)
- 6 mil polyethylene vapour retarder
- 1/2" GWB, painted finish

EW2 **Exterior Wall 2**
- Non-combustible cladding (fibre cement siding - Hardie or similar)
- 1" strapping (vented cavity)
- SPBO building wrap
- 1/2" OSB sheating
- 2 X 6 wood studs @ 16" O.C. (for existing first floor repair or replace deteriorated elements) cavity filled with R20 mineral wool batt insulation
- 6 mil polyethylene vapour retarder
- 1/2" GWB, painted finish

EW3 **Exterior Wall 3 (1 hr fire rating)**
- Non-combustible cladding (fibre cement siding - Hardie or similar)
- 1" strapping (vented cavity)
- SPBO building wrap
- 1/2" OSB sheating
- 2 X 6 wood studs @ 16" O.C. (for existing first floor repair or replace deteriorated elements) cavity filled with R20 mineral wool batt insulation
- 6 mil polyethylene vapour retarder
- 5/8" GWB, painted finish

ROOFS:

R1 **Roof 1**
- 2 X 6 PT wood decking on rigid insulation pedestals (anchored to rim joist and guardposts)
- 2-ply modified bitumen membrane
- Mechanically fastened asphaltic protection board
- 3/4" T&G plywood sheathing
- 2 X tapered purlins
- 2 X 10 joists at 16" O.C. (cavity filled with R40 mineral wool batt insulation)
- 1/2" GWB, painted finish

R2 **Roof 2**
- 2 X 6 PT wood decking on rigid insulation pedestals (anchored to rim joist and guard posts)
- 2-ply modified bitumen membrane
- Mechanically fastened asphaltic protection board
- 3/4" T&G plywood sheathing
- 2 X tapered purlins
- 2 X 10 joists at 16" O.C.
- T&G knotty pine

R3 **Roof 3 (Future Extensive Green Roof)**
- Same as Roof 1, omit decking

INTERIOR PARTITION WALLS:

PW1 **Partition Wall 1**
- 1/2" GWB, painted finish
- 2 X 4 wood or metal stud framing
- 1/2" GWB, painted finish

PW2 **Wet Partition Wall**
- 1/2" GWB, painted finish
- 2 X 6 wood stud framing
- 1/2" cement board w/tile or moisture resistant GWB w/painted finish

PW3 **Thin Partition Wall**
- 1/2" GWB, painted finish
- 2 X 3 wood or metal stud framing
- 1/2" GWB, painted finish

WINDOW AND DOOR SCHEDULE:

	Description	R.O.	Integrity #	Exterior Finish	Interior Finish	Nailing flange	* Jamb extension	Hardware	Glazing
W1	Front window. Casement-Fixed-Casement.	61" X 43 3/4"	ICA 2143 3CW	Bronze	Unfinished	yes	yes 7"	Satin-nickel	Double glazed w/argon
W2	Front basement. Fill in masonry opening.								N/A
W3	Back basement. Reuse existing.								Double glazed w/argon
W4	Back bedroom, 2nd floor. Casement-Casement.	57" X 39 5/8"	ICA 2939 2W	Bronze	Unfinished	yes	no	Almond	Double glazed w/argon
W5	Side basement	42" X 36"	N/A	White	White	no	no	no	Double glazed w/argon
W6	Side stairwell window. Casement.	29" X 35 5/8"	ICA 2935	Bronze	Unfinished	yes	no	Almond	Double glazed w/argon
W7	Bathroom, 2nd floor. Double hung. Frosted.	26 3/4" x 40 1/2"	ITDH 2640	Bronze	Primed	yes	yes 7-3/4"	White	Obscure
W8	Skylight. Velux, operable, curb mounted.	22.5" X 46.5"							Double glazed w/argon
D1	Front entrance door. RH, Outswing. Aluminum-clad exterior. Wood-textured fibreglass. Top lite English walnut stain kit.	38 7/8" X 82 5/8"	Fiber-Classic Oak 2100	Bronze	Unfinished	yes	yes 7"	Pre-drilled for handle and lockset	Double glazed w/argon
D2	Patio door 2nd floor balcony.	60" X 80"	ISP D5065 XO	Bronze	Unfinished	yes	no	Almond	Double glazed w/argon
D3	Patio door back ground floor.	60 1/4" X 80 1/4"	ISP D5065 XO	Bronze	Unfinished	yes	yes 7"	Satin-nickel, keyed lock.	Double glazed w/argon
H1	Roof hatch.	30" X 36"							

General Notes

No.	Revision/Issue	Date
4	For SIPs Design 1	18-07-2010
3	Termites	13-07-2010
2	For Permit R1	11-06-2010
1	For Permit	10-05-2010

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KEYNOTES

Project [redacted]

Date

Scale

Sheet A-7

GENERAL / STANDARD NOTES

BEFORE INSTALLATION OF YOUR INSULSPAN PANELS, INSULSPAN REQUIRES THAT YOU ARE FAMILIAR WITH THE PROVIDED INSULSPAN INSTALLATION AND CONSTRUCTION GUIDE.

INSULSPAN MAKES EVERY EFFORT TO SUPPLY COMPLETE PANEL LAYOUT DRAWINGS FROM THE ORIGINAL ARCHITECTURAL AND/OR STRUCTURAL DRAWINGS PROVIDED TO US. IT IS THE RESPONSIBILITY OF THE CONTRACTOR OR OWNER TO CHECK AND VERIFY ALL DIMENSIONS, NOTES AND DETAILS ON THE PANEL DRAWINGS FOR COMPATIBILITY WITH THE ARCHITECTURALS AND OTHER CONSULTANTS' DRAWINGS AND EXISTING CONDITIONS PRIOR TO COMMENCEMENT OF WORK.

THE CONTRACTOR ASSUMES RESPONSIBILITY FOR COORDINATING THE VARIOUS OTHER CONSTRUCTION DOCUMENTS WITH THE CURRENT INSULSPAN PANEL LAYOUT DRAWINGS TO ASSURE CODE COMPLIANCE AND CORRECTNESS OF WORK.

THE CONTRACTOR IS ALSO RESPONSIBLE FOR OBTAINING FINAL COMMENTS AND APPROVAL FROM ALL LOCAL GOVERNING AGENCIES.

BY USE OF THESE DOCUMENTS, THE OWNER AND THE CONTRACTOR CERTIFY THAT THEY HAVE REVIEWED THEM AND ARE IN AGREEMENT WITH THEIR CONTENT.

SHOULD ANY DISCREPANCIES OR OMISSIONS BE FOUND, IT IS UP TO THE CONTRACTOR OR OWNER TO NOTIFY AN INSULSPAN REPRESENTATIVE (IN WRITING), AS SOON AS POSSIBLE SO THAT CORRECTIONS CAN BE MADE.

FURTHERMORE, THE CONTRACTOR OR OWNER SHALL NOTIFY INSULSPAN (IN WRITING) OF ALL CHANGES TO SITE AND FIELD CONDITIONS PRIOR TO THE START OF PANEL FABRICATION.

IT IS UP TO THE CONTRACTOR OR OWNER TO PROVIDE A LEVEL AND SQUARE FOUNDATION TO ENSURE A GOOD FIT OF THE INSULSPAN PANELS. INSULSPAN DOES NOT ASSUME RESPONSIBILITY FOR ANY VARIANCES FROM THE FINAL SIGNED PANEL DRAWINGS AND SPECIFICATIONS OR ADJUSTMENTS REQUIRED RESULTING FROM THE CONDITIONS ENCOUNTERED ON THE JOB SITE, AND IS THE SOLE RESPONSIBILITY OF THE OWNER OR CONTRACTOR.

INSULSPAN PANEL LAYOUT DRAWINGS ARE TO BE USED AS A GUIDE FOR THE CORRECT PLACEMENT AND INSTALLATION OF THE PANELS AND ARE BY NO MEANS A REPLACEMENT FOR ARCHITECTURAL OR STRUCTURAL DRAWINGS. THESE DRAWINGS EXCLUDE ANY DESIGN OF SITE, FOUNDATION, MECHANICAL, ELECTRICAL OR PLUMBING.

ALL WRITTEN DIMENSIONS SHOWN ON PLANS, SECTIONS AND DETAILS TAKE PRECEDENCE OVER SCALED DRAWINGS.

SOME LUMBER MAY BE LABELED "TEMP", THIS IS TO ALLOW FOR THIS PIECE TO BE REMOVED FOR PANEL ADJUSTMENTS. THIS PIECE MUST BE NAILED OFF COMPLETELY PER THE NAIL SCHEDULE.

THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY BRACING REQUIRED FOR STRUCTURE STABILITY AND FOR CONSTRUCTION LOADING UNTIL THE PROJECT IS COMPLETED.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR INITIATING, MAINTAINING AND SUPERVISING ALL SAFETY PRECAUTIONS DURING CONSTRUCTION AND SHALL ENSURE COMPLIANCE TO CURRENT AND LOCAL REGULATIONS.

PANEL SCREWS @ 12" O.C. W/ 1-1/2" MIN. PENETRATION INTO STRUCTURAL SUPPORT (U.N.O.).

FOR MATERIAL SPECIFICATIONS ON SIPS REFER TO NER 520 DATED JAN. 01/04. SEE ALSO: www.insulspan.com

DRAWING SYMBOLS AND COLOR CODES

PANEL OUTLINE (TOP SKIN)
PANEL OUTLINE (BOTTOM SKIN)
DIMENSIONAL LUMBER
ELECTRICAL CHASE

WALL / A — INTERIOR / EXTERIOR ELEVATION REFERENCE

SECTION / A — BUILDING / WALL SECTION REFERANCE

100.01 — STANDARD INSULSPAN DETAIL REFERENCE

ELEVATION LEVEL LINE

WA01 = WALL ELEVATION "A" PANEL NUMBER
F04 = FLOOR PANEL NUMBER
RA01 = ROOFPLANE "A" PANEL NUMBER

REVIEWING CLIENT APPROVAL DRAWINGS

WHEN REVIEWING THESE DRAWINGS, BEGIN BY CHECKING THE FOLLOWING:

- CHECK AND CONFIRM THAT ALL OVERALL DIMENSIONS MATCH THOSE OF THE ARCHITECTURAL SET OF PLANS ISSUED FOR THE PROJECT.

- IF THERE ARE SIP ROOF PANELS FOR THIS PROJECT, AN OUTLINE OF THE SIP ROOF WILL BE SHOWN ON THE FLOOR PLAN. ALSO, SIP ROOF PANELS WILL BE DETAILED ON INDIVIDUAL DRAWINGS IN A DIAGONAL PROJECTION. CHECK ROOF PITCH(S), RIDGE CONFIGURATION/LAYOUT AND OVERHANG(S) AT EAVE(S) AND GABLE(S). IF THERE ARE SKYLIGHTS, CHECK THE ROUGH OPENING SIZE(S) AND LOCATION(S). ALL ROOF DIMENSIONS SHOULD MATCH THOSE OF THE ARCHITECTURAL SET OF PLANS ISSUED FOR THIS PROJECT.

- IF THERE IS A SIP WALL PANEL PACKAGE FOR THIS PROJECT, THE SIP WALL PANELS WILL BE SHOWN ON A KEYED FLOOR PLAN SEPARATED INTO FIRST AND SECOND FLOORS (WHEN NECESSARY). THE SIP WALL PANELS WILL BE CUT INTO LENGTHS THAT BEST SUIT INSULSPAN'S MANUFACTURING. EACH PANEL WILL BE LABELED. NOTE THAT SOME WALL LENGTHS WILL BE SHORTER DUE TO CORNER LAPS AND PANEL THICKNESS. CHECK SIP PANEL THICKNESS, CORNER LAPS AND SIP WALL LENGTHS AND HEIGHTS. THE OVERALL WALL DIMENSIONS SHOULD MATCH THOSE OF THE ARCHITECTURAL SET OF PLANS.

- CHECK THAT ALL WINDOW AND DOOR ROUGH OPENINGS ARE CORRECT SIZES AND THAT THEY ARE LOCATED AND DIMENSIONED CORRECTLY. THESE DIMENSIONS SHOULD MATCH THOSE OF THE ARCHITECTURAL SET OF PLANS ISSUED FOR THE PROJECT.

- CHECK LOCATIONS OF ELECTRICAL CHASES.

- IF THERE IS A SIP FLOOR PANEL PACKAGE FOR THIS PROJECT, CHECK DIMENSIONS AND LOCATIONS OF POINT LOADS AND OPENINGS.

THESE DRAWINGS ARE TO BE REVIEWED BY THE OWNER/CONTRACTOR AND APPROVED CONFIRMING ALL DIMENSIONS. IF THERE ARE ANY CHANGES/CORRECTIONS, NOTE THEM ON THESE DRAWINGS AND FORWARD TO INSULSPAN FOR REVISIONS.

ABBREVIATIONS

A.F.F. - ABOVE FINISHED FLOOR
APPROX. - APPROXIMATE
BLDG. - BUILDING
BLK. - BLOCK
BLKG. - BLOCKING
BM. - BEAM
B.O. - BY OTHERS
BOT. - BOTTOM
C/C - CENTER TO CENTER
C.F. - CUBIC FEET
CL. - CENTER LINE
C/W - COMPLETE WITH
CONC. - CONCRETE
CONT. - CONTINUOUS
DBL. - DOUBLE
D.F. - DOUGLAS FIR
DIA. - DIAMETER
DIM(S) - DIMENSION(S)
DN - DOWN
DWG. - DRAWING
EA. - EACH
ELEV. - ELEVATION
ELEC. - ELECTRICAL
EPS - EXPANDED POLYSTYRENE
EQ. - EQUAL
E.W.P. - ENGINEERED WOOD PRODUCT
EXT. - EXTERIOR
F.G. - FOAM GAP
FIN. - FINISH
FLR. - FLOOR
FND(S). - FOUNDATION(S)
GALV. - GALVANIZED
G.C. - GENERAL CONTRACTOR
G.L. - GLULAM
GLB. - GLULAM BEAM
GYP BD. - GYPSUM BOARD
HD. - HOLDOWN
HDR. - HEADER
HORIZ. - HORIZONTAL
HVAC. - HEAT, VENTILATION, AIR CONDITIONING
INSUL. - INSULATION
INT. - INTERIOR
LSL - LAMINATED STRAND LUMBER
LVL - LAMINATED VENEER LUMBER
MAX. - MAXIMUM
MIN. - MINIMUM
N/A - NOT APPLICABLE
N.T.S. - NOT TO SCALE
O.C. - ON CENTER
OSB - ORIENTED STRAND BOARD
PLYWD. - PLYWOOD
P.T. - PRESSURE TREATED
PSF - POUNDS PER SQUARE FOOT
PSL - PARALLEL STRAND LUMBER
REQ'D - REQUIRED
R.O. - ROUGH OPENING
SIM. - SIMILAR
SIP - STRUCTURAL INSULATED PANEL
SPEC(S). - SPECIFICATION(S)
SPF - SPRUCE/PINE/FIR
STD. - STANDARD
STRUCT. - STRUCTURE, STRUCTURAL
SPH - STRUCTURAL PANEL HEADER
SYS. - SYSTEM
T.O. - TOP OF
TYP. - TYPICAL
U.N.O. - UNLESS NOTED OTHERWISE
VERT. - VERTICAL
V.I.F. - VERIFY IN FIELD
W/ - WITH
W/O - WITHOUT
W.C. - WIRECHASE
WD. - WOOD

PANEL DESIGN CRITERIA

	PANEL THICKNESS	EPS CORE WIDTH	OSB WIDTH
HOUSE WALLS	$6\frac{1}{2}$"	$5\frac{5}{8}$"	$\frac{7}{16}$"
GARAGE WALLS			
ROOF	$10\frac{1}{4}$"	$9\frac{3}{8}$"	$\frac{7}{16}$"
FLOOR			

PROJECT DESIGN LOADS

SNOW LOAD, kPa $\frac{1}{50}$:
Ss=0.9 Sr=0.4
HOURLY WIND PRESSURE, kPa:
$\frac{1}{10}$= 0.35 $\frac{1}{50}$= 0.52

Engineering Note:
ADD AN ADDITIONAL 25 PSF/1.9 kPA DEAD LOAD FOR FUTURE GREEN ROOF LOADING PER CUSTOMER REQUEST.

List of Drawings

Page #	Description
P-1	COVER
P-2	PLAN AND ELEVATION VIEWS
P-3	DETAILS

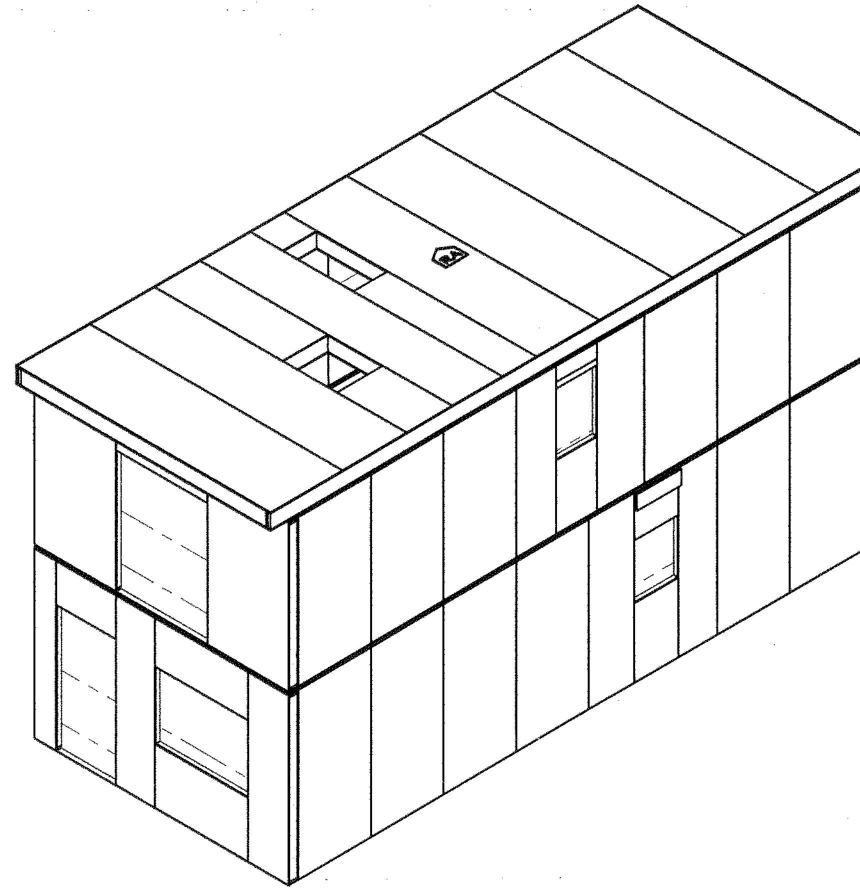
RESIDENCE VENTILATION NOTE:

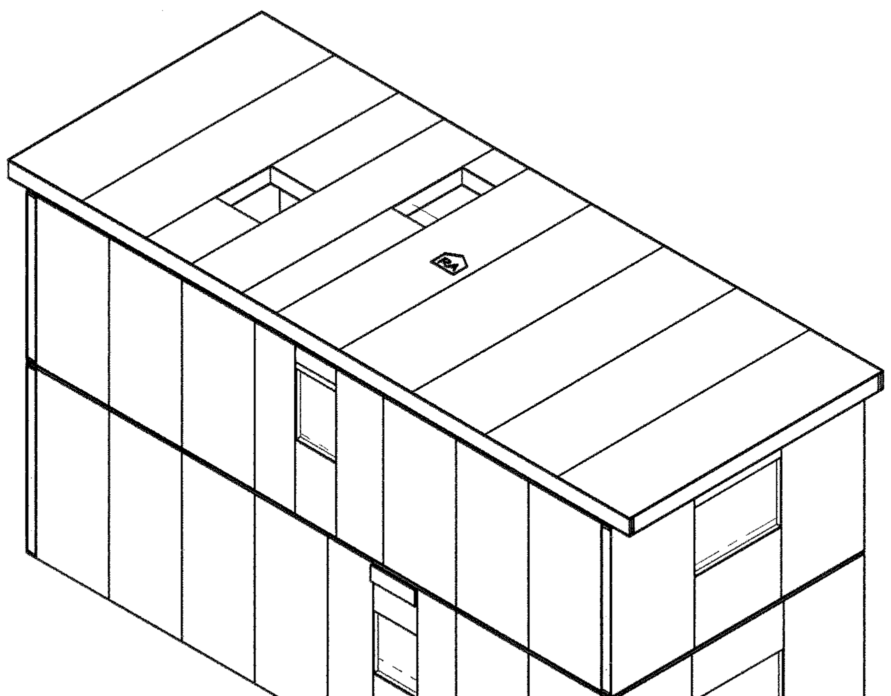
A MECHANICAL VENTILATION SYSTEM IS REQUIRED TO PROVIDE AIR MOVEMENT AND REMOVE HUMIDITY. EXCESS HUMIDITY IN THE HOME COULD RESULT IN A BUILD UP OF WATER VAPOR IN UNWANTED AREAS CAUSING SEVERE DAMAGE TO THE STRUCTURAL INSULATED PANEL OR OTHER BUILDING MATERIALS.

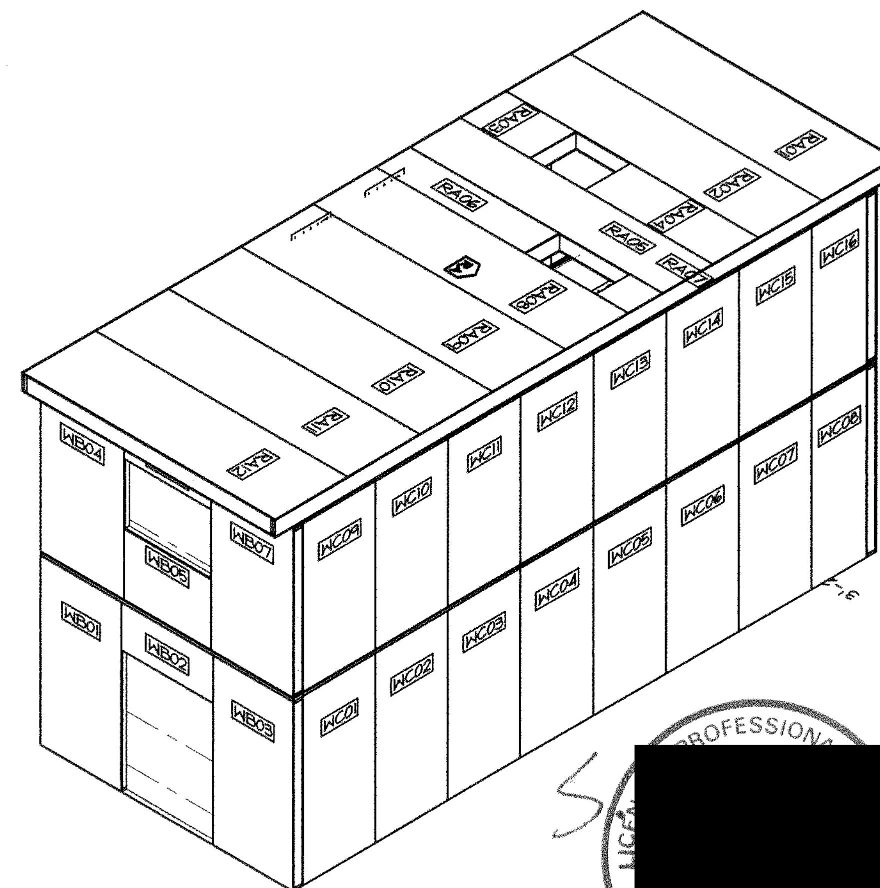
INSULSPAN REVISION POLICY

INSULSPAN UNDERSTANDS THAT SOME PROJECTS MAY REQUIRE ALTERATIONS. WE WILL DO OUR BEST TO HONOR YOUR CHANGES AND/OR ADJUSTMENTS, WITHIN REASON. IT SHOULD BE UNDERSTOOD THAT EACH CUSTOMER INITIATED CHANGE TO SHOP DRAWINGS MAY RESULT IN A COST REVIEW AND ADDITIONAL CHARGES MAY BE APPLIED AND MAY AFFECT DELIVERY.

-COVER-







Notes:
SOME PIECES OF LUMBER ARE LABELED AS "TEMP". THIS LUMBER IS ONLY TEMPORARILY ATTACHED (SCREWED) TO THE PANEL. IT IS TO BE REMOVED TO ASSIST IN THE INSTALLATION PROCESS AND TO ALLOW FOR DIMENSIONAL PANEL ADJUSTMENTS. PLEASE TAKE EXTRA CARE IN REMOVING AND INSTALLING THIS LUMBER PER INSULSPAN APPROVED DETAILS, SEE INSTALLATION MANUAL.

ALL WIRECHASES ARE INSTALLED @ 14" & 44" A.S.F. HORIZ. AND 6" VERT. TO EITHER SIDE OF DOOR OPENINGS UNLESS NOTED OTHERWISE.

PROFESSIONAL [redacted] PROVINCE OF ON

INSULSPAN
STRUCTURAL INSULATING PANEL SYSTEMS

INSULSPAN
STRUCTURAL INSULATING PANEL SYSTEMS
9012 East U.S. 223 P.O. Box 38
BLISSFIELD, MI. 49228
Phone 517-486-4844 Fax 517-486-2056
www.insulspan.com

CONTRACT DATE:	5-27-10
CHANGE ORDER NO.:	
PANEL CHKD /DESIGN:	
FOR CLIENT APPROVAL:	07-15-10
CLIENT APPROVED:	07-23-10
PANEL APPVD /DESIGN:	----
REVISION NO. 3:	07-29-10
FABRICATION:	

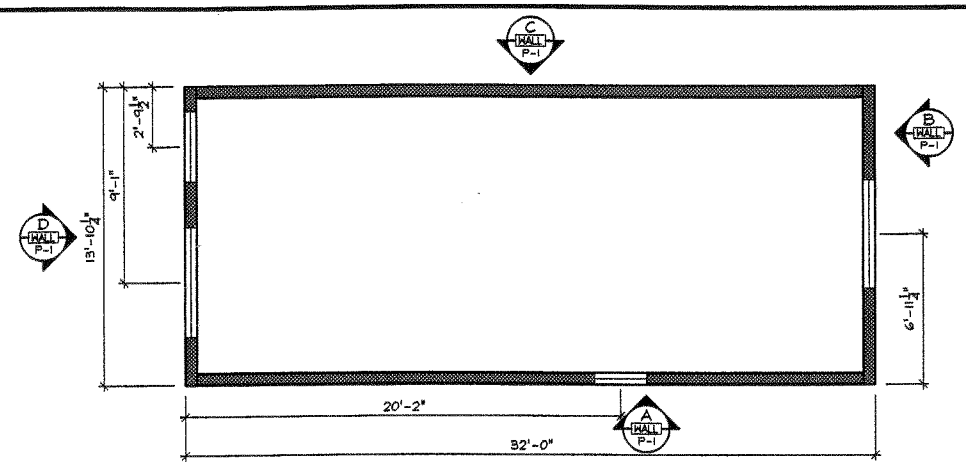
Proposed Residence For: [redacted]

energy

SALES PERSON:	JRN
DRAWN BY:	KAN
CHECKED BY:	
DWG DATE:	07-15-10
JOB NUMBER:	7353

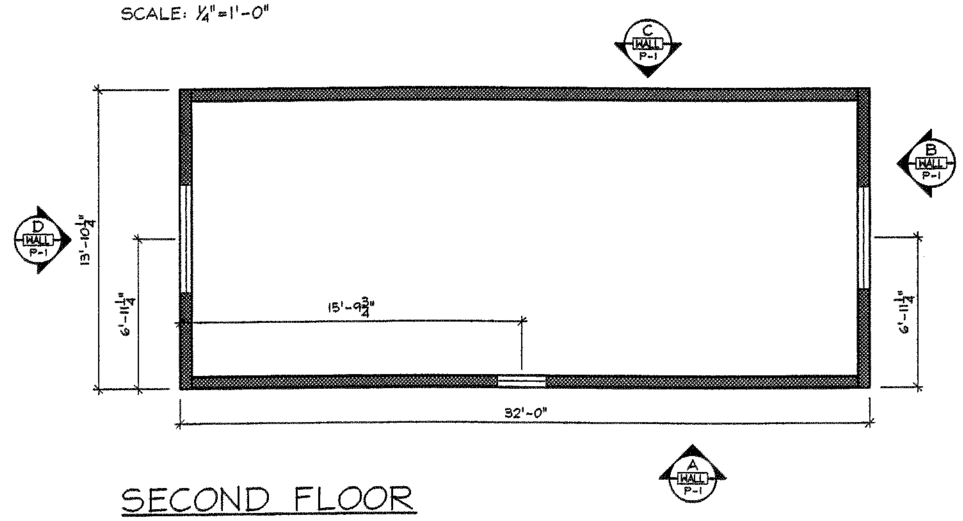
P-1 — SHEET 1 OF 3 — REV. 3

PLOT DATE: 07-29-10



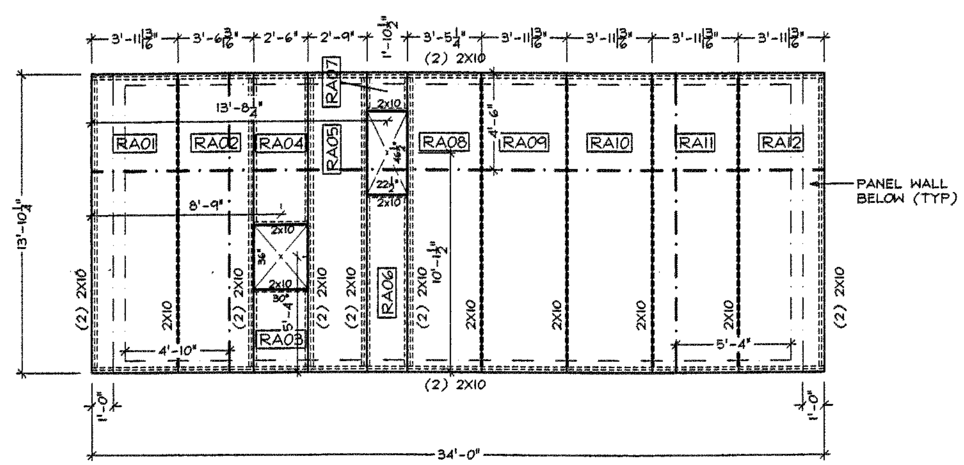
FIRST FLOOR WALL PANEL PLAN

SCALE: 1/4"=1'-0"



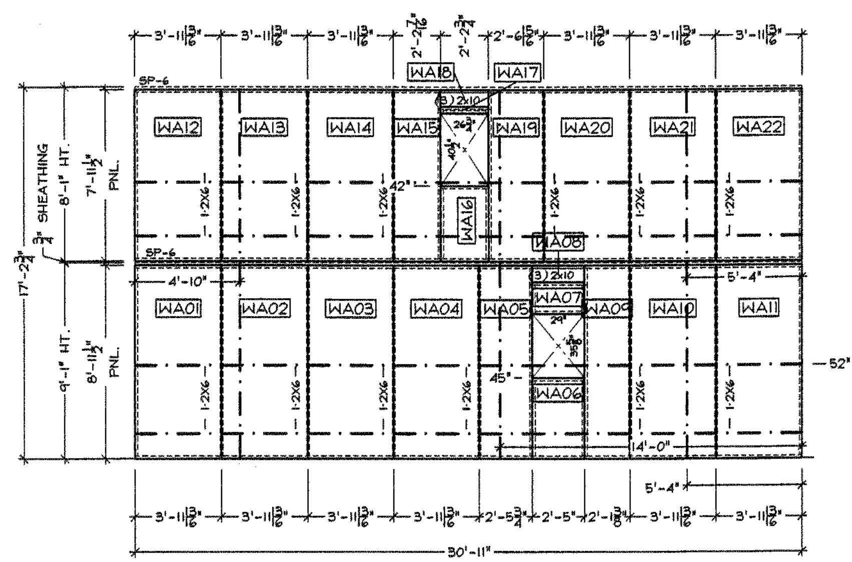
SECOND FLOOR WALL PANEL PLAN

SCALE: 1/4"=1'-0"



ROOF PANEL PLAN

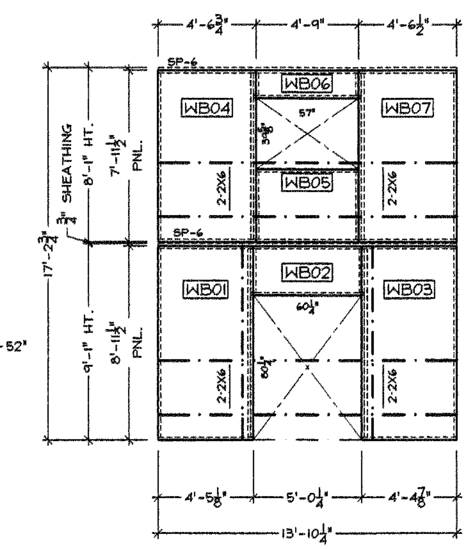
SCALE: 1/4"=1'-0"



WALL A

6-1/2" WALL PANELS

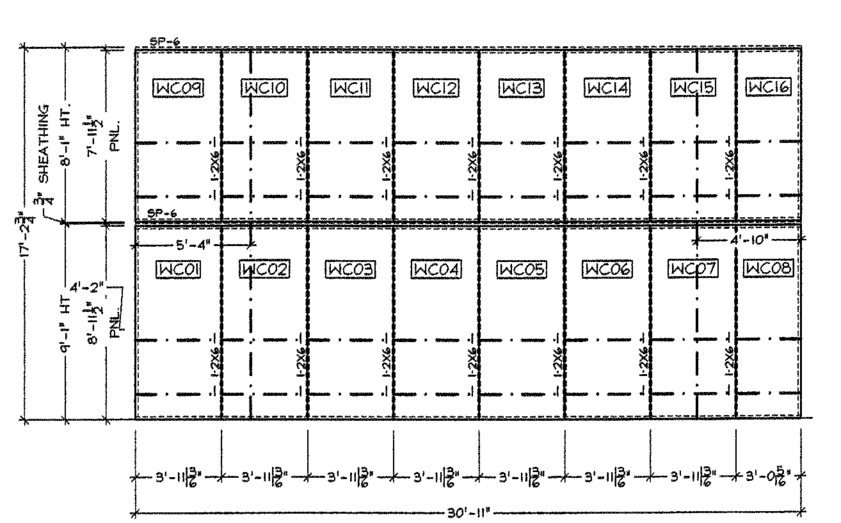
SCALE: 1/4"=1'-0"



WALL B

6-1/2" WALL PANELS

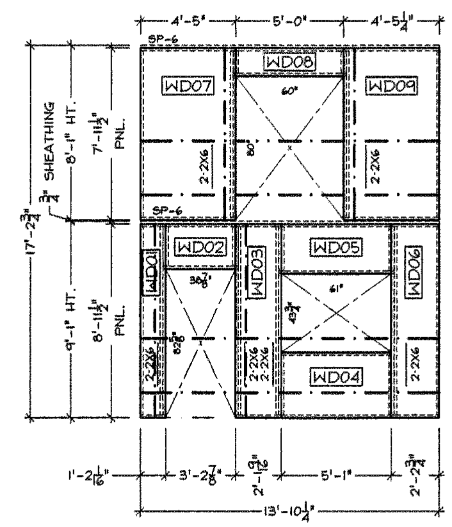
SCALE: 1/4"=1'-0"



WALL C

6-1/2" WALL PANELS

SCALE: 1/4"=1'-0"



WALL D

6-1/2" WALL PANELS

SCALE: 1/4"=1'-0"

Notes:
SOME PIECES OF LUMBER ARE LABELED AS "TEMP". THIS LUMBER IS ONLY TEMPORARILY ATTACHED (SCREWED) TO THE PANEL. IT IS TO BE REMOVED TO ASSIST IN THE INSTALLATION PROCESS AND TO ALLOW FOR DIMENSIONAL PANEL ADJUSTMENTS. PLEASE TAKE EXTRA CARE IN REMOVING AND INSTALLING THIS LUMBER PER INSULSPAN APPROVED DETAILS, SEE INSTALLATION MANUAL.

ALL WIRECHASES ARE INSTALLED @ 14" & 44" A.S.F. HORIZ. AND 6" VERT. TO EITHER SIDE OF DOOR OPENINGS UNLESS NOTED OTHERWISE.

Engineering Note:
ADD AN ADDITIONAL 25 PSF/1.9 kPA DEAD LOAD FOR FUTURE GREEN ROOF LOADING PER CUSTOMER REQUEST.

[redacted]

INSULSPAN
STRUCTURAL INSULATING PANEL SYSTEMS

INSULSPAN
STRUCTURAL INSULATING PANEL SYSTEMS
9012 East U.S. 223 P.O. Box 38
BLISSFIELD, MI 49228
Phone 517-486-4844 Fax 517-486-2056
www.insulspan.com

CONTRACT DATE:	5-27-10
CHANGE ORDER NO.:	
PANEL CHKD./DESIGN:	
FOR CLIENT APPROVAL:	07-15-10
CLIENT APPROVED:	07-23-10
PANEL APPVD./DESIGN:	----
REVISION NO. 3:	07-29-10
FABRICATION:	

Proposed Residence For: [redacted]

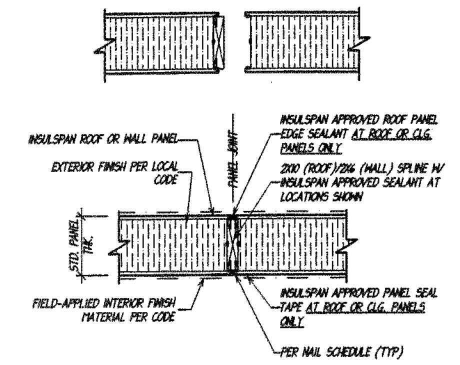
SALES PERSON:	JRN
DRAWN BY:	KAN
CHECKED BY:	
DWG. DATE:	07-15-10
JOB NUMBER:	7353

P-2 SHEET 2 OF 3 REV. 3

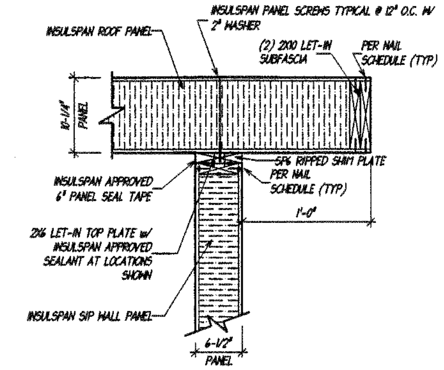
PLOT DATE: 07-29-10

Notes:
CEILING FAN INSTALLATION:
ATTACH A LOW PROFILE/SHALLOW ELECTRICAL BOX (+/- 3/4") DIRECTLY TO CEILING PANEL OSB. INTERIOR FINISH AND OR TRIM AROUND BOX AS REQUIRED TO CONCEAL BOX.

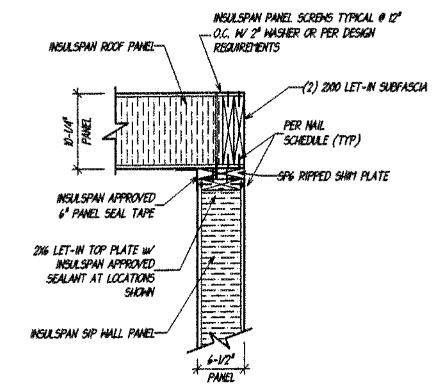
STANDARD "CAN" LIGHTS ARE <u>NOT</u> APPROVED FOR USE WITH SIPS. LOW PROFILE LED LIGHTS CAN BE INSTALLED DIRECTLY TO THE OSB AND 'ENCLOSED' BY DRYWALL OR CEILING INT. FINISHES.



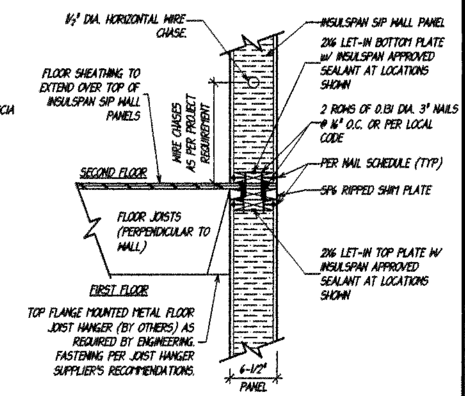
5 / P-3 **2X LUMBER SPLINE**
SCALE: 1"=1'-0"



1 / P-3 **RAKE/GABLE**
SCALE: 1"=1'-0"



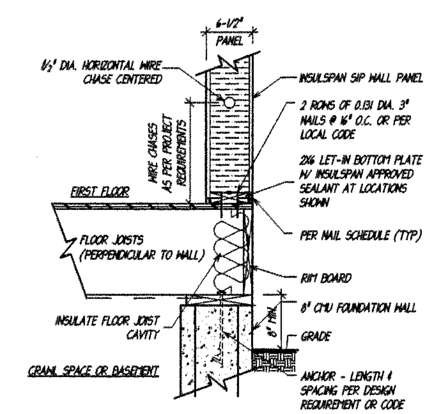
4 / P-3 **EAVE**
SCALE: 1"=1'-0"



2 / P-3 **2ND FLOOR**
SCALE: 1"=1'-0"

<u>NAIL SCHEDULE:</u>
8D FULL ROUND HEAD NAILS 2 1/2" LONG BY 0.113" SMOOTH SHANK @ 6" O.C.

<u>NOTES:</u>
ALL BUILDING COMPONENTS USED IN CONJUNCTION WITH THIS DETAIL SHALL BE IN COMPLIANCE WITH LOCAL CODE REQUIREMENT.



3 / P-3 **SILL**
SCALE: 1"=1'-0"

[redacted]

INSULSPAN
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9012 East U.S. 223 P.O. Box 38
BLISSFIELD, MI. 49228
Phone 517-486-4844 Fax 517-486-2056
www.insulspan.com

CONTRACT DATE:	5-27-10
CHANGE ORDER NO. :	
PANEL CHKD /DESIGN:	
FOR CLIENT APPROVAL:	07-15-10
CLIENT APPROVED:	07-23-10
PANEL APPVD /DESIGN:	----
REVISION NO. 3:	07-29-10
FABRICATION:	

Proposed Residence For: [redacted]

SALES PERSON:	JRN
DRAWN BY:	KAN
CHECKED BY:	
DWG. DATE:	07-15-10
JOB NUMBER:	7353

P-3
SHEET 3 OF 3
REV. 3
PLOT DATE 07-29-10

Appendix B: Specification Sheets

24ACC6
Comfort™ 16 SEER Air Conditioner with Puron® (R-410A) Refrigerant Single Phase
1-1/2 - 5 Nominal Tons (Size 18-60)

turn to the experts

Carrier Corporation•Syracuse, NY 13221
SUBJECT TO CHANGE WITHOUT NOTICE

A08246

Carrier Comfort™ 16 Air Conditioner with Puron Refrigerant, Model 24ACC6 is available in 1.5-5 ton nominal-sized units.

STANDARD FEATURES

Energy Efficiency
- 14-16.5 SEER / 11.5-13 EER

New Aesthetic Design
- WeatherArmor™ System
  - Baked-on powder paint
  - Steel-louver Coil Guard

Quiet Operation
- Sound as low as 72 dBA
- Compressor Sound Blanket
- 8-Pole Condenser Fan Motor

Reliability, Quality and Durability
- Scroll Compressor
- Field-installed Filter Drier
- Front-seating Service Valves
- High-Pressure Switch
- Low-Pressure Switch
- Internal Pressure-Relief Valve
- Internal thermal overload

LIMITED WARRANTY*
- 10 year limited to original purchaser on compressor and parts upon timely registration, otherwise 5 years

*For owner occupied, residential applications

This product has been designed and manufactured to meet Energy Star criteria for energy efficiency when matched with appropriate coil components. However, proper refrigerant charge and proper air flow are critical to achieve rated capacity and efficiency. Installation of this product should follow all manufacturing refrigerant charging and airflow instructions. Failure to confirm proper charge and airflow may reduce energy efficiency and shorten equipment life.

Use of the AHRI Certified TM Mark indicates a manufacturer's participation in the program For verification of certification for individual products, go to www.ahridirectory.org.

ISO 9001:2000

SAP CATALOG ORDERING NO.	NOMINAL COOLING SIZE (Btu X 1,000)	VOLTS-PHASE (60 HZ)	OPERATING VOLTAGE RANGE	PACKAGED DIMENSIONS (IN.) D X W X H*†	APPROX SHIP WT (LB)†	PRICE
24ACC618A003	18	208-230-1	197-253	25-3/4 x 25-3/4 x 28-11/16	163	
24ACC624A003	24			31-3/16 x 31-3/16 x 28-5/16	198	
24ACC630A003	30			31-3/16 x 31-3/16 x 32-5/16	204	
24ACC636A003	36			35 x 35 x 28-15/16	219	
24ACC642A003	42			35 x 35 x 39-1/8	281	
24ACC648A003	48			35 x 35 x 32-15/16	291	
24ACC660A003	60			35 x 35 x 47-1/16	330	

* All units are individually skidded for shipment.
† Weight and height may vary by series. See PD for actual weights and dimensions by series. Height shown is maximum.

OPTIONAL EXTENDED WARRANTIES (Single Phase Puron Units Only)	NET PRICE
System Parts Only - 6th through 10th year*†	
System Labor Only - 2nd through 5th year*	
System Labor Only - 2nd through 10th year*	
System Labor Only - 1st through 5th year*	
System Labor only - 1st through 10th year*	
Parts Only - 6th through 10th year†‡	
Labor Only - 2nd through 5th year‡	
Labor Only - 2nd through 10th year‡	
Labor Only - 1st through 5th year‡	
Labor Only - 1st through 10th year‡	
Compressor Parts Only - 6th through 10th year	

* Thermostat, Infinity Control, Infinity Air Purifier, Electronic Air Cleaner, Humidifier, UV Light, Strip Heater only can be added to the "system" at no additional charge when included with registration. Zoning should be added separately at an additional charge. UV Light includes only control, not lamp.

† Excludes compressor.

‡Carrier branded thermostat or Infinity Control included.

NOTE: To qualify for system purchase, all equipment must be manufactured by Carrier and branded Carrier; System includes (outdoor unit + indoor unit) + thermostat.

ACCESSORIES

DESCRIPTION	PART NO.	USED WITH	PRICE
Evaporator Freeze Thermostat	KAAFT0101AAA	All	
Time-Delay Relay	KAATD0101TDR	All	
Winter Start Control	KAAWS0101AAA	All	
Low- Ambient Pressure Switch	KSALA0301410	All	
MotorMaster® 230V Low-Ambient Controller	KSALA0601AAA	All	
Ball-Bearing Motor Fan (RCD) (230V)	HC32GE234	18	
	HC34GE240	24, 30	
	HC32GE229	36	
	HC38GE228	42	
	HC40GE228	48, 60	
Start Assist–Capacitor/Relay Type	KSAHS1701AAA	All	
Cycle Protector - 5-Minute Time Delay	KSACY0101AAA	All	
Support Feet	KSASF0101AAA	All	
Start Assist–PTC	KAACS0201PTC	All	
Liquid-Line Solenoid Valve	KAALS0201LLS	All	
Low-Pressure Switch	Standard	All	
High-Pressure Switch	Standard	All	
Crankcase Heater	KAACH1701AAA	18, 24, 30, 36	
	KAACH1601AAA	42	
TXV- Hard Shutoff (Puron)	KSATX0201PUR	18-30	
	KSATX0301PUR	36	
	KSATX0401PUR	42	
	KSATX0501PUR	48-60	
Compressor Sound Blanket	Standard	All	

2013 ENERGY STAR® Qualification Chart

Does your door qualify?

Door Collection / Glass Design

Fiber-Classic® Oak Collection™

6'8" Doors

Glass Size (Inches)	22x64	20x64		16x64	22x47			14x64	22x36	20x36	8x36	16x40	8x42	22x10	8x6	8x36			7x64	8x47	8x36	8x44
Arden™	.27 / .26				.25 / .21				.22 / .15		.22 / .15	.22 / .15	.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Avonlea®	.27 / .26				.25 / .21				.22 / .15		.22 / .15	.22 / .15	.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Blackstone®	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15	.22 / .15	.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Concorde™	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15	.22 / .15	.18 / .09	.18 / .09		.18 / .09			.18 / .09	.18 / .09	.18 / .09	.18 / .09
Crystal Diamonds™	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15	.22 / .15	.18 / .09	.18 / .09		.18 / .09			.18 / .09	.18 / .09	.18 / .09	.18 / .09
Crystalline™	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15		.18 / .09	.18 / .09	.18 / .09	.18 / .09			.18 / .09	.18 / .09	.18 / .09	.18 / .09
Element	.27 / .26																		.18 / .09			
Frosted Images®	.33 / .32	.33 / .32			.29 / .25				.25 / .18		.25 / .18	.25 / .18		.20 / .09		.20 / .09			.20 / .09		.20 / .09	
Kensington	.27 / .26				.25 / .21				.22 / .15		.22 / .15	.22 / .15	.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Keystone™	.27 / .26				.25 / .21				.22 / .15		.22 / .15	.22 / .15		.18 / .09		.18 / .09			.18 / .09	.18 / .09	.18 / .09	.18 / .09
Maple Park™	.27 / .26				.25 / .21				.22 / .15		.22 / .15		.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Salinas®	.33 / .29	.33 / .29			.29 / .23				.25 / .16		.25 / .16		.20 / .10			.20 / .10			.20 / .10	.20 / .10	.20 / .10	
Saratoga™	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15		.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Sedona	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15		.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Sedona Art Glass	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15		.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Texas Star	.27 / .26				.25 / .21				.22 / .15		.22 / .15	.22 / .15				.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Wellesley™	.27 / .26	.27 / .26			.25 / .21				.22 / .15	.22 / .15	.22 / .15	.22 / .15	.18 / .09			.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Privacy Glass	.27 / .26	.27 / .26		.25 / .21	.25 / .21				.22 / .15	.22 / .15	.22 / .15	.22 / .15	.18 / .09	.18 / .09	.18 / .09	.18 / .09			.18 / .09	.18 / .09	.18 / .09	
Bevelline™	.33 / .32	.33 / .32							.25 / .18		.25 / .18			.20 / .09		.20 / .09			.20 / .09		.20 / .09	
Internal Blinds	.33 / .32	.33 / .32		.29 / .25					.25 / .18	.25 / .18						.20 / .09			.20 / .09		.20 / .09	
Clear Glass	.35 / .32				.29 / .25				.26 / .18	.26 / .18	.26 / .18	.25 / .18	.20 / .09	.20 / .09	.21 / .09	.21 / .09			.21 / .09	.20 / .09	.21 / .09	.20 / .09
Clear with External Lite Dividers	.35 / .32								.26 / .18	.26 / .18	.26 / .18			.20 / .09		.21 / .09			.21 / .09		.21 / .09	
Clear Low-E Glass	.30 / .18	.30 / .18		.26 / .14	.23 / .14				.23 / .10	.23 / .10	.23 / .10	.21 / .10	.18 / .05	.19 / .05	.19 / .05	.19 / .05			.19 / .05	.18 / .05	.19 / .05	.18 / .05
Clear Low-E with External Lite Dividers	.30 / .18	.30 / .18		.26 / .14					.23 / .10	.23 / .10	.23 / .10			.19 / .05		.19 / .05			.19 / .05		.19 / .05	
Clear Low-E Grilles Between Glass	.28 / .16	.28 / .16		.25 / .12				.21 / .09	.22 / .09		.22 / .09					.19 / .05			.19 / .05		.19 / .05	
Solid Panel (Includes all panel designs.)																	.14 / .01					

6'8" Doors with Impact Glass

Glass Size (Inches)	22x64	20x64		16x64	22x47			14x64	22x36	20x36	8x36	16x40	8x42	22x10	8x6	8x36			7x64	8x47	8x36	8x44
Arden™ with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Avonlea® with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Blackstone® with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Concorde™ with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Crystal Diamonds™ with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Crystalline™ with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Element with Impact	.29 / .23																		.19 / .08			
Frosted Images® with Impact	.31 / .27	.31 / .27			.28 / .21				.24 / .15		.24 / .15					.20 / .08			.20 / .08		.20 / .08	
Kensington with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Keystone™ with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Maple Park™ with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Salinas® with Impact	.31 / .25				.28 / .19				.24 / .14		.24 / .14					.20 / .09			.20 / .09	.20 / .09	.20 / .09	
Saratoga™ with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Texas Star with Impact	.29 / .23				.26 / .18				.23 / .13		.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Wellesley™ with Impact	.29 / .23	.29 / .23			.26 / .18				.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Privacy with Impact	.29 / .23	.29 / .23			.26 / .18			.23 / .13	.23 / .13	.23 / .13	.23 / .13					.19 / .08			.19 / .08	.19 / .08	.19 / .08	
Clear Glass with Impact	.31 / .27	.31 / .27			.28 / .21			.24 / .15	.24 / .15	.24 / .15	.24 / .15					.20 / .08			.20 / .08	.20 / .08	.20 / .08	
Clear Grilles Between Glass with Impact	.31 / .24	.31 / .24						.24 / .13	.24 / .13		.24 / .13					.20 / .07			.20 / .07		.20 / .07	
Clear Low-E Glass with Impact	.25 / .19	.25 / .19			.23 / .15			.20 / .11	.20 / .11	.20 / .11	.20 / .11					.18 / .06			.18 / .06	.18 / .06	.18 / .06	
Clear Low-E Grilles Between Glass with Impact	.25 / .17	.25 / .17						.20 / .10	.20 / .10										.18 / .05			
Turtle Glass with Impact	.31 / .27																					

KEY

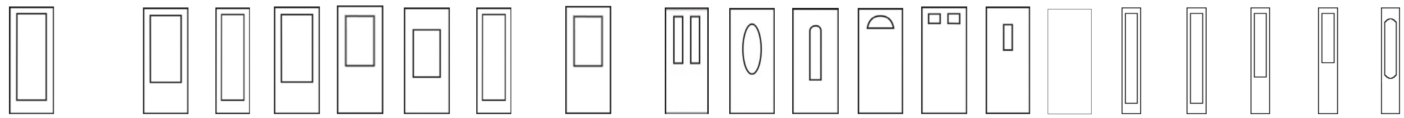
- (green) Indicates the product is ENERGY STAR® qualified.
- (red) Indicates the product is not ENERGY STAR® qualified.

A blank box indicates that this door / glass combination is not part of our product offering.

The numbers represent NFRC ratings: U-Value / Solar Heat Gain Coefficient (SHGC)

2013 ENERGY STAR® Qualification Chart

Does your door qualify?



Fiber-Classic® Oak Collection™

6'6" & 6'8" Doors with Flush-Glazed Glass

Door Collection / Glass Design Glass Size (Inches)	27x64	25x64	20x64						14x64	22x36								8x64			8x36	
Bevelline™	.33 / .32	.33 / .32	.33 / .32																			
Bevelline™ Low-E	.26 / .18	.26 / .18	.26 / .18																			
Clear Glass	.33 / .32	.33 / .32	.33 / .32						.25 / .18	.25 / .18								.25 / .18			.20 / .09	
Clear with External Lite Dividers	.33 / .32	.33 / .32	.33 / .32						.25 / .18	.25 / .18								.25 / .18			.20 / .09	
Clear Grilles Between Glass	.33 / .28	.33 / .28	.33 / .28						.25 / .16	.25 / .16								.25 / .16			.20 / .08	
Clear Low-E Glass	.26 / .18	.26 / .18	.26 / .18						.21 / .10	.21 / .10								.21 / .10			.18 / .05	
Clear Low-E with External Lite Dividers	.26 / .18	.26 / .18	.26 / .18						.21 / .10	.21 / .10								.21 / .10			.18 / .05	
Clear Low-E Grilles Between Glass	.27 / .16	.27 / .16	.27 / .16						.22 / .09	.22 / .09								.22 / .09			.18 / .05	

8'0" Doors

Glass Size (Inches)	22x80	20x80	22x64	14x80		22x47	22x47							8x6	8x36		7x80		7x64	8x47	
Arden™			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Avonlea®			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Blackstone®	.27 / .26	.27 / .26	.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Concorde™	.27 / .26		.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Crystal Diamonds™			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Crystalline™	.27 / .26	.27 / .26	.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Element			.27 / .26																.18 / .09		
Frosted Images®	.33 / .32		.33 / .32			.29 / .25	.29 / .25								.20 / .09		.25 / .18		.20 / .09		
Kensington			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Keystone™			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Maple Park®			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Salinas®	.33 / .29	.33 / .29	.33 / .29			.29 / .23	.29 / .23								.20 / .10		.25 / .16		.20 / .10	.20 / .10	
Saratoga™			.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Sedona	.27 / .26		.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Sedona Art Glass	.27 / .26		.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Texas Star			.27 / .26			.25 / .21	.25 / .21								.18 / .09				.18 / .09	.18 / .09	
Wellesley™	.27 / .26	.27 / .26	.27 / .26			.25 / .21	.25 / .21								.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Privacy Glass	.27 / .26	.27 / .26	.27 / .26			.25 / .21	.25 / .21							.18 / .09	.18 / .09		.22 / .15		.18 / .09	.18 / .09	
Bevelline™			.33 / .32												.20 / .09				.20 / .09		
Internal Blinds	.33 / .32	.33 / .32	.33 / .32												.20 / .09		.25 / .18		.20 / .09		
Clear Glass	.33 / .32	.33 / .32	.35 / .32	.29 / .25		.29 / .25	.29 / .25							.21 / .09	.21 / .09		.25 / .18		.21 / .09	.20 / .09	
Clear with External Lite Dividers	.33 / .32	.33 / .32	.35 / .32												.21 / .09		.25 / .18		.21 / .09		
Clear Low-E Glass	.30 / .18	.30 / .18	.30 / .18			.23 / .14	.23 / .14							.19 / .05	.19 / .05		.21 / .10		.19 / .05	.18 / .05	
Clear Low-E with External Lite Dividers	.30 / .18	.30 / .18	.30 / .18												.19 / .05		.21 / .10		.19 / .05		
Clear Low-E Grilles Between Glass	.28 / .16	.28 / .16	.28 / .16	.23 / .12											.19 / .05				.19 / .05		
Solid Panel (Includes all panel designs.)																.14 / .01					

KEY

- (green) Indicates the product is ENERGY STAR® qualified.
- (red) Indicates the product is not ENERGY STAR® qualified.

A blank box indicates that this door / glass combination is not part of our product offering.

The numbers represent NFRC ratings: U-Value / Solar Heat Gain Coefficient (SHGC)

2013 ENERGY STAR® Qualification Chart

THERMA-TRU DOORS

Does your door qualify?

Door Collection / Glass Design

Fiber-Classic® Oak Collection™

8'0" Doors with Impact Glass

Glass Size (Inches)	22x80	20x80	22x64	14x80		22x47	22x47							8x6	8x36		7x80		7x64	8x47	
Arden™ with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Avonlea® with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Blackstone® with Impact	.29 / .23	.29 / .23	.29 / .23			.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Concorde™ with Impact	.29 / .23	.29 / .23	.29 / .23			.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Crystal Diamonds™ with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Crystalline™ with Impact	.29 / .23	.29 / .23	.29 / .23			.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Element with Impact			.29 / .23																.19 / .08		
Frosted Images® with Impact	.31 / .27	.31 / .27	.31 / .27			.28 / .21	.28 / .21								.20 / .08		.24 / .15		.20 / .08		
Kensington with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Keystone™ with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Maple Park® with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Salinas® with Impact	.31 / .25		.31 / .25			.28 / .19	.28 / .19								.20 / .09		.24 / .14		.20 / .09	.20 / .09	
Saratoga™ with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Texas Star with Impact			.29 / .23			.26 / .18	.26 / .18								.19 / .08				.19 / .08	.19 / .08	
Wellesley™ with Impact	.29 / .23	.29 / .23	.29 / .23			.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Privacy with Impact	.29 / .23	.29 / .23	.29 / .23	.26 / .18		.26 / .18	.26 / .18								.19 / .08		.23 / .13		.19 / .08	.19 / .08	
Clear Glass with Impact	.31 / .27	.31 / .27	.31 / .27	.28 / .21		.28 / .21	.28 / .21								.20 / .08		.24 / .15		.20 / .08	.20 / .08	
Clear Grilles Between Glass with Impact	.31 / .24	.31 / .24	.31 / .24	.28 / .19											.20 / .07		.24 / .13		.20 / .07		
Clear Low-E with Impact	.25 / .19	.25 / .19	.25 / .19	.23 / .15		.23 / .15	.23 / .15								.18 / .06		.20 / .11		.18 / .06	.18 / .06	
Clear Low-E Grilles Between Glass with Impact	.25 / .17	.25 / .17	.25 / .17	.23 / .13													.20 / .10		.18 / .05		
Turtle Glass with Impact	.31 / .27		.31 / .27																		

8'0" Doors with Flush-Glazed Glass

Glass Size (Inches)	25x80	21x80	14x80
Clear Glass	.33 / .32	.33 / .32	.33 / .32
Clear with External Lite Dividers	.33 / .32	.33 / .32	.33 / .32
Clear Grilles Between Glass	.33 / .28	.33 / .28	.33 / .28
Clear Low-E Glass	.26 / .18	.26 / .18	.26 / .18
Clear Low-E with External Lite Dividers	.26 / .18	.26 / .18	.26 / .18
Clear Low-E Grilles Between Glass	.27 / .16	.27 / .16	.27 / .16

KEY

Indicates the product is ENERGY STAR® qualified.

Indicates the product is not ENERGY STAR® qualified.

A blank box indicates that this door / glass combination is not part of our product offering.

The numbers represent NFRC ratings: U-Value / Solar Heat Gain Coefficient (SHGC)

ERVCCSVB, ERVCCSHB Energy Recovery Ventilators HRVCCSVB, HRVCCSHB Heat Recovery Ventilators

turn to the experts

Product Data

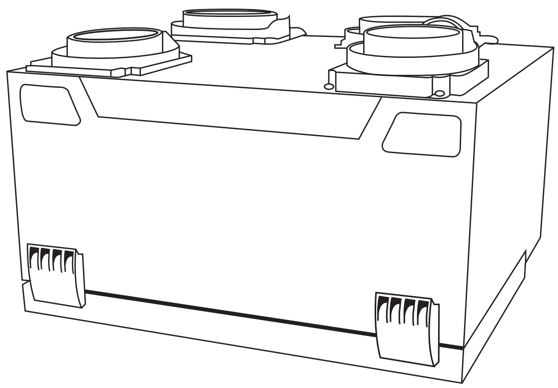


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Fig. 1 - ERVCCSVB / HRVCCSVB

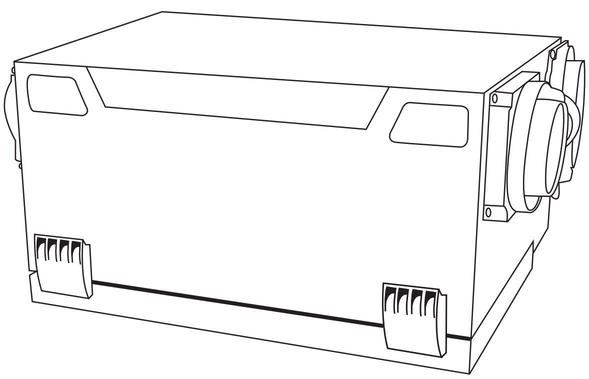

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Fig. 2 - ERVCCSHB / HRVCCSHB

Energy Recovery Ventilation (ERV) and Heat Recovery Ventilation (HRV) systems offered by Carrier are the finest on the market today. These units provide efficient and cost effective heat and energy recovery during the heating and cooling season when needed most.

As temperatures drop below 23°F (-5°C), indoor air is recirculated periodically through the heat exchanger core to prevent frost from forming. Competitors' methods of supplementary electric defrost waste energy. Unlike rotary wheel heat exchangers which mix air streams, these cross-flow or counterflow heat exchangers ensure that there is no mixing of the stale air stream with the fresh outdoor air stream.

A filter installed on the incoming outdoor air stream removes large airborne particles from the intake air stream before they enter the heat exchanger and reduces the maintenance required. The units' acoustically engineered design makes the Carrier ERVs and HRVs are the quietest on the market and ensures that comfort is felt, not heard.

Unlatching two (2) suitcase style latches allows easy removal of the filters and core for cleaning.

NOTE: The HRV should not be installed in an attic or unconditioned space unless provisions are made for drain-line freezing and condensation.

STANDARD FEATURES

- Drainless design - ERVs / Drains provided - HRVs
- Integrated airflow balancing points
- High pressure blowers
- Onboard control for continuous high/low ventilator operation
- Energy saving defrost cycle
- Cross-flow, counterflow heat exchangers
- One filter on incoming air; one filter on outgoing air to protect core
- No-tools maintenance
- Enthalpic heat exchanger core - ERVs
- Polypropylene heat exchanger core - HRVs

MODEL NUMBER NOMENCLATURE

1	2	3	4	5	6	7	8	9	10	11	12
E	R	V	C	C	S	H	B	1	1	0	0

Product Type
ERV – Energy Recovery Ventilator
HRV – Heat Recovery Ventilator

Brand
CC – Carrier

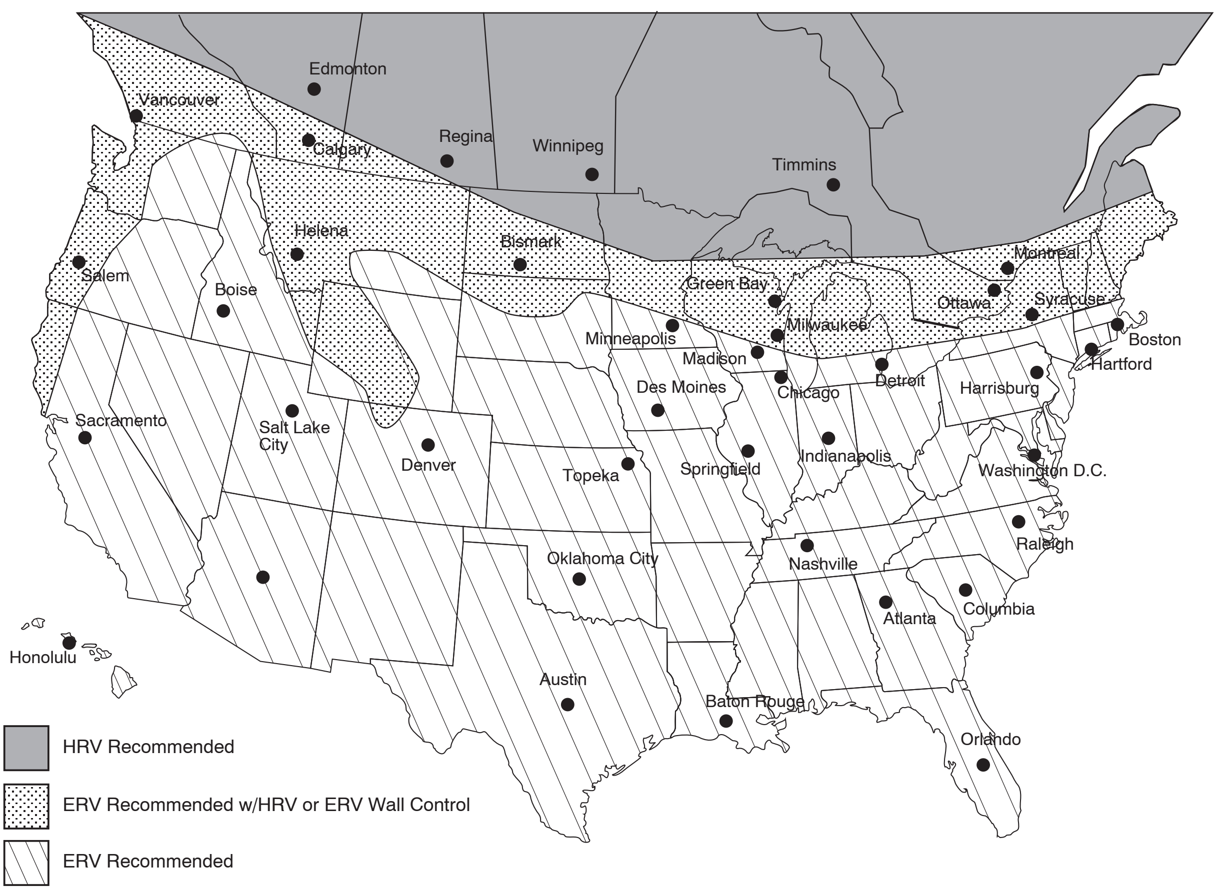
Style
SHB – Small Horizontal
SVB – Small Vertical

Electrical Supply
1 – 115 Volts

Maximum Capacity
100 – 100 CFM

These products earned the ENERGY STAR® by meeting strict energy efficiency guidelines set by Natural Resources Canada and the US EPA. They meet ENERGY STAR requirements only when used in Canada.

Climate Map for Energy and Heat Recovery Ventilators



VENTILATOR ACCESSORY NUMBER NOMENCLATURE

1	2	3	4	5	6	7	8	9	10	11	12
K	V	B	C	N	0	1	0	1	C	B	S

Product
KV – Ventilator Accessory Kit

Series
A – Original Series
B – Second Series

Type
AC01 – Accessory
CN01 – Control
TM01 – Timer

Package Quantity
01 – Single Pack

Control Description
CBS – Carrier Basic Control
CLC – Carrier Latent Control
CLT – Carrier OneTouch Control
CST – Carrier Standard Control
Accessory Description
HCO – Concentric Intake/Exhaust Hood
HOD – Intake Hood
KIT – Airflow Measuring Kit
Timer Description
20C – 20 Minute Timer Kit
60M – 60 Minute Timer Kit

KIT NUMBER	DESCRIPTION	WHERE USED
KVAAC0101HOD	Exterior Intake and Exhaust Hood	2 Required
KVAAC0101HCO	Concentric Intake and Exhaust Hood	Used as a single intake/exhaust for SVB1100, SHB1100 models only
KVBCN0101CBS	Basic HRV Control	Used with all HRVs
KVBCN0101CLC	Latent Control	Used with ERVs only
KVBCN0101CLT	Carrier OneTouch Control	Used with all ERVs and HRVs as a main wall control
KVBCN0101CST	Standard HRV Control	Used with all HRVs
KVATM010120C	20 Minute Push Button Timer	Used with all HRVs when 20 minute manual operation is required
KVATM010160M	60 Minute Timer	Used with all HRVs, time is adjustable between 10 and 60 minutes
KVBAC0101KIT	Airflow Measuring Kit	Used with all ERVs and HRVs to balance intake/exhaust airflow

CONTROL DESCRIPTION	FAN SPEED CONTROL	HUMIDISTAT CONTROL	DEHUMIDISTAT CONTROL	CONTINUOUS MODE	INTERMITTENT MODE
Latent	Yes	Yes	No	Yes	Yes
OneTouch	Yes	No	No	Yes	Yes
Basic	Yes	No	No	Yes	No
Standard	Yes	Yes	Yes	Yes	Yes

Control features

Basic Control:

Allows the user to manually set fan speed to low or high as required to maximize comfort.

Standard Control:

Offers automatic dehumidistat control and the option to select continuous or intermittent fan operation. Setting the wall control to low will activate the continuous mode.

OneTouch Control:

Allows control of ventilator with the touch of a button. This control will operate as a main wall control. The OneTouch will operate the unit in Intermittent Mode (20 minutes per hour), continuous low speed, continuous high speed, and off.

Latent Control (ERVs only):

Low Exchange Mode—If the relative humidity inside the building is lower than selected, air exchange would occur with the outside at high speed. If the relative humidity inside the building is higher than selected, air exchange would occur with the outside at low speed. This ensures continuous air exchange for constant air quality.

Intermittent Mode—If the relative humidity inside the building is higher than selected, no air exchange would occur and the system would turn off. If the relative humidity inside the building is lower than selected, air exchange would occur with the outside at high speed. This mode is ideal for maintaining the proper humidity level when the continuous mode cannot.

Automatic Defrost Cycle Features

All models offer a non–electric defrost cycle feature which prevents frost and ice buildup within the heat recovery core. When the outside air temperature falls below 23°F (–5°C) it is electronically sensed and the dampers close the outside air ports. This allows warm indoor air to recirculate within the heat recovery core. The frequency of this cycle increases as the outside air temperature decreases.

MODEL	23°F TO −17°F (−5°C TO −27°C)		BELOW −17°F (−27°C)	
	DEFROST*	EXCHANGE†	DEFROST*	EXCHANGE†
ERVCCSHB HRVCCSHB	8 Minutes	25 Minutes	10 Minutes	22 Minutes
ERVCCSVB HRVCCSVB	8 Minutes	25 Minutes	10 Minutes	22 Minutes

* All defrost times are in the standard mode (as shipped)

† Time between defrost when within specified temperature range

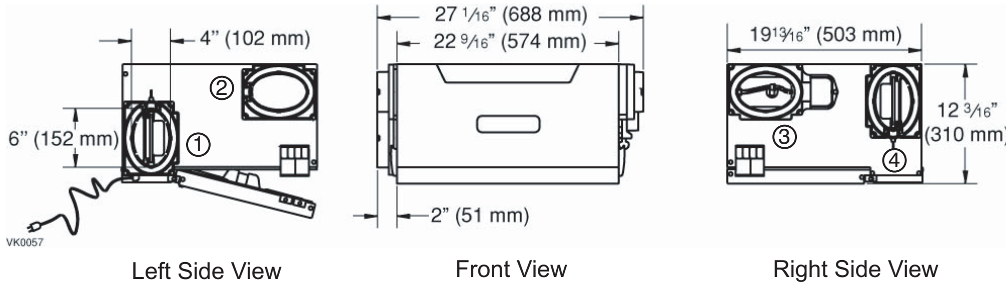


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Fig. 3 - ERVCCSHB and HRVCCSHB Unit Dimensions

Key to Unit Port Locations

① Fresh air to building
② Stale air from building
③ Fresh air from outside
④ Stale air to outside

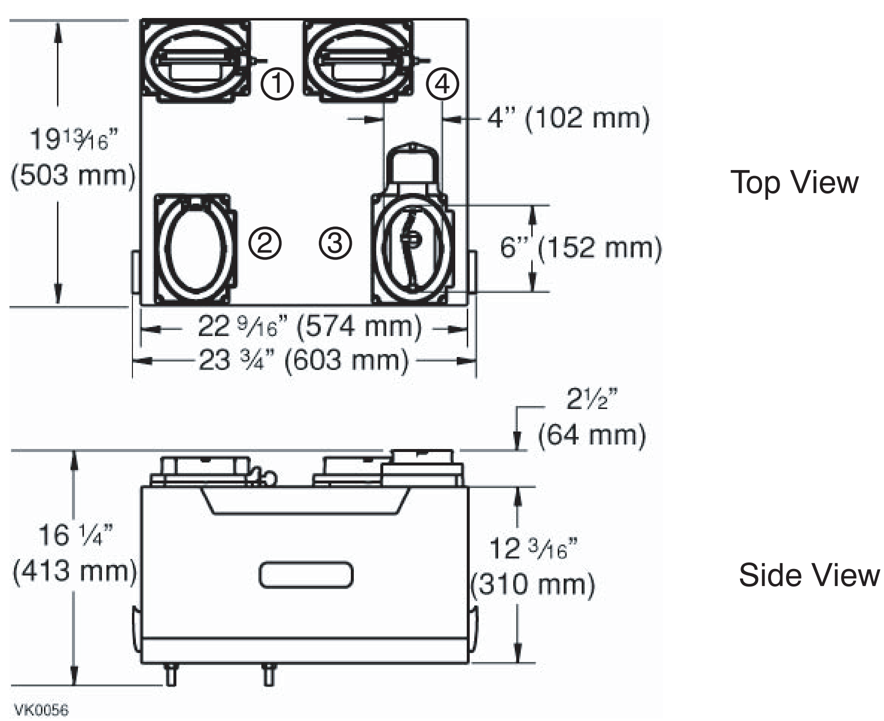

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Fig. 4 - ERVCCSVB and HRVCCSVB Unit Dimensions

PHYSICAL DATA

MODEL	ERVCCSVB1100	ERVCCSHB1100	HRVCCSVB1100	HRVCCSHB1100
Port Locations	Top	Side	Top	Side
Core Type	Enthalpic transfer media with plastic stack	Enthalpic transfer media with plastic stack	Polypropylene Cross Flow	Polypropylene Cross Flow
Core Exchange Area	56 sq. ft. (5.2m$^{2)}$	56 sq. ft. (5.2m$^{2)}$	55 sq. ft. (5.1m$^{2)}$	55 sq. ft. (5.1m$^{2)}$
Weight lb (kg)	42 (19)	42 (19)	42 (19)	42 (19)
Shipping Weight lb (kg)	48 (22)	48 (22)	48 (22)	48 (22)
Shipping Dimensions in. (mm) Height Width Depth	25.5 (648) 17.5 (445) 23.0 (584)	30.0 (762) 15.0 (381) 23.0 (584)	25.5 (648) 17.5 (445) 23.0 (584)	30.0 (762) 15.0 (381) 23.0 (584)
Voltage	120	120	120	120
Max Power (Watts)	104	104	100	100
Max Amps	0.87	0.87	0.85	0.85

NOTE: Drain Connector Kits are supplied with HRVs only. They are not necessary with ERVs.

ERV / HRV

Ventilator Sizing

Tables 1 and 2 should be used to determine the required airflow for a home. These guidelines are taken from ASHRAE 62.2-2007.

Table 1 – Ventilation Air Requirements, cfm

FLOOR AREA (ft^2)	BEDROOMS				
	0–1	2–3	4–5	6–7	>7
<1500	30	45	60	75	90
1501–3000	45	60	75	90	105
3001–4500	60	75	90	105	120
4501–6000	75	90	105	120	135
6001–7500	90	105	120	135	150
>7500	105	120	135	150	165

Table 2 – Ventilation Air Requirements, L/s

FLOOR AREA (m^2)	BEDROOMS				
	0–1	2–3	4–5	6–7	>7
<139	14	21	28	35	42
139.1–279	21	28	35	42	50
279.1–418	28	35	42	50	57
418.1–557	35	42	50	57	64
557.1–697	42	50	57	64	71
>697	50	57	64	71	78

PERFORMANCE DATA

HVI Rated Energy Performance

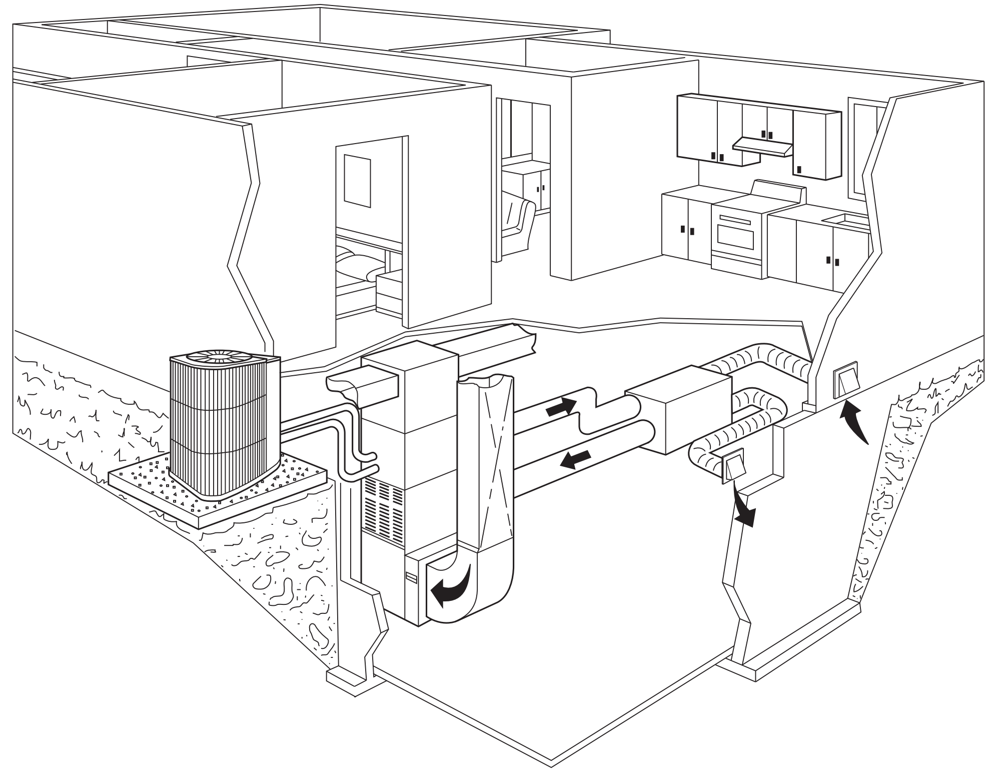
MODEL	MODE	SUPPLY TEMP		NET AIR FLOW		POWER CONSUMED (WATTS)	SENSIBLE RECOVERY EFFICIENCY	APPARENT SENSIBLE EFFECTIVENESS	LATENT RECOVERY MOISTURE TRANSFER	TOTAL RECOVERY EFFICIENCY
		°C	°F	L/S	CFM					
ERVCCSH B1100	Heating	0	32	21	45	42	68	79	0.63	
		0	32	27	58	46	68	76	0.58	
		0	32	41	87	70	63	71	0.48	
		–25	–13	22	47	58	55	78	0.60	
	Cooling	35	95	21	44	42				52
ERVCCSVB 1100	Heating	0	32	21	45	42	68	79	0.63	
		0	32	27	58	46	68	76	0.58	
		0	32	41	87	70	63	71	0.48	
		–25	–13	22	47	58	55	78	0.60	
	Cooling	35	95	21	44	42				52
HRVCCSH B1100	Heating	0	32	18	39	37	66	78	0.03	
		0	32	24	50	44	65	74	0.01	
		0	32	40	85	68	59	68	0.01	
		–25	–13	23	48	56	57	84	0.03	
	Cooling	35	95							
HRVCCSV B1100	Heating	0	32	18	39	37	66	78	0.03	
		0	32	24	50	44	65	74	0.01	
		0	32	40	85	68	59	68	0.01	
		–25	–13	23	48	56	57	84	0.03	
	Cooling	35	95							

Ventilation Performance

MODEL	EXT. STATIC PRESSURE		NET SUPPLY AIR FLOW		GROSS AIR FLOW			
					SUPPLY		EXHAUST	
	PA	IN WC	L/S	CFM	L/S	CFM	L/S	CFM
ERVCCSHB1100	25	0.1	55	116	56	119	55	116
	50	0.2	53	113	54	115	53	112
	100	0.4	50	105	51	108	50	105
	200	0.8	42	89	43	92	41	87
	250	1.0	38	80	39	83	37	78
ERVCCSVB1100	25	0.1	55	116	56	119	55	116
	50	0.2	53	113	54	115	53	112
	100	0.4	50	105	51	108	50	105
	200	0.8	42	89	43	92	41	87
	250	1.0	38	80	39	83	37	78
HRVCCSHB1100	25	0.1	52	110	53	112	57	121
	50	0.2	50	106	51	108	54	115
	100	0.4	46	97	47	100	50	106
	200	0.8	37	79	38	81	42	90
	250	1.0	33	70	34	72	37	79
HRVCCSVB1100	25	0.1	52	110	53	112	57	121
	50	0.2	50	106	51	108	54	115
	100	0.4	46	97	47	100	50	106
	200	0.8	37	79	38	81	42	90
	250	1.0	33	70	34	72	37	79

NOTE: For additional data points, refer to HVI Directory at www.hvi.org

VENTILATOR INSTALLED WITH FORCED AIR SYSTEM



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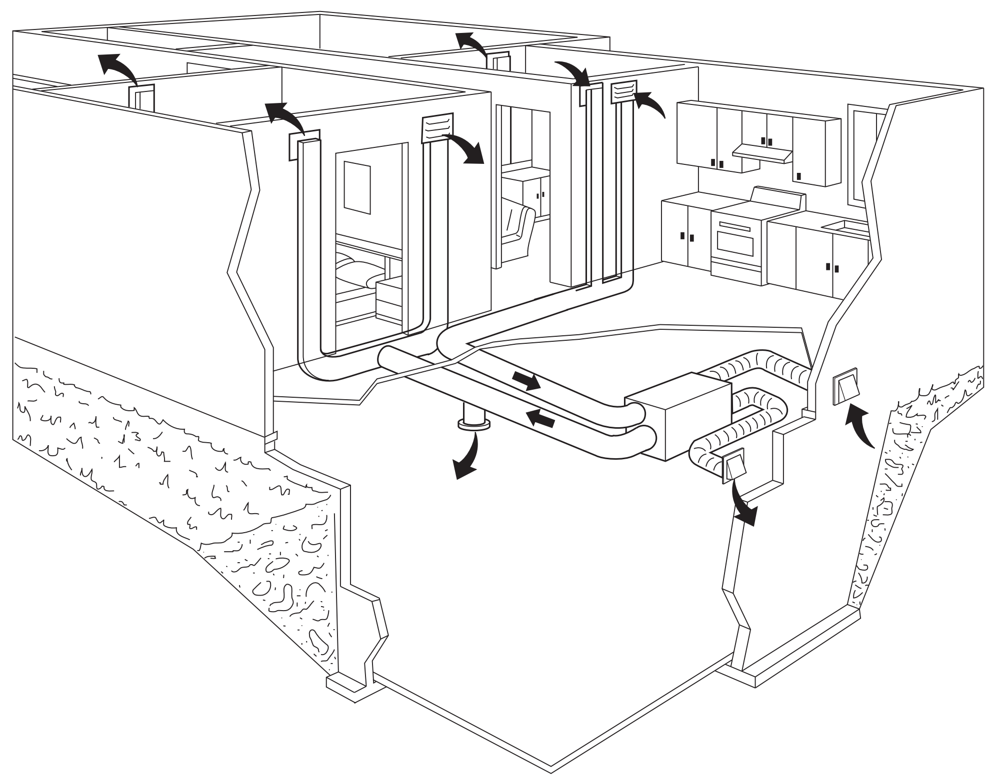
VENTILATOR INSTALLED WITH INDEPENDENT AIR DISTRIBUTION



A10106

ERV / HRV

Catalog No: ERVHRV−01PD

Replaces: NEW

Performance™ 96

Carrier®

Gas Furnace with Comfort Heat Technology® Feature

turn to the experts℠

High-Efficiency Gas Furnace with
up to 96.7% AFUE

Innovation and the Environment

Over 100 years ago, a humble but determined engineer solved one of mankind's most elusive challenges by controlling the indoor environment. A leading engineer of his day, Dr. Willis Carrier would file more than 80 patents over the course of his career. His genius would enable incredible advancements in health care, manufacturing processes, food preservation, art and historical conservation, indoor comfort and much more.

Carrier's foresight changed the world forever and paved the way for over a century of once-impossible innovations. Yet in addition to being an accomplished inventor, he was also an avid outdoors-man. Carrier recognized the power and beauty of the natural environment. This appreciation of our world and its resources continues to guide Carrier Corporation today. We will never rest on our accomplishments, but instead consistently look for ways to improve our products, our environment and our world.

The Performance™ 96 two-stage gas furnace with Comfort Heat Technology® feature continues the Carrier® story with money-saving efficiency and enhanced heating comfort you and your family can really enjoy.

Leaders in Technology

What Efficiency Means to You

Furnaces use gas to provide warm, comfortable heat for your home. You can compare efficiencies of different furnace models by checking the AFUE (Annual Fuel Utilization Efficiency) ratings, available through your Carrier dealer or manufacturer web sites. Using these ratings is a lot like miles per gallon for your car – the higher the number, the more efficient the product and the greater potential for savings. Actual furnace performance will vary depending on your home, comfort preferences and more.

The Performance 96 two-stage gas furnace with Comfort Heat Technology® feature converts up to 96.7 cents of every dollar spent on gas into heated air for your home. Standard furnaces can waste up to 20 cents or more per dollar.

UP TO 96.7% AFUE RATING

As an ENERGY STAR® partner, Carrier Corporation has determined that the Performance 96 two-stage gas furnace meets ENERGY STAR guidelines for energy efficiency.

Proper sizing and installation of equipment is critical to achieve optimal performance. Ask your dealer for details or visit www.energystar.gov.

1 Heating Capacity That Fits Your Needs

To better match the heating needs of your home, our two-stage gas valve offers low-stage heating for milder days while high-stage heating engages during colder temperatures. You will enjoy high-efficiency comfort as a result.

2 Efficient Comfort and Savings

The two-speed inducer fan controls air intake within the combustion system to ensure energy-efficient performance based on high and low heating needs.

3 Optimized Gas Efficiency

Heat exchangers are vital to your comfort and the efficiency of your furnace because they extract heat from the gas used. The Performance™ 96 uses two heat exchangers to optimize efficiency. Our primary heat exchanger does most of the work. Then, our secondary heat exchanger pulls additional heating energy from operation to maximize efficiency and provide soothing comfort.

4 Enhanced Indoor Air Quality

The optional air cleaner cabinet allows for the easy addition of a Carrier® high-efficiency air filter for improved indoor air.

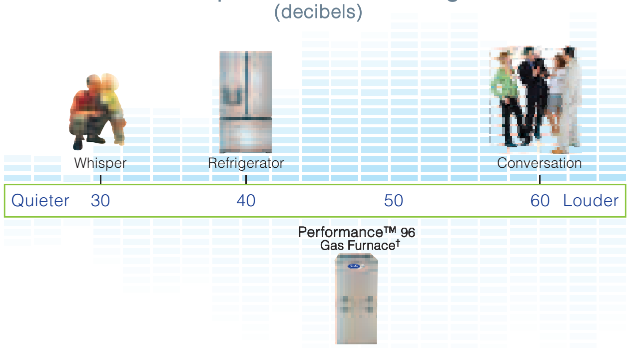
5 Precision Comfort Control

The Carrier furnace control board allows the system to connect with a Performance series Edge® programmable thermostat for responsive comfort control and our SmartEvap™ moisture control function. To help customize your comfort, the ComfortFan™ function allows you to select furnace fan speeds from the Edge thermostat on the wall in your home.

6 Extra-Quiet Operation

It starts with our Performance ECM™ blower which provides airflow optimized for your home's needs to help keep operational sound to a minimum. Add our two-speed inducer motor and insulated cabinet and you will enjoy the comfort of extra-quiet operation.

Comparison Sound Ratings
(decibels)



† Carrier manufactures gas furnaces that are among the quietest in the industry. We test our products in a sound laboratory specifically built to resemble a typical residence. Sound level recordings produced at steady state, single-stage operation (the most common operating condition), measured three feet from furnace. Other sound levels, mentioned for comparison, as published at http://www.noisyplanet.nidcd.nih.gov/SiteCollectionDocuments/Bookmark_2up.pdf.

It's About Your Comfort

The Carrier Performance 96 two-stage gas furnace represents years of design, development and testing with one goal in mind – making you more comfortable. We have taken the lead in creating new technologies that deliver the comfort and efficiency you deserve while staying ahead of industry trends and global initiatives.

Comfort Heat Technology® feature is Carrier's answer to smoothing out heating cycles so you can stay consistently comfortable as conditions change. This feature accurately predicts the need for heating based on previous furnace cycles to effectively reduce temperature swings. It's a much more comfortable and efficient system than single-stage furnaces that deliver heating in full-force blasts followed by idle periods of falling indoor temperatures.

ComfortHeat

The Carrier HYBRID HEAT® dual fuel system delivers peace of mind to homeowners concerned about the unpredictable nature of utility costs. This system pairs the Performance 96 two-stage gas furnace with an electric heat pump and Edge programmable thermostat to provide comfort, economy and flexibility. Your Carrier HYBRID HEAT dual fuel system will automatically switch between electric and gas heating as needed to keep your home comfortable all winter long while optimizing the efficiencies of each fuel source.

Thinks. Heats. Saves.
HYBRIDHEAT

10 YEAR LIMITED WARRANTY

Limited Warranty

To the original owner, the Carrier Performance 96 two-stage gas furnace is covered by a 10-year parts and lifetime heat exchanger limited warranty upon timely registration. The limited warranty period is five years for parts and twenty years for the heat exchanger if not registered within 90 days of installation. Jurisdictions where warranty benefits cannot be conditioned on registration will receive the registered limited warranty periods. See warranty certificate at carrier.com for complete details and restrictions. Be sure to ask your Carrier dealer about optional labor warranties.

Carrier® Systems for Unmatched Performance in Every Season

Willis Carrier's meticulous attention to quality and detail led to a major culture shift in the way we live indoors. More than a century later, Carrier Corporation operates with a unique willingness to develop new technology, the confidence to revise proven designs and the ability to deliver results with every new installation.

Part of that equation is our nationwide network of experts you can turn to for all of your indoor comfort needs. Your local Carrier dealer is well equipped to evaluate your home – everything from size, window placement, ductwork, venting and other structural specifics – and create a customized system designed around your lifestyle. So when it's time to make a choice for your family's comfort, make the best decision you'll ever make – Carrier – and let the experts do the rest.

The Total Indoor Comfort System

Air Conditioner provides reliable, high-efficiency cooling for long-lasting comfort and energy savings.

Gas Furnace provides reliable, high-efficiency heating for long-lasting comfort and energy savings.

Evaporator Coil is matched with the proper outdoor unit to provide top heating and cooling efficiency and years of reliable service.

Air Cleaner improves air quality by removing harmful and irritating airborne pollutants in your home.

Ventilator combines fresh outdoor air with conditioned indoor air for improved air quality and maximum efficiency – great for today's tightly constructed home.

Humidifier replenishes moisture to dry air.

Zoning sets different temperatures for up to eight different areas of your home for truly customized comfort and enhanced utility savings.

UV Lamp inhibits the growth of contaminants on the indoor coil, leaving your home with cleaner, fresher indoor air.

Edge® Programmable Thermostat allows precise temperature and humidity control along with programmable features to further customize your comfort.

Models 59TP5

01-858-584-25

Jackson LUMBER & MILLWORK

Why fiberglass?

THERMA TRU® DOORS
THE DOOR SYSTEM YOU CAN BELIEVE IN

durability

- fiberglass doors won't dent, rot or rust.
- withstands wide temperature ranges.

beauty

- our doors are made to look and feel like real wood.
- beautiful decorative glass patterns to accent your home and personal style.

low maintenance

- durable fiberglass construction requires less maintenance than wood or steel doors.

energy efficiency

- solid foam core offers 5 times the insulation value of wood.
- triple pane insulated tempered safety glass.

Smooth-Star ® Their ready-to-paint, smooth surface resists dents and won't rust. Distinct panel detailing and stile and rail lines provide greater curb appeal than steel doors.

Classic-Craft ® Entry Doors

Make a grand entrance. Premium Classic-Craft door systems combine crisp door detailing, square edges and deep profiles to create a rich, attractive entrance. AccuGrain™ Technology adds the exact grains, textures and feel of premium wood to top off this ultimate expression of style, durability and security.

Classic-Craft ® American Style Collection™
Simple vertical grains, solid wood edges, architecturally-correct stiles and rails and recessed panels create a timeless American style that's as sturdy as it is classic.

Classic-Craft ® Mahogany Collection™
The look of genuine Honduran mahogany provides a rich complement to any façade. The optional multi-point locking system enhances security for peace of mind.

Classic-Craft ® Rustic Collection™
Enjoy the character of rustic woods that can coordinate with door glass, sidelites, decorative clavos and strap hinges without compromising privacy.

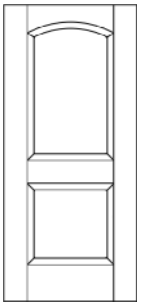
Classic-Craft ® Oak Collection™
The warm, oak grain look of these doors rival that of authentic hardwood. They can be painted or stained to match a home's style and can be trimmed up to 2 ½" for a perfect fit.

Product Feature	Traditions	Profiles	Smooth-Star Series	Fiber-Classic	Classic-Craft
System Warranty	5-Year Limited Warranty (Lites 10 years)	10-Year Limited Warranty	20-Year Limited Warranty	Limited Lifetime Warranty	Limited Lifetime Warranty
Skin Construction	25 Gauge Steel	24 Gauge Steel	Smooth, paint-grade dent-resistant fiberglass skin	Grained, stain or paint grade, dent resistant fiberglass skin (Min. Thickness of 1/16")	Grained, stain or paint grade, dent resistant fiberglass skin (Min. Thickness of 3/32")
Skin Finish	White Prime	Bright White Prime	White Prime	Wood grained	Natural oak or mahogany grained–Rustic alder/Fir
Molded Open Product	Not Available	Not Available	Available fanlite, half-lite & full-lite, 3/4 Oval	Not Available	Available 3/4 oval, fanlite, center arch
Lock Block	10" Wood lock block	10" Wood lock block	10" Wood lock block	19" Wood lock block	Full length LSL lock block
Door Stiles	1-1/4" Finger-joint primed, lock & hinge	1-1/4" Finger-joint primed, lock & hinge	1-1/4" LVL lock 1-1/4" FJP hinge	1-1/4" LVL lock 1-1/4" FJP hinge	4" LSL lock 1-1/4" LVL hinge 1/2" Oak or Mahogany edge
End Rails	Moistureshield Bottom Rail Only	Moistureshield Bottom Rail Only	Moistureshield Top & Bottom Rails	Moistureshield Top & Bottom Rails	Moistureshield Top & Bottom Rails
Doorlite Options	BTS Doorlites (non-yellowing, non-warping, OK behind storm door)	BTS Doorlites (non-yellowing, non-warping, OK behind storm door)	BTS Doorlites (non-yellowing, non-warping, OK behind storm door)	TCM Doorlites (non-yellowing, non-warping, OK behind storm door)	SMC Doorlites (non-yellowing, non-warping, OK behind storm door)
Fire Door Options	20-minute smoke & draft	20-minute Available	20-minute Available	20-minute Available	20-minute Available
7/0 & 8/0 Options	8/0 Available	Not Availalbe	8/0 Available	7/0 & 8/0 Available	8/0 Available
R Value	10 R Value Polyurethane Foam Core	12 R Value Polyurethane Foam Core	15.5 R Value Polyurethane Foam Core	15.5 R Value Polyurethane Foam Core	15.5 R Value Polyurethane Foam Core
Trimability without Reblocking					2-1/2"
Flush Glazing	Not Availalbe	Not Availalbe	1/2 Lite 3/4 Lite Full Lite	Not Availalbe	Some Designs

Jackson LUMBER & MILLWORK

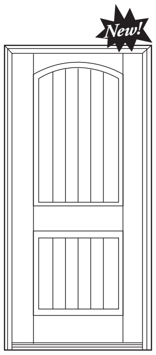
Smooth-Star® FIBERGLASS DOORS

THERMA-TRU® DOORS
THE DOOR SYSTEM YOU CAN BELIEVE IN



S-200

–
2-8 x 6-8
3-0 x 6-8



S-205

–
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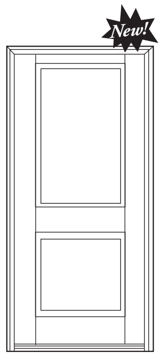
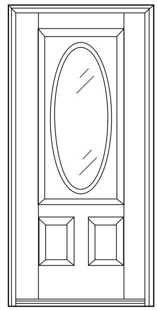
3-0 x 6-8



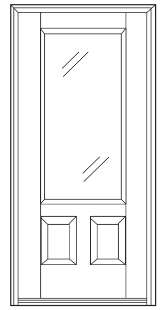
S-220

–
2-8 x 6-8
3-0 x 6-8



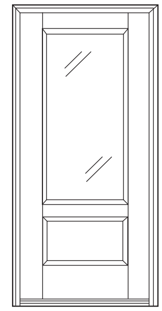
S-70
Shown w/Clear Glass Option

–
2-8 x 6-8
3-0 x 6-8



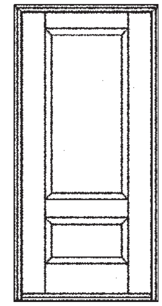
S-80
Shown w/Clear Glass Option

–
2-8 x 6-8
3-0 x 6-8



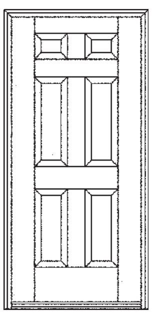
S-90
Shown w/Clear Glass Option

–
2-8 x 6-8
3-0 x 6-8



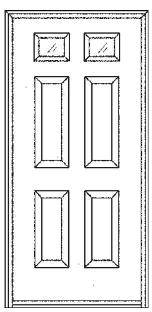
S-93

–
2-8 x 6-8
3-0 x 6-8



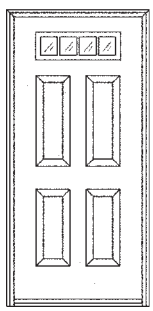
S-210

2-6 x 6-8
2-8 x 6-8
3-0 x 6-8



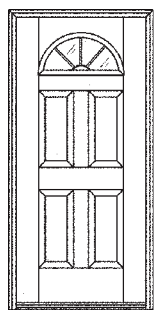
S-296

–
2-8 x 6-8
3-0 x 6-8



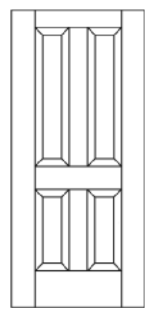
S-236
(Fixed grille)

–
3-0 x 6-8



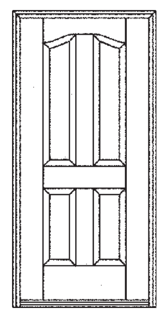
S-255
(Fixed grille)

–
2-8 x 6-8
3-0 x 6-8



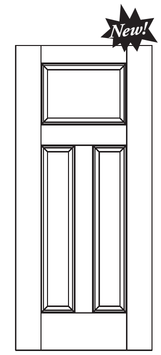
S-960

–
2-8 x 6-8
3-0 x 6-8



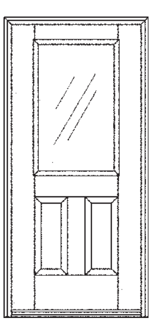
S-270

–
2-8 x 6-8
3-0 x 6-8



S-600

2-6 x 6-8
2-8 x 6-8
3-0 x 6-8



S-206

–
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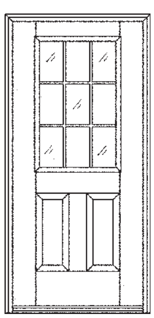
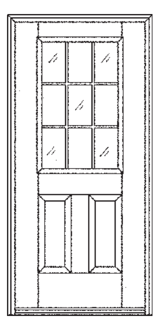
3-0 x 6-8



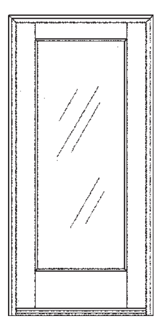
S-262
(Fixed grille)

–
2-8 x 6-8
3-0 x 6-8



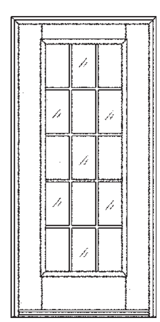
S-262 GBG

–
2-8 x 6-8
3-0 x 6-8



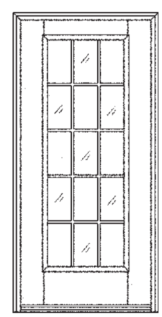
S-118

–
2-8 x 6-8
3-0 x 6-8



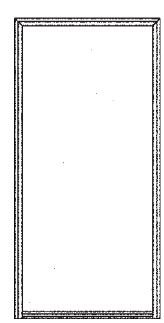
S-108
(Fixed grille)

–
2-8 x 6-8
3-0 x 6-8



S-108 GBG

–
2-8 x 6-8
3-0 x 6-8



S-100

2-6 x 6-8
2-8 x 6-8
3-0 x 6-8

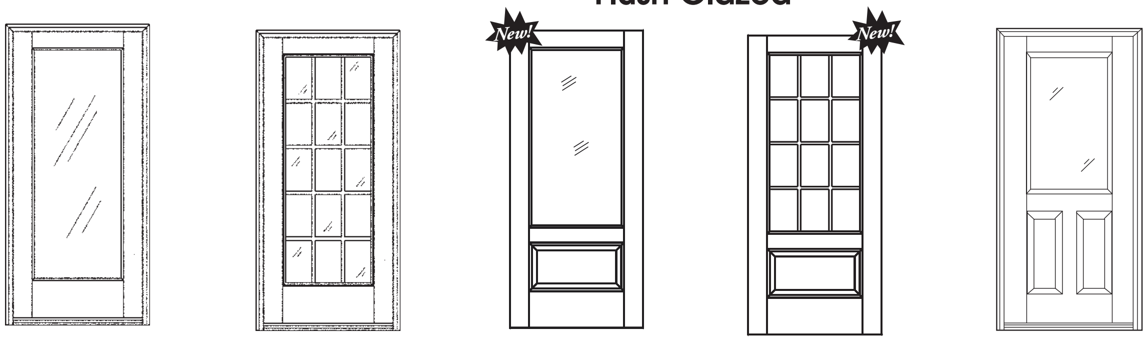
Jackson
LUMBER & MILLWORK

Smooth-Star®

Fiberglass Doors

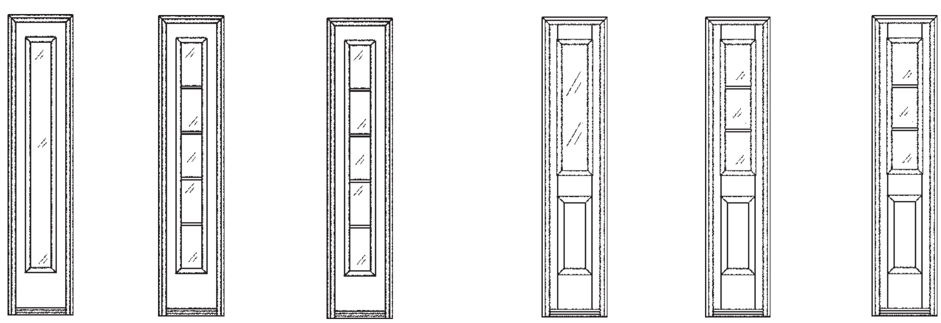
THERMA TRU® DOORS
THE DOOR SYSTEM YOU CAN BELIEVE IN

Flush Glazed



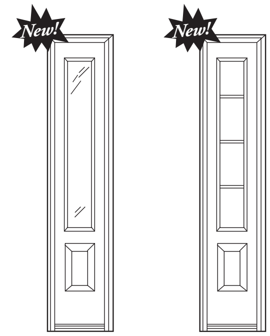
S-2000	S-2050 GBG	S-2200	S-2250 GBG	S-2100	S-2150 GBG
–	–	2-6 x 6-8	2-6 x 6-8	2-6 x 6-8	–
2-8 x 6-8	2-8 x 6-8	2-8 x 6-8	2-8 x 6-8	2-8 x 6-8	2-8 x 6-8
3-0 x 6-8	3-0 x 6-8	3-0 x 6-8	3-0 x 6-8	3-0 x 6-8	3-0 x 6-8

Sidelights



S-100SL	S-308SL (Fixed grille)	S-308SL GBG	S210SL	S-263SL (Fixed grille)	S-263SL GBG
1-0 x 6-8	1-0 x 6-8	1-0 x 6-8	1-0 x 6-8	1-0 x 6-8	1-0 x 6-8
1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8

Flush Glazed



S90SL Shown w/clear glass option	S91SL GBG
1-0 x 6-8	1-0 x 6-8
1-2 x 6-8	1-2 x 6-8

Smooth-Star features:

- A smooth, paintable surface
- Crisp stile and rail lines comparable to a wood door
- Durable fiberglass that won't dent, ding or rust
- A solid polyurethane foam core with five times the insulating value of wood
- An optional multi-point locking system for enhanced security
- A full system 20-year limited warranty*

*For complete details on our full system warranty visit www.thermatru.com.

LIMITED
20-Year
Warranty

Stock

Size	Rough Opening
3-0 x 6-8	38 1/2" x 83"
2-8 x 6-8	34 1/2" x 83"
1-0 x 3-0	51 1/2" x 83"
1-0 x 3-0 x 1-0	64 1/2" x 83"
1-2 x 3-0 x 1-2	68 1/2" x 83"
6-0 x 6-8	75 1/2" x 83"

For Outswing unit 81 1/2 Ht

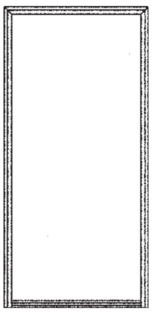
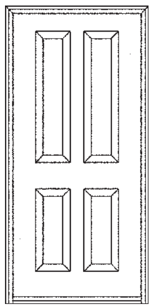
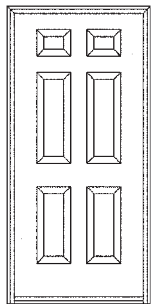
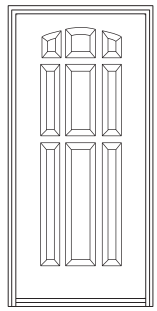
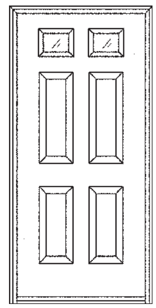
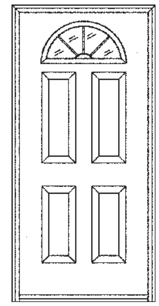
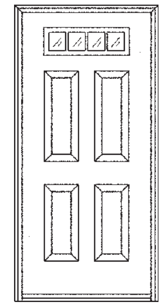
Units shipped with 1/2" plywood shim under sill.

Jackson LUMBER & MILLWORK

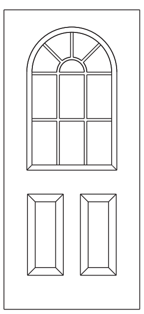
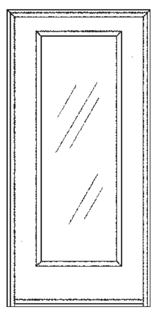
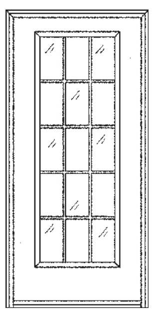
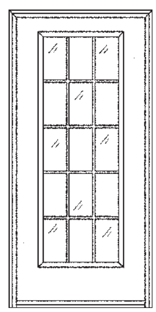
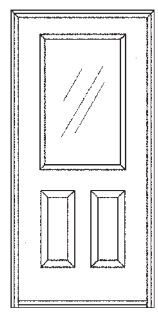
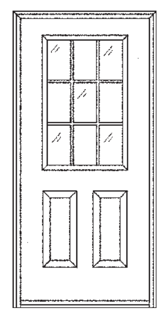
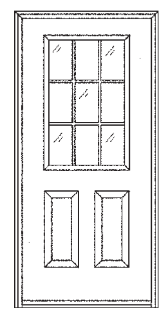
Traditions

Steel entry doors

THERMA TRU DOORS
THE DOOR SYSTEM YOU CAN BELIEVE IN

TS-100*	TS-214*	TS-210*	TS-290*	TS-296	TS-255	TS-236
2-0 x 6-8	–	–	–	–	–	–
2-6 x 6-8	–	**2-6 x 6-8**	–	–	–	–
2-8 x 6-8	2-8 x 6-8	**2-8 x 6-8**	2-8 x 6-8	**2-8 x 6-8**	–	**2-8 x 6-8**
3-0 x 6-8	3-0 x 6-8	**3-0 x 6-8**	3-0 x 6-8	**3-0 x 6-8**	**3-0 x 6-8**	**3-0 x 6-8**
3-6 x 6-8 (Profiles 100)	–	–	–	–	–	–

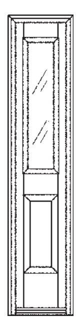
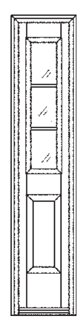
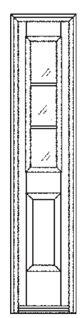
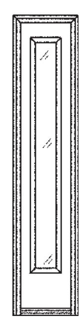
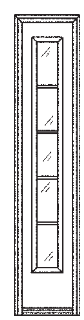
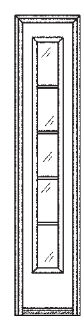








TS-151	TS-118	TS-108	TS-108 GBG	TS-206	TS-262	TS-262 GBG
2-8 x 6-8	2-8 x 6-8	2-8 x 6-8	2-8 x 6-8	**2-8 x 6-8**	**2-8 x 6-8**	**2-8 x 6-8**
3-0 x 6-8	**3-0 x 6-8**	**3-0 x 6-8**	**3-0 x 6-8**	**3-0 x 6-8**	**3-0 x 6-8**	**3-0 x 6-8**
–	–	–	–	–	–	–

Traditions Features:

- 25-gauge steel skins, primed white and ready-to-paint
- Solid polyurethane foam core offering double the R-value of polystyrene core
- Rot-resistant composite top and bottom rails
- Solid wood lock block for reinforcement
- 20-minute positive pressure fire rating*
- Five-year limited warranty on door systems and 10-year limited warranty on glass

For complete details on our full system warranty see your nearby Therma-Tru dealer or visit www.thermatru.com.

TS-210SL	TS-263SL	TS-263SL GBG	TS-100SL	TS-308SL	TS-308SL GBG
1-0 x 6-8	**1-0 x 6-8**	**1-0 x 6-8**	**1-0 x 6-8**	**1-0 x 6-8**	**1-0 x 6-8**
1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8	1-2 x 6-8

LIMITED 5-Year Warranty Door System

LIMITED 10-Year Warranty Glass System

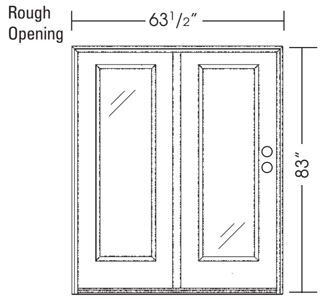
Stock

Jackson LUMBER & MILLWORK

Hinged Patio Units

THERMA-TRU DOORS
THE DOOR SYSTEM YOU CAN BELIEVE IN

SIZES



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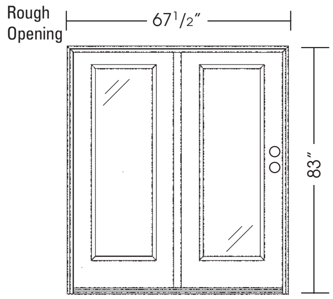

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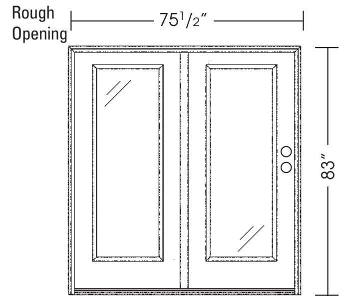
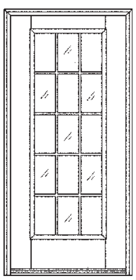


6068
CODE = PXD

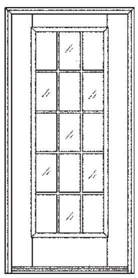
FEATURES:

- Tru-Defense Frame System
- Full Screen
- Available Hinged off the mull post or the side jamb
- Economical Patio Door Option

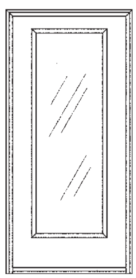
Door Options: Tradition Steel



TS-108
Fixed Grille



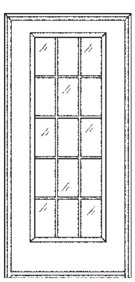
TS-108 GBG



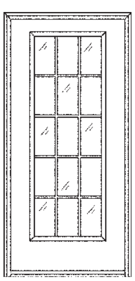
TS-118

Screen Code
2668 = TTPD26SCRN
2808 = TTPD28SCRN
3008 = TTPD30SCRN

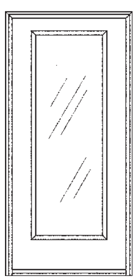
Door Options : Smooth-Star Fiberglass



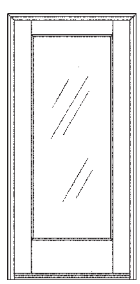
S-108
Fixed Grille



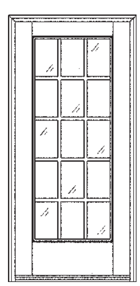
S-108 GBG



S-118



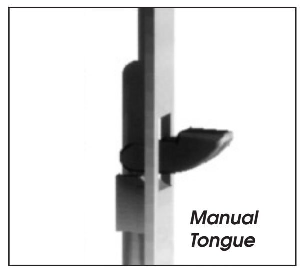
S-2000
Flush Glaze



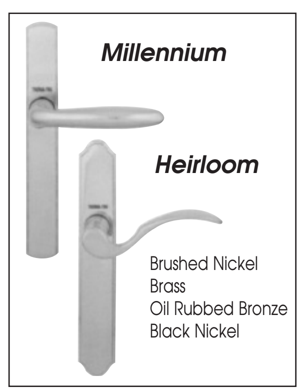
S-2050 GBG
Flush Glaze

- See ThermaTru Catalog For Full Product Offering.

Optional Multi-Point Locking System



- 300 Series Stainless Steel
  - won't pit or stain
  - excellent corrosion resistance
  - passed 3000 hours salt spray test
- Self-Lubricating Mechanisms
- Provides smooth operation with no need to lubricate locks
- Solid Stainless Steel Deadbolt
  - stronger than traditional deadbolts
  - 1" deadbolt throw

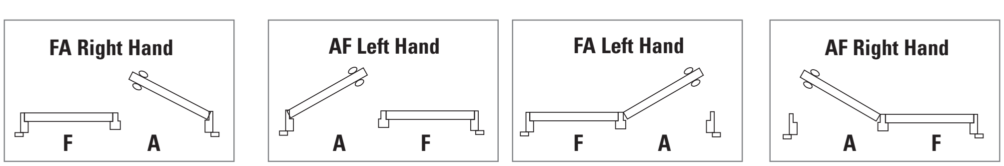


OPTIONS:

- FrameSaver Jambs
- FJP 908 casing
- FJP 5/4 x 3 1/2 casing
- PVC 908
- PVC 5/4 x 3 1/2
- PVC 908 w/J Channel
- PVC 5/4 x 3 1/2 w/J Channel
- DeadBolt preps
- Sill Pan
- Wood, Steel or Fiberglass Doors available as a Special Order
- Rain Deflector
- Available w/Transoms mulled above
- Units shipped with 1/2" ply-wood shim under sill

Handing Chart

Inside



Outside

RESIDENTIAL WATER HEATERS

GSW / John Wood Natural Draft Water Heaters

GSW / John Wood offers a complete line of residential natural gas and propane water heaters that feature technological innovation and design durability and efficiency.

Flame Guard® Safety System: Recent changes in industry standards require that certain gas-fired water heaters feature Flammable Vapor Ignition Resistant (FVIR) technology, to prevent the ignition of flammable vapors. With over 4 billion hours of outstanding performance in the field and more than 800,000 installations in homes across North America, John Wood Flame Guard® safety system gas water heaters are the only Flammable Vapor Ignition Resistant (FVIR) compliant water heaters on the market with more than five years of proven technology that you can trust.

All Models Feature:

- CFC-free foam design with a durable textured finish.
- 3/4″ NPT water connections.
- 1″ insulation.
- 1/2″ gas connection.
- Installed temperature and pressure valves.
- Tamperproof drain valves with 3/4″ hose connections.
- Patented Tanksaver® technology for extended inner tank life.

Models over 20 US Gallons comply with harmonized ANSI Z21.10.1 and CSA 4.1. FVIR models comply with harmonized ANSI 21.10.1a-2002 and CSA 4.1-M98.

Temperature and pressure valve over-flow tubes are not included.

NEE #	BTU	Fuel Type	Capacity	Description	Diameter	Height	Weight	Recovery Rates USG at 100º F
SSP30S30FV-06	27,000	Propane	30 US, 25 Imperial Gallon, 114 L	FVIR	18″	48.9″	108 lbs	23
SS30S27FV-04	27,000	Natural Gas	30 US, 25 Imperial Gallon, 114 L	FVIR	18″	46.7″	110 lbs	23
GP640S34FV-06	34,000	Propane	40 US, 33.3 Imperial Gallon, 151 L	FVIR	20.5″	53″	141 lbs	28.8
GP640S38FV-05	38,000	Propane	40 US, 33.3 Imperial Gallon, 151 L	FVIR	20.5″	53″	141 lbs	32.2
JW40S34FV-04	34,000	Natural Gas	40 US, 33.3 Imperial Gallon, 151 L	FVIR	20.5″	53″	141 lbs	28.8
GP650S36FV-06	36,000	Propane	50 US, 41.6 Imperial Gallon, 189 L	FVIR	22″	54.4″	165 lbs	31.5
JW50S36FV-04	36,000	Natural Gas	50 US, 41.6 Imperial Gallon, 189 L	FVIR	22″	54.4″	165 lbs	30.5
JW602NA-FV-03	47,000	Natural Gas	60 US, 50 Imperial Gallon, 227 L	FVIR	22″	59.7″	182 lbs	39.4
6G75P	67, 500	Propane	75 US, 62.5 Imperial Gallon, 284 L	Standard	24″	62.1″	259 lbs	50
6G75N	75,000	Natural Gas	75 US, 62.5 Imperial Gallon, 284 L	Standard	26.25″	60.5″	325 lbs	55.4

RESIDENTIAL WATER HEATERS

GSW Power Vent Superflue™ Water Heaters

GSW John Wood

SuperFlue™ models are superior, ultra-quiet power vent water heaters that supply ultimate satisfaction with abundant hot water, quiet operation, electronic ignition, reliability and performance that comes from more than 150 years in the industry.

Manufactured for use in a variety of applications, including combo-heating, SuperFlue power vents are the ideal choice for professional installers. Temperature and pressure relief valves are installed on all units, and also feature CFC-free foam design with a durable textured finish.

All propane as well as the 75 gallon natural gas units are manufactured with a cast iron burner, and most models feature the new "quiet" EBM blower design, and have 1" insulation. These models are CSA International approved and comply with ANSI Z21.10.1 and CSA 4.1.

Temperature and pressure valve over-flow tubes are not included.

Power Vent - Superflue

History: With the introduction of high-efficiency furnaces in the 1980's, a chimney was no longer required in the home. GSW responded to industry need with the introduction of the next evolution in water heating, the SuperFlue Power Vent Water Heater.

Length of Venting: The Power Vent can travel up to 80 feet, depending on the model, with 3" ABS and CPVC venting. (PVC can be used with some models).

Features:

- Quietest blower in the industry, 25% quieter than the competition.
- Flexible venting - can be vented horizontally or vertically through a roof (Direct Vent is horizontally vented only).
- Power Vent has no standing pilot light.
- No chimney is required.
- Can be used for larger applications (comes in 40, 50, 60 and 75 gallon sizes and with higher BTU inputs up to 74,999 BTU).
- Used for combo heating and space heating applications.
- Features an electronic thermostat control with self-diagnostic trouble-shooting system.

Energy Efficient: Meets the 2004 NRCan energy efficiency requirements.

Helps Protect Your Family from Flammable Vapor Hazards FLAME GUARD Safety System

All 40 and 50 gallon Power Vented units comply with FVIR requirements with the "Flame Guard feature". FVIR will be a requirement on all domestic water heaters by Jan 2007.

NEE #	BTU	Fuel Type	Capacity	Description	Diameter	Height	Weight	Recovery Rates USG at 100º F
6G40PVH-FV-06	30,000	Propane	40 US, 33.3 Imperial Gallon, 151 L	Electronic Ignition with FVIR	20"	57"	142 lbs	30
6G40NVH-FV-04		Natural Gas				57"	142 lbs	30
6G5065SPV-FV-06	58, 500	Propane	50 US, 41.6 Imperial Gallon, 189 L		22"	60"	190 lbs	34
6G50PVH-FV-06	34,000					59"	174 lbs	34
6G50NVH-FV-04		Natural Gas				60"	190 lbs	55
6G5065SNV-FV-04	65,000					59"	174 lbs	55
6G50PVH-FV-06	37, 800	Propane	60 US, 50 Imperial Gallon, 227 L			68"	186 lbs	32
6G50NVH-FV-04	38,000	Natural Gas				68"	186 lbs	32
6G75PCV-06	67, 500	Propane	75 US, 62.5 Imperial Gallon, 284 L	Standing Pilot	24"	72"	279 lbs	64

RESIDENTIAL WATER HEATERS

GSW Direct Vent Water Heaters

The Direct Vent operates quietly with no need for an electric fan or external power supply.

The balanced flue design with a side wall vent termination allows installation in locations without a chimney. The sealed combustion chamber and coaxial vent uses fresh air taken from outside rather then pre-heated air from within the home. Quiet, reliable and efficient operation in a quality design: the GSW Direct Vent water heater.

Temperature and pressure valve over-flow tubes are not included.

Direct Vent

History: Direct Vent appliances became popular in the late 1980's with the introduction of tighter homes in Canada. These airtight homes caused negative air conditions, which could result in naturally drafted appliances exhausting flue gases in the home. The Direct Vent water heater, which offers sealed combustion and a balanced flue design, became an important alternative.

Length of Venting: A Direct Vent appliance needs to be within 90" of the outside wall.

Features:
- Virtually silent operation because it does not have a blower or a motor.
- Uses outside air for combustion rather than heated air from inside the house - suitable for R2000 homes.
- No chimney is required.
- Does not require electricity to operate - hot water always available.
- Easy to install flexible co-axial venting that comes in the water heater carton along with silicone and metal bands.
- Comes in 40 and 50 gallon models.
- Used for combo heating and space heating applications.
- Vent riser available to raise the termination.

Energy Efficient: Meets the 2004 NRCan energy efficiency requirements and has 2" of CFC-free foam insulation.

NEE #	BTU	Fuel Type	Capacity	Diameter	Height	Weight	Recovery Rates USG at 100º F
6G50BFP-FV	42,000	Propane (FVIR)	50 US, 41.6 Imperial Gallon, 189 L	22"	57.7"	190 lbs	41.5
6G50TBFNA-FV-02	42,000	Natural Gas (FVIR)	50 US, 41.6 Imperial Gallon, 189 L	22"	57.7"	190 lbs	41.5
6G40BFNA-FV	38,000	Natural Gas (FVIR)	40 US, 33.3 Imperial Gallons, 151 L	22.3"	56.8"	148	33.3
6G40BFP-FV	38,000	Propane (FVIR)	40 US, 33.3 Imperial Gallons, 151 L	22.3"	56.8"	148	33.3

NATIONAL ENERGY EQUIPMENT INC.

RESIDENTIAL WATER HEATERS

WATER HEATERS

GSW Power Direct Vent Water Heaters

An advanced line of sealed combustion power direct vented water heaters. The Power Direct Vent (PDV) is designed with a sealed combustion chamber, ultra quiet blower and state-of-the-art gas control for highly accurate and reliable temperature control. Perfect for both residential new home construction and replacement water heater applications; the Power Direct Vent will provide the ultimate solution for your hot water needs.

Features:

- Sealed combustion chamber design prevents accidental ignition of flammable vapors and enhances air quality as no indoor air is required for combustion.
- Continues the GSW tradition of quiet power vent water heaters.
- Convenient 3/4" side taps for combination applications.
- Quick recovery with 65,000 BTU input.
- Exclusive patented TankSaver design to prolong tank life.
- Low profile design is ideal for replacement applications.
- Exceeds energy efficiency standards.
- No heated indoor air used for combustion.
- Flexible venting configurations can be vented with 3" ABS, PVC or CPVC up to 60 equivalent feet, horizontally through the wall or vertically through the roof.
- Auto-reset temperature switch monitors vent temperature.

NEE #	BTU	Fuel type	Capacity	Dia	Height	Weight	Recovery rates
G5065SP-PDV-05	65,000	Natural Gas	50 US, 41.6 Imperial Gallons, 189 L	31"	62"	190	59.6
G5065SN-PDV-02	65,000	Propane	50 US, 41.6 Imperial Gallons, 189 L	31"	62"	190	59.6

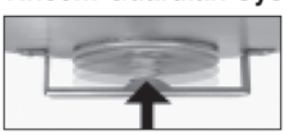
Rheem Natural Draft Water Heaters

Fury Gas (RR Series) with the Guardian System

The Guardian System™ is a one-of-a-kind air/fuel shut-off device that offers double protection, it is maintenance free – no filter to clean, and easy to light (no matches required). Energy efficient, it produces more hot water at lower operating cost. It is High Altitude compliant with all models certified for applications up to 4, 500 feet above sea level. The magnesium anode rod protects the tank from rust assuring a longer life expectancy. Temperature and pressure valve over-flow tubes are not included.

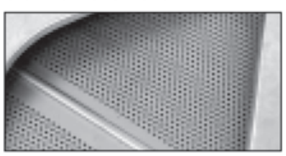
NEE #	BTU	Fuel Type	Capacity	Diameter	Height	Recovery Rates USG at 100º F
RR30-27PFV	27,000	Propane	30 US, 25 Imperial Gallon, 114 L	19 3/4"	49 3/4"	25.4
RR30-30FV	30,000	Natural Gas	30 US, 25 Imperial Gallon, 114 L	19 3/4"	49 3/4"	28.2
RR40-36PFV	36,000	Propane	40 US, 33.5 Imperial Gallon, 151 L	21 3/4"	53 3/4"	33.8
RR40-36FV	36,000	Natural Gas	40 US, 33.5 Imperial Gallon, 151 L	21 3/4"	53 3/4"	33.8
RR50-36PFV	36,000	Propane	50 US, 41.6 Imperial Gallon, 189 L	21 3/4"	53 3/4"	33.8
RR50-40FV	40,000	Natural Gas	50 US, 41.6 Imperial Gallon, 189 L	21 3/4"	53 3/4"	37.6

Rheem Guardian System Features...



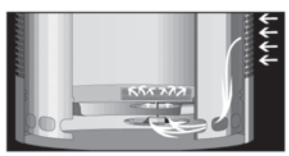
Exclusive Combustion Shut-off System

Should a spill incident occur, the Guardian System shuts off the gas supply and the air supply preventing a sustained vapor burn in the combustion chamber.



Flame Arrestor Plate

A specially-designed flame arrestor prevents ignition of vapors outside the combustion chamber.



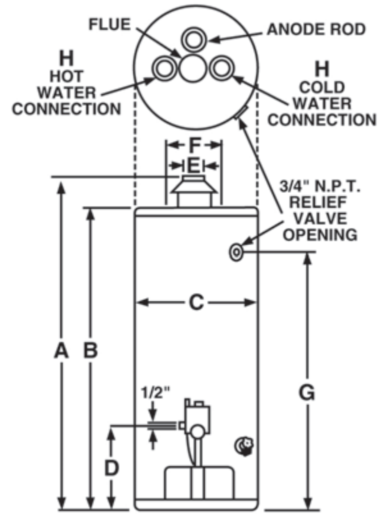
Maintenance Free

Superior air filtration prevents the flame arrestor from becoming clogged by lint, dust and oil.

These units are designed to meet or exceed ANSI (American National Standards Institute) requirements and have been tested according to D.O.E. test procedures and meet or exceed the energy efficiency requirements of NAECA, ASHRAE standard 90, ICC Code and all state energy efficiency performance criteria for energy consuming appliances.

PROTECTIONPLUS™

6 YEAR LIMITED TANK WARRANTY BECOMES 10



RESIDENTIAL WATER HEATERS

Rheem Power Vent Water Heaters

Features:

- Guardian System™: One-of-a-kind air/fuel shut-off device offers double protection
- Maintenance free – no filter to clean
- Standard replacement parts
- Self-Cleaning EverKleen™ patented system fights sediment build-up
- Reduces fuel costs
- Provides more hot water
- Easy to Light, No matches required
- Energy Efficient with more hot water at low operating cost
- High Altitude Compliant, all models are certified for applications up to 4, 500 feet above sea level
- Longer Life, patented magnesium anode rod design protects the tank from rust
- Brass drain valve and temperature and pressure relief valve are included
- Meets or exceeds NRCan requirements

FVIR will be a requirement on all domestic water heaters by Jan 2007.

NEE #	BTU	Fuel type	Capacity	Diameter	Height	Weight	Recovery Rates
PVS40-36FV	40,000	Natural Gas	40 US, 33.3 Imperial Gallons, 151 L	21 3/4"	53 3/4"	136	37.5
PVS40-32PFV	36,000	Propane	40 US, 33.3 Imperial Gallons, 151 L	21 3/4"	53 3/4"	136	33.8
PVS50-36FV	36,000	Natural Gas	50 US, 41.6 Imperial Gallons, 189 L	23 3/4"	53 3/4"	158	42.2
PVS50-32PFV	32,000	Propane	50 US, 41.6 Imperial Gallons, 189 L	23 3/4"	53 3/4"	158	37.5
PVR75WCE-1FV	75,000	Natural Gas	75 US, 62.5 Imperial Gallons, 284 L	26 1/4"	60 1/2"	325	69
PVR75WCEP-1FV	75,000	Propane	75 US, 62.5 Imperial Gallons, 284 L	26 1/4"	60 1/2"	325	69

What Size Water Heater Do You Need?

Household Size		GAS*	ELECTRIC
5 OR MORE	Regular Demand	50 U.S.Gal. 41.6 Imp. Gal. 189 Litres	60 Imp. Gal. 270 Litres
	High Demand	60 U.S.Gal. 49.9 Imp. Gal. 227 Litres	60 Imp. Gal. 270 Litres
3 TO 4	Regular Demand	40 U.S.Gal. 33.3 Imp. Gal. 151 Litres	38.5 Imp. Gal. 175 Litres
	High Demand	50 U.S.Gal. 41.6 Imp. Gal. 189 Litres	60 Imp. Gal. 270 Litres
2 OR LESS	Regular Demand	40 U.S.Gal. 33.3 Imp. Gal. 151 Litres	38.5 Imp. Gal. 175 Litres
	High Demand	40 U.S.Gal. 33.3 Imp. Gal. 151 Litres	38.5 Imp. Gal. 175 Litres

Other sizes are available. This chart is designed to help you select the appropriate water heater capacity. Your use may vary. *Regular Demand* capacities are based on a home with a washing machine and an automatic dishwasher. *High Demand* capacities meet the hot water needs of teenagers, whirlpool tubs, spas, and oversized baths. Always anticipate your family's future needs when selecting your water heater.

RESIDENTIAL WATER HEATERS

Common Repair & Service parts

GSW John Wood

NEE #	Description	For GSW Models
93476	T&P Relief Valve all models	all
71906	Anode Rod - 33", 40 Gallon	all 40 Gallon
71907	Anode Rod - 36", 50 Gallon	all 50 Gallon
81361	Robertshaw Gas Valve, 160º	Natural Draft
62635-02	Control Valve - SIT (after 2002)	Natural Draft
94857	Pilot Burner	Natural Draft
Q390A1095	18" Univ. Thermocouple	Natural Draft
63390	Robertshaw Gas Valve, 160º	Power Vent
86483	Starlite Ignitor	Power Vent
71075	Flame Sensor	Power Vent
63172	Blower Motor	Power Vent
71080	High Limit Switch	Power Vent
63243	Air Pressure Switch	Power Vent

Rheem

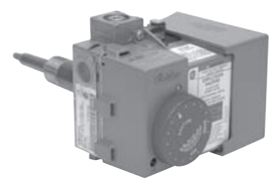
NEE #	Description	For Rheem Models
AP12574E	T&P Relief Valve	all
AP11524BJ	Anode Rod, 30 & 40 Gallon	all 30 & 40 Gallon
09-240	Anode Rod, 50 Gallon	all 50 Gallon
AP11114C	Thermostat Control Valve	Natural Draft
AP8980C	Pilot Burner - RR30 AND RR40	Natural Draft
07-277	Pilot Burner - RR50	Natural Draft
Q390A1095	18" Univ. Thermocouple	Natural Draft
07-193	Gas Valve	Power Vent
AP12557B	Thermostat Control	Power Vent
AP12948	Thermostat Control	Power Vent
AS39271	Hot Surface Ignitor	Power Vent
07-100	Flame Sensor	Power Vent
09-190	Blower Motor	Power Vent
75-07-022	Booster Coil for Gas Valve	Power Vent
SP20107C-2	Air Pressure Switch	Power Vent

71906, 71907, 09-225, 09-240 Anode Rod

93476, AP12574E T&P Relief Valve

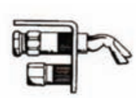
63390 Gas Valve

AP11114C Thermostat Control Valve



AP12948 Thermostat Control

Q390A1095 Thermocouple



94857 Pilot Burner

09-190 Blower Motor

86483 Starlight Ignitor

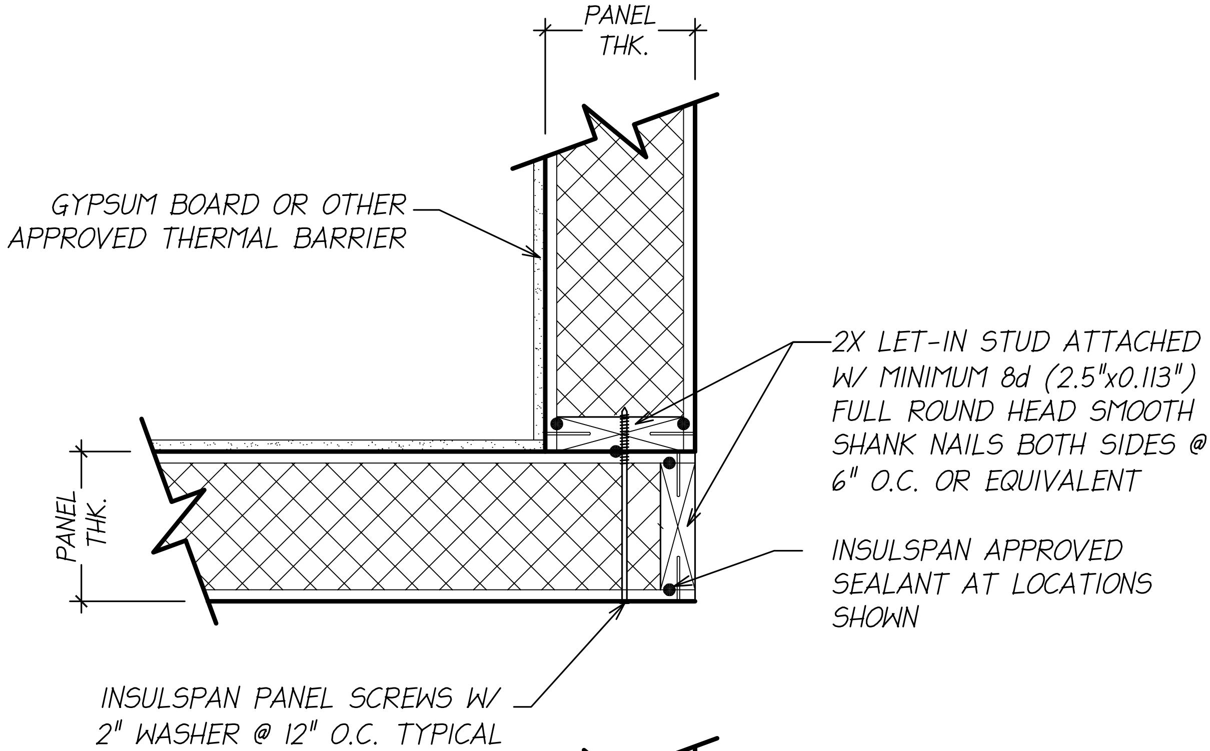
81361 Gas Valve

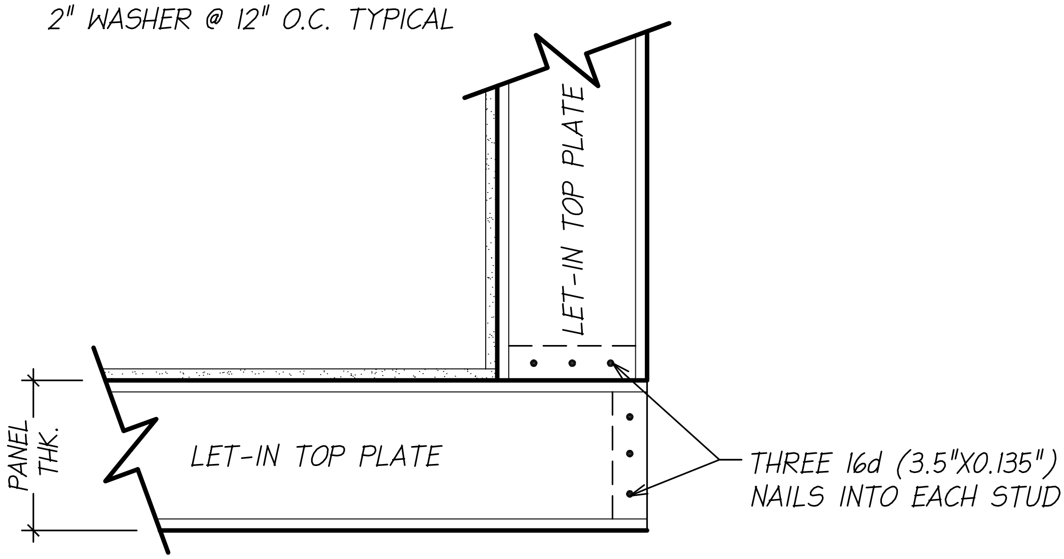
63172 Blower Motor

63243 07-174 Air Pressure Switch

75-07-022 Booster Coil

Appendix C: SIP Details





NOTES:

1. THE DETAIL IS TO BE USED WITH INSULSPAN CONSTRUCTION DRAWINGS AND INSTALLATION GUIDE. REFER TO INSULSPAN CONSTRUCTION DRAWINGS FOR FINAL NAIL AND SCREW SCHEDULES.
2. ALL BUILDING COMPONENTS USED IN CONJUNCTION WITH THIS DETAIL SHALL BE IN COMPLIANCE WITH LOCAL CODE REQUIREMENT.

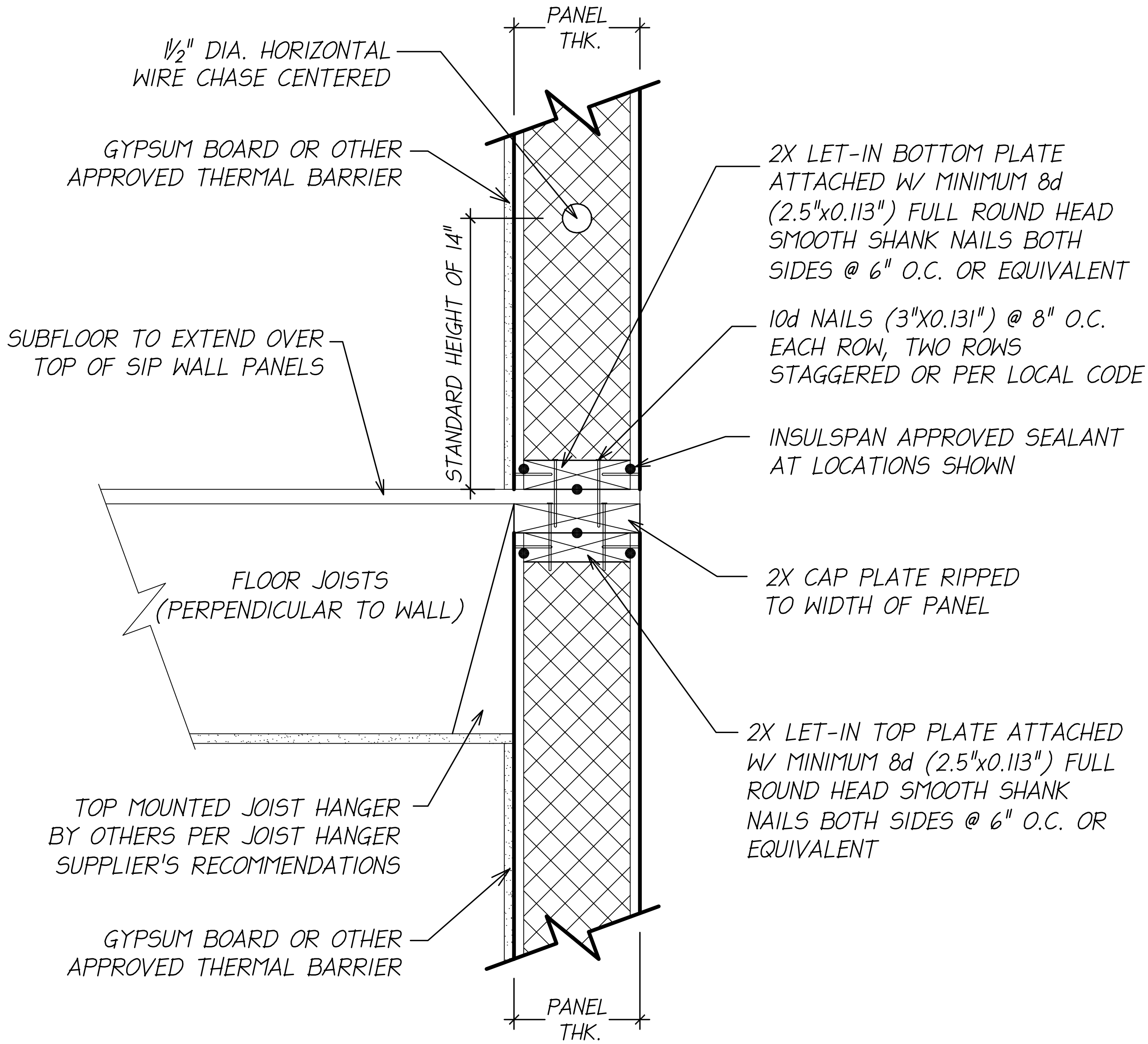
INSULSPAN® STRUCTURAL INSULATING PANEL SYSTEM

SIP WALL CORNER

SCALE:N.T.S.

LAST UPDATE: JUNE 22, 2010

200.03



NOTES:

1. THE DETAIL IS TO BE USED WITH INSULSPAN CONSTRUCTION DRAWINGS AND INSTALLATION GUIDE. REFER TO INSULSPAN CONSTRUCTION DRAWINGS FOR FINAL NAIL AND SCREW SCHEDULES.
2. ALL BUILDING COMPONENTS USED IN CONJUNCTION WITH THIS DETAIL SHALL BE IN COMPLIANCE WITH LOCAL CODE REQUIREMENT.

INSULSPAN®
STRUCTURAL INSULATING PANEL SYSTEM

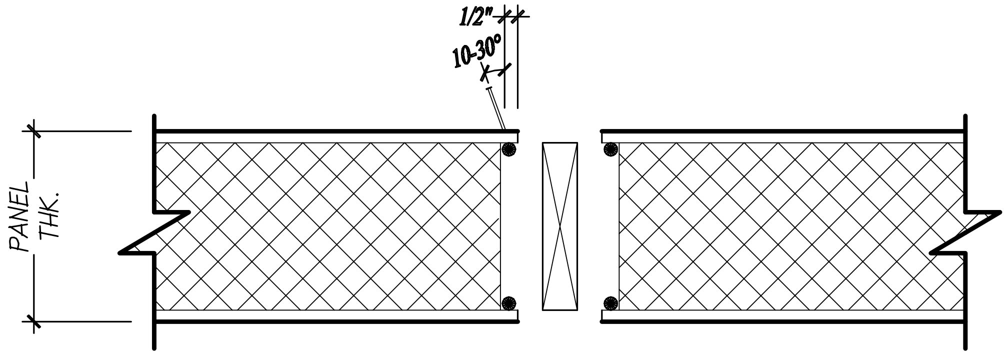
SIP WALL/FLOOR/JOIST HANGER

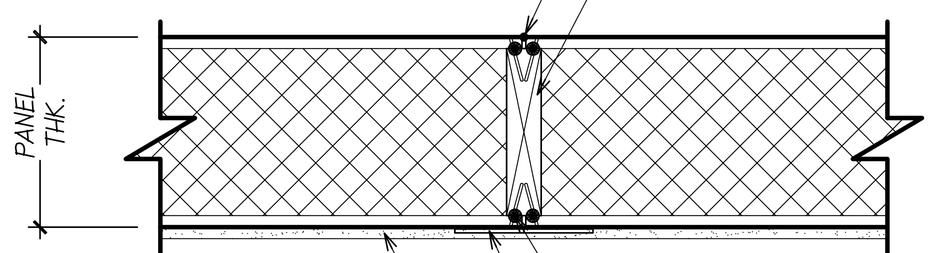
SCALE:N.T.S.

LAST UPDATE: JUNE 22, 2010

200.01

NOTE: NAILS DRIVEN AT 10°-30° ANGLE





NOTES:

1. THE DETAIL IS TO BE USED WITH INSULSPAN CONSTRUCTION DRAWINGS AND INSTALLATION GUIDE. REFER TO INSULSPAN CONSTRUCTION DRAWINGS FOR FINAL NAIL AND SCREW SCHEDULES.
2. ALL BUILDING COMPONENTS USED IN CONJUNCTION WITH THIS DETAIL SHALL BE IN COMPLIANCE WITH LOCAL CODE REQUIREMENT.

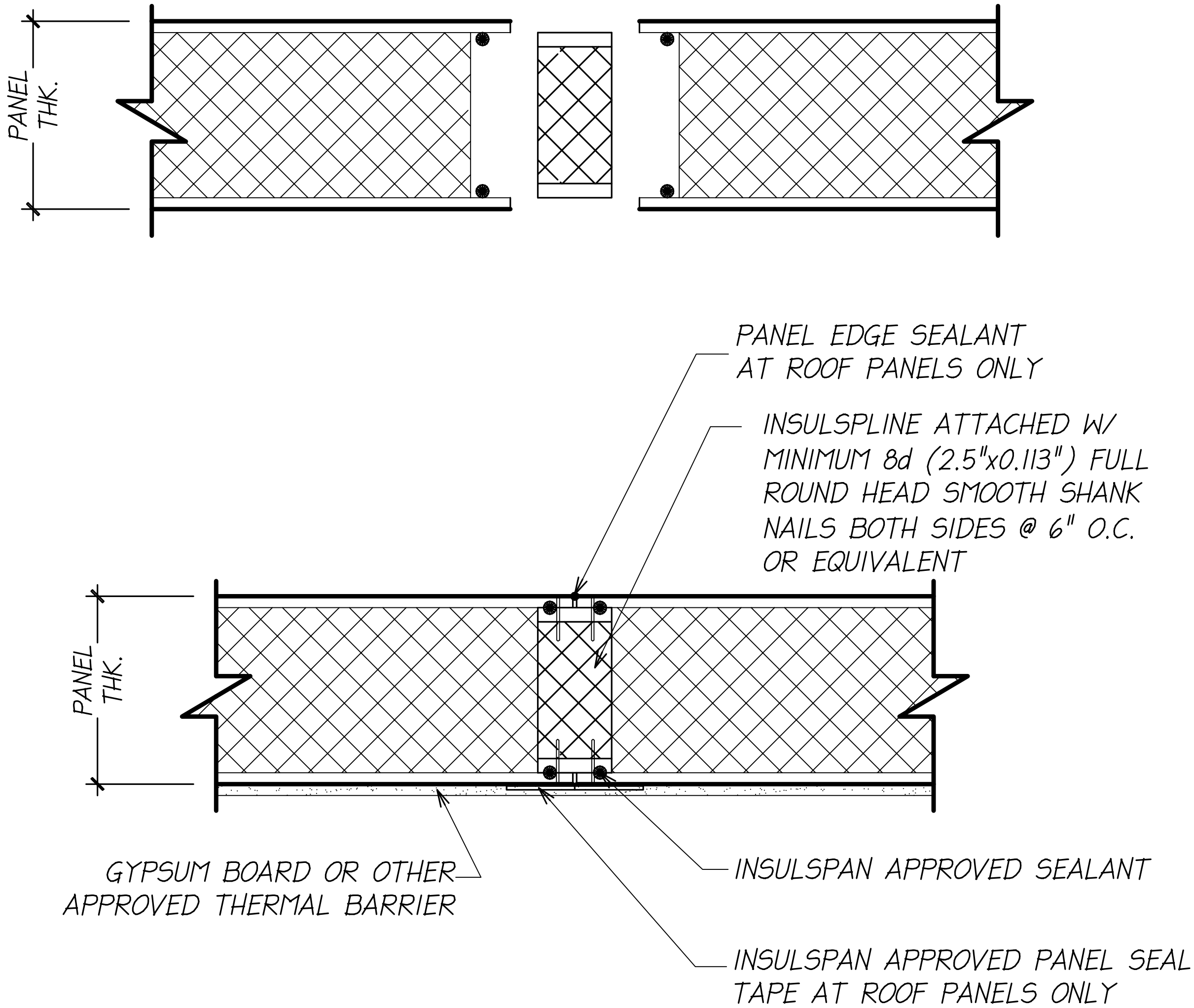
INSULSPAN®
STRUCTURAL INSULATING PANEL SYSTEM

SIP JOINT/SINGLE LUMBER SPLINE

SCALE: N.T.S.

LAST UPDATE: JUNE 22, 2010

400.01



NOTES:

1. THE DETAIL IS TO BE USED WITH INSULSPAN CONSTRUCTION DRAWINGS AND INSTALLATION GUIDE. REFER TO INSULSPAN CONSTRUCTION DRAWINGS FOR FINAL NAIL AND SCREW SCHEDULES.
2. ALL BUILDING COMPONENTS USED IN CONJUNCTION WITH THIS DETAIL SHALL BE IN COMPLIANCE WITH LOCAL CODE REQUIREMENT.

INSULSPAN®
STRUCTURAL INSULATING PANEL SYSTEM

SIP JOINT/INSULSPLINE

SCALE:N.T.S.

LAST UPDATE: JUNE 22, 2010

400.03

Appendix D: Utility Summary

Electricity Consumption

Previous Date	Current Date	Days	Adjusted Consumption (kWh)	Total Cost ($)
26-Feb-13	26-Apr-13	59	665.101	118.11
27-Dec-12	26-Feb-13	61	773.012	131.99
27-Oct-12	27-Dec-12	61	791.688	135.54
27-Aug-12	26-Oct-12	60	699.342	122.17
26-Jun-12	27-Aug-12	62	877.809	144.88
26-Apr-12	26-Jun-12	61	647.462	116.43
27-Feb-12	26-Apr-12	59	691.041	117.7
28-Dec-11	27-Feb-12	61	803.102	132.97
27-Oct-11	28-Dec-11	62	931.785	148.62
26-Aug-11	27-Oct-11	62	638.445	111.61
27-Jun-11	26-Aug-11	60	808.538	130.05
27-Apr-11	27-Jun-11	61	608.915	107.43
24-Feb-11	27-Apr-11	62	720.707	121.92
22-Dec-10	24-Feb-11	64	242.228	69.21
22-Oct-10	22-Dec-10	61	500.123	91.08
24-Aug-10	22-Oct-10	59	77.82	45.85
23-Jun-10	24-Aug-10	62	411.927	82.66
26-Apr-10	23-Jun-10	58	649.538	104.27
26-Feb-10	26-Apr-10	59	916.201	121.74
30-Dec-09	26-Feb-10	58	1070.803	135.8
29-Oct-09	30-Dec-09	62	1138.247	144.52
28-Aug-09	29-Oct-09	62	760.561	108.01
26-Jun-09	28-Aug-09	63	639.162	97.2
27-Apr-09	26-Jun-09	60	445.13	77.08
26-Feb-09	27-Apr-09	60	547.853	84
23-Dec-08	26-Feb-09	65	1008.547	129.56
27-Oct-08	23-Dec-08	57	997.134	123.68
26-Aug-08	27-Oct-08	62	866.396	109.52
23-Jun-08	26-Aug-08	64	907.9	113.17
23-Apr-08	23-Jun-08	61	709.718	92.76
25-Feb-08	23-Apr-08	58	616.334	82.77
22-Dec-07	25-Feb-08	65	722.17	95.69
22-Oct-07	22-Dec-07	61	521.913	76.09

Natural Gas Consumption

Current Date	Previous Date	Days	Adjusted Consumption (m^3)	Total Cost ($)
23-Apr-13	23-Mar-13	31	130	50.8
22-Mar-13	23-Feb-13	27	127	50.73
22-Feb-13	24-Jan-13	29	171	61.21
23-Jan-13	21-Dec-12	33	180	62.07
20-Dec-12	23-Nov-12	27	103	42.82
22-Nov-12	25-Oct-12	28	93	40.65
24-Oct-12	25-Sep-12	29	31	26.98
24-Sep-12	25-Aug-12	30	37	28.2
24-Aug-12	26-Jul-12	29	28	26.26
25-Jul-12	26-Jun-12	29	19	24.24
25-Jun-12	26-May-12	30	34	27.48
25-May-12	24-Apr-12	31	58	32.65
23-Apr-12	24-Mar-12	30	86	39.55
23-Mar-12	22-Feb-12	30	110	47.61
21-Feb-12	25-Jan-12	27	147	56.76
24-Jan-12	21-Dec-11	34	166	61.43
20-Dec-11	23-Nov-11	27	179	64.77
22-Nov-11	22-Oct-11	31	9	21.36
21-Oct-11	24-Sep-11	27	13	22.42
23-Sep-11	24-Aug-11	30	49	32.15
23-Aug-11	22-Jun-11	62	58	53.6
25-Jul-11	22-Jun-11	33	77	39.41
21-Jun-11	21-Apr-11	61	102	8.13
25-May-11	21-Apr-11	34	145	55.94
20-Apr-11	24-Mar-11	27	17	23.37
23-Mar-11	23-Feb-11	28	232	75.54
22-Feb-11	22-Dec-10	62	348	8.54
25-Jan-11	22-Dec-10	34	460	122.55
22-Dec-10	22-Oct-10	61	18	2.61
22-Nov-10	22-Oct-10	31	185	52.3
21-Oct-10	21-Aug-10	61	13	2.05
22-Sep-10	21-Aug-10	32	69	20.84
20-Aug-10	22-Jun-10	59	52	16.196
22-Jul-10	22-Jun-10	30	57	17.85
21-Jun-10	22-May-10	30	53	18.03
21-May-10	22-Apr-10	29	133	43.87
21-Apr-10	24-Mar-10	28	96	28.54
23-Mar-10	23-Feb-10	28	259	67.29
22-Feb-10	23-Jan-10	30	429	110.75
22-Jan-10	22-Dec-09	31	356	91.43
21-Dec-09	25-Nov-09	26	170	43.49
24-Nov-09	27-Oct-09	28	173	44.24
26-Oct-09	26-Sep-09	30	167	43.12
25-Sep-09	28-Aug-09	28	81	22.51
27-Aug-09	24-Jul-09	34	78	21.68
24-Jul-09	27-May-09	58	61	18.33
25-Jun-09	27-May-09	29	67	20.64
27-May-09	24-Apr-09	33	108	32.85
24-Apr-09	26-Mar-09	29	261	84.32
26-Mar-09	24-Feb-09	30	271	117.69
24-Feb-09	26-Jan-09	29	295	128.01
26-Jan-09	22-Dec-08	35	442	197.86
22-Dec-08	24-Nov-08	28	235	117.28
24-Nov-08	23-Nov-08	1	240	119.75
23-Oct-08	24-Sep-08	29	171	86.38
24-Sep-08	25-Aug-08	30	69	36.61
25-Aug-08	24-Jul-08	32	74	38.45
24-Jul-08	23-Jun-08	31	71	32.138
23-Jun-08	26-May-08	28	116	47.36
26-May-08	24-Apr-08	32	130	52.99
24-Apr-08	27-Mar-08	28	200	79.95
27-Mar-08	25-Feb-08	31	342	130.28
25-Feb-08	25-Jan-08	31	408	155.15
25-Jan-08	21-Dec-07	35	326	126.19
21-Dec-07	21-Nov-07	30	299	119.93
25-Nov-07	25-Oct-07	31	177	71.53
25-Oct-07	22-Oct-07	3	13	5.26

*note highlighted readings were estimated by Enbridge

Water Consumption

Current Date	Previous Date	Days	Consumption (m^3)	Total Cost ($)
28-Jan-13	8-Oct-12	112	34.5	92.46
8-Oct-12	25-Aug-12	44	13.3	34.86
25-Aug-12	16-Jul-12	40	13.2	34.6
16-Jul-12	2-Mar-12	136	45.8	120.04
2-Mar-12	7-Nov-11	116	34.1	85.93
7-Nov-11	7-Jul-11	123	21.2	50.98
7-Jul-11	16-Mar-11	113	42.9	103.16
12-Jan-11	28-Jun-10	198	18.7	40.58
4-Nov-10	28-Jun-10	129	49.2	106.77
28-Jun-10	7-Mar-10	113	43.1	93.53
7-Mar-10	13-Oct-09	145	64.5	133.68
13-Oct-09	22-Jun-09	113	35	69.68
22-Jun-09	2-Mar-09	112	42.5	84.61
2-Mar-09	1-Nov-08	121	49.5	94.51
1-Nov-08	9-Jul-08	115	60.9	111.23
8-Jul-08	26-Feb-08	133	40.1	73.24
26-Feb-08	22-Oct-07	127	38	65.86

Appendix E: HOT2000 Output

HOT2000

Natural Resources CANADA
Version 10.51

File: [redacted]
Application Type:

Weather Library: C:\PROGRA~2\Hot2000\Dat\Wth100.dir

Weather Data for TORONTO MET RES STN, ONTARIO

Builder Code:

Data Entry by:
Date of entry: 09/07/2012
Company:

Client name: [redacted]
Street address:

City: Toronto
Postal code: [redacted]

Region: Ontario
Telephone:

Mailing address:
City: [redacted]
Postal Code:

Region: Ontario

GENERAL HOUSE CHARACTERISTICS

House type:	Single Detached		
Number of storeys:	Two storeys		
Plan shape:	Rectangular		
Front orientation:	West		
Year House Built:	2001		
Wall colour:	Default	**Absorptivity:**	0.40
Roof colour:	Medium brown	**Absorptivity:**	0.84
Soil Condition:	Normal conductivity (dry sand, loam, clay)		
Water Table Level:	Normal (7-10m/23-33ft)		

House Thermal Mass Level: (A) Light, wood frame

Effective mass fraction 1.000

Occupants :
2 Adults for 50.0% of the time
2 Children for 50.0% of the time
0 Infants for 0.0% of the time

Sensible Internal Heat Gain From Occupants: 2.40 kWh/day

HOUSE TEMPERATURES

Heating Temperatures

Main Floor:	21.0 °C
Basement:	19.0 °C
TEMP. Rise from 21.0 °C:	2.8 °C

Basement is- Heated: YES **Cooled:** NO **Separate T/S:** NO
Fraction of internal gains released in basement : 0.150

Indoor design temperatures for equipment sizing

Heating:	22.0 °C
Cooling:	24.0 °C

WINDOW CHARACTERISTICS

Label	Location	#	Overhang Width (m)	Header Height (m)	Tilt deg	Curtain Factor	Shutter (RSI)
South							
Skylight	R3 - main roof	1	0.00	0.00	0.0	1.00	0.00
W5	South Wall	1	0.00	0.00	90.0	1.00	0.00
W6	South Wall	1	0.00	0.00	90.0	1.00	0.00
W7	South Wall	1	0.00	0.00	90.0	1.00	0.00
East							
D2	East Wall	1	0.00	0.00	90.0	1.00	0.00
W3	West Wall	1	0.00	0.00	90.0	1.00	0.00
W4	West Wall	1	0.00	0.00	90.0	1.00	0.00
West							
D3	West Wall	1	0.00	0.00	90.0	1.00	0.00
W1	East Wall	1	0.00	0.00	90.0	1.00	0.00

Label	Type	#	Window Width (m)	Window Height (m)	Total Area (m^2)	Window RSI	SHGC
South							
Skylight	213255	1	0.57	1.18	0.67	0.295	0.4619
W5	213206	1	1.07	0.91	0.98	0.654	0.4148
W6	213206	1	0.74	0.90	0.67	0.647	0.3977
W7	213206	1	0.68	1.03	0.70	0.647	0.3982
East							
D2	213206	1	1.52	2.03	3.10	0.671	0.4508
W3	213206	1	1.45	1.01	1.46	0.660	0.4286
W4	213206	1	1.45	1.01	1.46	0.660	0.4286
West							
D3	213206	1	1.53	2.04	3.12	0.672	0.4509
W1	213206	1	1.55	1.11	1.72	0.663	0.4343

WINDOW CODE SCHEDULE

Name	Internal Code	Description (Glazings, Coatings, Fill, Spacer, Type, Frame)
213255	213255	Double/double with 1 coat, Low-E .04 (soft), 13 mm Argon, Insulating, Skylight, Reinforced vinyl, RE* = -17.704, Eff. RSI= 0.57
213206	213206	Double/double with 1 coat, Low-E .04 (soft), 13 mm Argon, Insulating, Picture, Fibreglass, RE* = -3.032, Eff. RSI= 0.66

* Window Standard Energy Rating estimated for assumed dimensions, and Air tightness type: CSA - A1; Leakage rate = 2.790 m^3/hr/m

BUILDING PARAMETER DETAILS

CEILING COMPONENTS

	Construction Type	Code Type	Roof Slope	Heel Ht.(m)	Section Area (m^2)	R. Value (RSI)
R1 - under deck	Flat	2200WF0000	0.000/12	0.13	11.64	4.43
R3 - main roof	Flat	User specified	0.000/12	0.13	41.19	6.83

CEILING CODE SCHEDULE

Name	Internal Code	Description (Structure, typ/size, Spacing, Insull, 2, Int., Sheathing, Exterior, Studs)
2200WF0000	2200WF0000	Wood frame, 38x89 mm (2x4 in), 305 mm (12 in), N/A, N/A, None, N/A, N/A, N/A

MAIN WALL COMPONENTS

Label	Lintel Type	Fac. Dir	Number of Corn.	Number of Inter.	Height (m)	Perim. (m)	Area (m^2)	R. Value (RSI)
East Wall Type: User specified	N/A	N/A	1	0	3.71	4.22	15.66	4.31
North Wall Type: User specified	N/A	North	1	0	3.71	9.75	36.17	4.31
South Wall Type: User specified	N/A	South	1	0	3.71	9.75	36.17	4.31
West Wall Type: User specified	N/A	N/A	1	0	3.71	4.22	15.66	4.31
2nd Floor Type: User specified		North	4	4	0.25	9.75	2.44	1.98
2nd floor Type: User specified		N/A	4	4	0.25	9.75	2.44	1.98
Basement Type: User specified		N/A	4	4	0.35	9.75	3.41	1.12
Basement Type: User specified		N/A	4	4	0.35	9.75	3.41	1.12

DOORS

Label	Type	Height (m)	Width (m)	Gross Area (m^2)	R. Value (RSI)
D1 Loc: East Wall	User specified	2.10	0.98	2.05	2.73

FOUNDATIONS

Foundation Name:	Foundation		
Foundation Type:	Basement	**Volume:**	168.9 m^3

Data Type:	Library	**Opening to Main Floor:**	0.00 m^2
Total Wall Height:	3.20 m	**Rectangular**	
Depth Below Grade:	1.52 m	**Floor Length:**	12.51 m
		Floor Width:	4.22 m
Interior wall type:	User specified	**R-value:**	3.00 RSI
Exterior wall type:	User specified	**R-Value:**	0.00 RSI
Number of corners :	4		
Lintel type:	N/A		
Added to slab type :	User specified	**R-Value:**	2.11 RSI
Floors Above Found.:	User specified	**R-Value:**	0.34 RSI

Exposed areas for: Foundation
Exposed Perimeter: 33.46 m

Configuration: BCIB_1
- concrete walls and floor
- interior surface of wall insulated over full-height
- sub-surface of floor slab fully insulated but no insulation under footings
- any first storey construction type

FOUNDATION CODE SCHEDULE

Added To Slab

Name	Code	Description (Framing, Spacing, Insulation, Int., Sheathing)
76 mm EPS II (3 in)	00800	None, 305 mm (12 in), 76 mm (3 in) EPS II, None, None

ROOF CAVITY INPUTS

Sloped Roof		**Total Area:**	0.00 m^2
Sheathing Material	Plywood/Part. bd 12.7 mm (1/2 in)		0.11 RSI
Exterior Material:	Asphalt shingles		0.08 RSI
Total Cavity Volume:	0.0 m^3	**Ventilation Rate:**	0.50 ACH/hr

BUILDING ASSEMBLY DETAILS

Label	Construction Code	Nominal (RSI)	System (RSI)	Effective (RSI)
CEILING COMPONENTS				
R1 - under deck	2200WF0000	5.19	4.43	4.43

BUILDING PARAMETERS SUMMARY

ZONE 1 : Above Grade

Component	Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ	% Annual Heat Loss
Ceiling	52.83	52.15	6.09	2507.17	4.82
Main Walls	115.36	100.11	3.44	11547.98	22.18
Doors	2.05	2.05	2.73	323.58	0.62
South Windows	3.02	3.02	0.51	2536.70	4.87
East Windows	6.01	6.01	0.67	3884.41	7.46
West Windows	4.84	4.84	0.67	3116.82	5.99
		ZONE 1 Totals:		**23916.67**	**45.95**

INTER-ZONE Heat Transfer : Floors Above Basement

Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ
52.79	52.79	0.340	7750.41

ZONE 2 : Basement

Component	Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ	% Annual Heat Loss
Walls above grade	56.21	56.21	-	8042.29	15.45
Below grade foundation	103.65	103.65	-	9093.95	17.47
		ZONE 2 Totals:		**17136.23**	**32.92**

Ventilation

House Volume	Air Change	Heat Loss MJ	% Annual Heat Loss
321.30 m^3	0.575 ACH	11001.245	21.13

AIR LEAKAGE AND VENTILATION

Building Envelope Surface Area: 328.05 m^2

Air Leakage Test Results at 50 Pa.(0.2 in H_2O) = 0.72 ACH

Equivalent Leakage Area @ 10 Pa = 87.82 cm2

Terrain Description	Height	m
@ Weather Station : Open flat terrain, grass	Anemometer	10.0
@ Building site : Suburban, forest	Bldg. Eaves	5.5

Local Shielding:	**Walls:**	Very heavy
	Flue :	Light

Leakage Fractions- **Ceiling:** 0.200 **Walls:** 0.650 **Floors:** 0.150

Normalized Leakage Area @ 10 Pa:	0.2677 cm^2/m^2
Estimated Airflow to cause a 5 Pa Pressure Difference:	14 L/s
Estimated Airflow to cause a 10 Pa Pressure Difference:	22 L/s

F326 VENTILATION REQUIREMENTS

Kitchen, Living Room, Dining Room	3 rooms @ 5.0 L/s: 15.0 L/s
Utility Room	1 rooms @ 5.0 L/s: 5.0 L/s
Bedroom	1 rooms @ 10.0 L/s: 10.0 L/s
Bedroom	1 rooms @ 5.0 L/s: 5.0 L/s
Bathroom	1 rooms @ 5.0 L/s: 5.0 L/s
Basement Rooms	: 10.0 L/s

CENTRAL VENTILATION SYSTEM

System Type:	HVI Certified HRV
Manufacturer:	Carrier
Model Number:	HRVCCSVB1100

Fan and Preheater Power at 0.0 °C:	68 Watts
Fan and Preheater Power at -25.0 °C:	56 Watts
Preheater Capacity:	0 Watts
Sensible Heat Recovery Efficiency at 0.0 °C	59%
Sensible Heat Recovery Efficiency at -25.0 °C	57%
Total Heat Recovery Efficency in Cooling Mode	25%
Low Temperature Ventilation Reduction:	0%
Low Temperature Ventilation Reduction: Airflow Adjustment	0 L/s (0.0%)

Vented combustion appliance depressurization limit: 5.00 Pa.

Ventilation Supply Duct

Location:	Basement	**Type:**	Flexible
Length:	1.5 m	**Diameter:**	152.4 mm

Insulation:	0.7 RSI	**Sealing Characteristics:**	Very tight

Ventilation Exhaust Duct

Location:	Basement	**Type:**	Flexible
Length:	1.5 m	**Diameter:**	152.4 mm
Insulation:	0.7 RSI	**Sealing Characteristics:**	Very tight

Mechanical Ventilator Fan Power: 68.00 Watts

SECONDARY FANS & OTHER EXHAUST APPLIANCES

	Control	Supply (L/s)	Exhaust (L/s)
Dryer	Continuous	-	1.20

Dryer is vented outdoors

AIR LEAKAGE AND VENTILATION SUMMARY

F326 Required continous ventilation:	50.000 L/s (0.56 ACH)
Central Ventilation Supply Rate ():	50.000 L/s (0.56 ACH)
Total house ventilation is Balanced	
Gross Air Leakage and Ventilation Energy Load:	22532.754 MJ
Seasonal Heat Recovery Ventilator Efficiency:	58.446 %
Estimated Ventilation Electrical Load: Heating Hours:	1876.243 MJ
Estimated Ventilation Electrical Load: Non-Heating Hours:	180.936 MJ
Net Air Leakage and Ventilation Load:	11939.366 MJ

SPACE HEATING SYSTEM

Primary Heating Fuel:	Natural Gas
Equipment:	Condensing furnace/boiler
Manufacturer:	Carrier
Model:	58UVB060-14
Specified Output Capacity:	17.58 kW
AFUE:	95.00
Steady State Efficiency:	96.42
Fan Mode:	Auto
ECM Motor:	Yes
Low Speed Fan Power:	0 watts
High Speed Fan Power:	100 watts

DOMESTIC WATER HEATING SYSTEM

Primary Water Heating Fuel:	Natural gas
Water Heating Equipment:	Direct vent (sealed)
Energy Factor:	0.830
Manufactuer:	Superflue
Model:	8G40NVH-ES-02

Tank Capacity =	151.40 Litres	**Tank Blanket Insulation**	0.00 RSI
Tank Loacation:	Basement		
Pilot Energy =	0.00 MJ/day	**Flue Diameter**	0.00 mm

ANNUAL DOMESTIC WATER HEATING SUMMARY

Daily Hot Water Consumption:	225.00 Litres
Hot Water Temperature:	55.00 °C
Estimated Domestic Water Heating Load:	15687 MJ
Primary Domestic Water Heating Energy Consumption:	18835.21 MJ
Primary System Seasonal Efficiency:	83.28%

ANNUAL SPACE HEATING SUMMARY

Design Heat Loss at -22.00 °C (17.10 Watts / m3):	5494.03 Watts
Gross Space Heat Loss:	52054.14 MJ
Gross Space Heating Load:	52054.14 MJ
Usable Internal Gains:	14390.91 MJ
Usable Internal Gains Fraction:	27.65 %
Usable Solar Gains:	8016.36 MJ
Usable Solar Gains Fraction:	15.40 %
Auxilary Energy Required:	29646.88 MJ

Space Heating System Load:	29646.58 MJ
Furnace/Boiler Seasonal efficiency:	96.43 %
Furnace/Boiler Annual Energy Consumption:	30575.05 MJ

BASE LOADS SUMMARY

	kwh/day	Annual kWh
Interior Lighting	2.00	730.00
Appliances	6.50	2372.50
Other	1.00	365.00
Exterior Use	1.00	365.00
HVAC Fans		
HRV/Exhaust	1.57	571.44
Space Heating	0.13	46.57
Space Cooling	0.00	0.00
Total Average Electrical Load	12.19	4450.51

FAN OPERATION SUMMARY (kWh)

Hours	HRV/Exhaust Fans	Space Heating	Space Cooling
Heating	521.2	46.6	0.0
Neither	50.3	0.0	0.0
Cooling	0.0	0.0	0.0
Total	571.4	46.6	0.0

ENERGY CONSUMPTION SUMMARY REPORT

Estimated Annual Space Heating Energy Consumption	= 30742.70 MJ	= 8539.64 kWh
Ventilator Electrical Consumption: Heating Hours	= 1876.24 MJ	= 521.18 kWh
Estimated Annual DHW Heating Energy Consumption	= 18835.21 MJ	= 5232.00 kWh
ESTIMATED ANNUAL SPACE + DHW ENERGY CONSUMPTION	= 51454.15 MJ	= 14292.82 kWh

Estimated Greenhouse Gas Emissions 4.899 tonnes/year

ESTIMATED ANNUAL FUEL CONSUMPTION SUMMARY

Fuel	Space Heating	Space Cooling	DHW Heating	Appliance	Total
Natural Gas (m3)	820.61	0.00	505.52	0.00	1326.13
Electricity (kWh)	567.75	0.00	0.00	3882.76	4450.51

ESTIMATED ANNUAL FUEL CONSUMPTION COSTS

Fuel Costs Library = Embedded

RATE	Electricity (Toronto)	Natural Gas (Toronto)	Oil (Ottawa08)	Propane (Ottawa08)	Wood (Sth Ont)	Total
$	329.34	389.76	0.00	0.00	0.00	719.10

Fuel Costs Library Listing

Filename = Embedded

Record # 1	Fuel: Electricity		
Rate ID = Ottawa08	Hydro Rate Block		
Rate Block		Dollars	Charge
	kWhr	Per kWhr	($)
Minimum	0.0		9.540
1	600.0	0.0926	
2	99999.0	0.1016	
Record # 2	Fuel: Natural Gas		
Rate ID = Toronto	these are not real rates		
Rate Block		Dollars	Charge
	m3	Per m3	($)
Minimum	0.0		8.000

1	30.0	0.2265	
2	85.0	0.2219	
3	170.0	0.2183	
4	99999.0	0.2156	
Record # 3	Fuel: Oil		
Rate ID = Ottawa08	Oil Rate Block		
Rate Block		Dollars	Charge
	Litre	Per Litre	($)
Minimum	0.0		0.000
1	99999.0	1.1750	
Record # 4	Fuel: Propane		
Rate ID = Ottawa08	Propane Rate Block		
Rate Block		Dollars	Charge
	Litre	Per Litre	($)
Minimum	0.0		0.000
1	99999.0	0.7200	
Record # 5	Fuel: Wood		
Rate ID = Sth Ont	Cord Rate		
Rate Block		Dollars	Charge
	Cord	Per Cord	($)
Minimum	0.0		0.000
1	99999.0	210.0000	
Record # 6	Fuel: Natural Gas		
Rate ID = Ottawa08	Gas Rate Block		
Rate Block		Dollars	Charge
	m3	Per m3	($)
Minimum	0.0		14.000
1	30.0	0.5338	
2	85.0	0.5277	
3	170.0	0.5229	
4	99999.0	0.5194	
Record # 7	Fuel: Electricity		
Rate ID = Toronto	Hydro Rate Block		
Rate Block		Dollars	Charge
	kWhr	Per kWhr	($)
Minimum	0.0		0.000
1	1000.0	0.0740	
2	99999.0	0.0870	

MONTHLY ENERGY PROFILE

Month	Energy Load (MJ)	Internal Gains (MJ)	Solar Gains (MJ)	Aux. Energy (MJ)	HRV Eff. %
Jan	8769.3	1324.5	913.7	6531.0	58.3
Feb	7636.4	1191.3	1122.1	5323.1	58.4
Mar	6898.4	1325.3	1366.8	4206.3	58.5
Apr	4616.6	1298.5	1117.2	2200.9	58.6
May	2658.8	1363.4	755.3	540.1	58.7
Jun	1227.2	1072.9	132.5	21.8	58.5
Jul	708.3	701.0	6.8	0.6	58.1
Aug	797.7	782.0	14.7	1.1	58.2
Sep	1773.0	1283.8	387.7	101.5	58.6
Oct	3769.5	1387.2	870.4	1512.0	58.5
Nov	5524.4	1320.0	624.2	3580.2	58.5
Dec	7674.6	1341.1	705.1	5628.4	58.4
Ann	52054.1	14390.9	8016.4	29646.9	58.4

FOUNDATION ENERGY PROFILE

	Heat Loss (MJ)				
Month	Crawl Space	Slab	Basement	Walkout	Total
Jan	0.0	0.0	1399.7	0.0	1399.7
Feb	0.0	0.0	1142.6	0.0	1142.6
Mar	0.0	0.0	902.8	0.0	902.8
Apr	0.0	0.0	472.3	0.0	472.3
May	0.0	0.0	115.8	0.0	115.8
Jun	0.0	0.0	4.7	0.0	4.7
Jul	0.0	0.0	0.1	0.0	0.1
Aug	0.0	0.0	0.2	0.0	0.2
Sep	0.0	0.0	21.8	0.0	21.8
Oct	0.0	0.0	324.5	0.0	324.5
Nov	0.0	0.0	768.5	0.0	768.5
Dec	0.0	0.0	1208.1	0.0	1208.1
Ann	0.0	0.0	6361.0	0.0	6361.0

FOUNDATION TEMPERATURES & VENTILATION PROFILE

	Temperature (Deg °C)			Air Change Rate		Heat Loss
Month	Crawl Space	Basement	Walkout	Natural	Total	(MJ)
Jan	0.0	18.8	0.0	0.039	0.611	2035.9
Feb	0.0	18.6	0.0	0.038	0.611	1766.5
Mar	0.0	18.6	0.0	0.033	0.606	1539.9
Apr	0.0	18.9	0.0	0.025	0.599	957.2
May	0.0	19.6	0.0	0.016	0.577	473.1
Jun	0.0	20.8	0.0	0.010	0.530	147.6
Jul	0.0	22.2	0.0	0.007	0.483	30.1

Aug	0.0	21.7	0.0	0.007	0.508	53.2
Sep	0.0	20.5	0.0	0.012	0.567	292.0
Oct	0.0	19.7	0.0	0.021	0.594	770.3
Nov	0.0	19.4	0.0	0.028	0.602	1193.0
Dec	0.0	19.1	0.0	0.035	0.608	1742.2
Ann	0.0	19.8	0.0	0.022	0.575	11001.2

SPACE HEATING SYSTEM PERFORMANCE

Month	Space Heating Load (MJ)	Furnace Input (MJ)	Pilot Light (MJ)	Indoor Fans (MJ)	Heat Pump Input (MJ)	Total Input (MJ)	System Cop
Jan	6531.0	6735.6	0.0	36.9	0.0	6772.5	1.0
Feb	5323.1	5489.8	0.0	30.1	0.0	5519.9	1.0
Mar	4206.3	4338.0	0.0	23.8	0.0	4361.8	1.0
Apr	2200.9	2269.8	0.0	12.4	0.0	2282.3	1.0
May	540.1	557.0	0.0	3.1	0.0	560.0	1.0
Jun	21.8	22.5	0.0	0.1	0.0	22.6	1.0
Jul	0.5	0.5	0.0	0.0	0.0	0.5	1.0
Aug	0.9	0.9	0.0	0.0	0.0	0.9	1.0
Sep	101.5	104.7	0.0	0.6	0.0	105.2	1.0
Oct	1512.0	1559.3	0.0	8.5	0.0	1567.9	1.0
Nov	3580.2	3692.3	0.0	20.2	0.0	3712.6	1.0
Dec	5628.4	5804.7	0.0	31.8	0.0	5836.5	1.0
Ann	29646.6	30575.1	0.0	167.6	0.0	30742.7	1.0

MONTHLY ESTIMATED ENERGY CONSUMPTION BY DEVICE (MJ)

	Space Heating		DHW Heating		Lights &	HRV &	Air
Month	**Primary**	**Secondary**	**Primary**	**Secondary**	**Appliances**	**FANS**	**Conditioner**
Jan	6735.6	0.0	1750.5	0.0	1171.8	216.3	0.0
Feb	5489.8	0.0	1602.4	0.0	1058.4	193.2	0.0
Mar	4338.0	0.0	1751.5	0.0	1171.8	205.7	0.0
Apr	2269.8	0.0	1634.2	0.0	1134.0	188.7	0.0
May	557.0	0.0	1601.7	0.0	1171.8	181.1	0.0
Jun	22.5	0.0	1463.8	0.0	1134.0	159.6	0.0
Jul	0.5	0.0	1445.1	0.0	1171.8	150.3	0.0
Aug	0.9	0.0	1424.7	0.0	1171.8	158.5	0.0
Sep	104.7	0.0	1405.6	0.0	1134.0	170.9	0.0
Oct	1559.3	0.0	1517.3	0.0	1171.8	190.7	0.0
Nov	3692.3	0.0	1550.7	0.0	1134.0	196.5	0.0
Dec	5804.7	0.0	1687.8	0.0	1171.8	213.3	0.0
Ann	30575.1	0.0	18835.2	0.0	13797.0	2224.8	0.0

ESTIMATED FUEL COSTS (Dollars)

Month	Electricity	Natural Gas	Oil	Propane	Wood	Total
Jan	28.53	58.01	0.00	0.00	0.00	86.54
Feb	25.73	49.94	0.00	0.00	0.00	75.67
Mar	28.32	44.12	0.00	0.00	0.00	72.44
Apr	27.19	31.32	0.00	0.00	0.00	58.51
May	27.81	20.99	0.00	0.00	0.00	48.80
Jun	26.59	16.99	0.00	0.00	0.00	43.58
Jul	27.18	16.75	0.00	0.00	0.00	43.92
Aug	27.34	16.63	0.00	0.00	0.00	43.97
Sep	26.82	17.13	0.00	0.00	0.00	43.96
Oct	28.01	26.46	0.00	0.00	0.00	54.47
Nov	27.35	39.16	0.00	0.00	0.00	66.51
Dec	28.47	52.26	0.00	0.00	0.00	80.73
Ann	329.34	389.76	0.00	0.00	0.00	719.10

The calculated heat losses and energy consumptions are only estimates, based upon the data entered and assumptions within the program. Actual energy consumption and heat losses will be influenced by construction practices, localized weather, equipment characteristics and the lifestyle of the occupants.

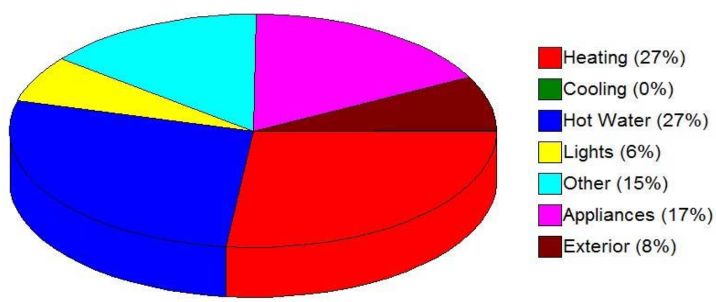
HOUSE REPORT

HOT2000
Natural Resources CANADA Version

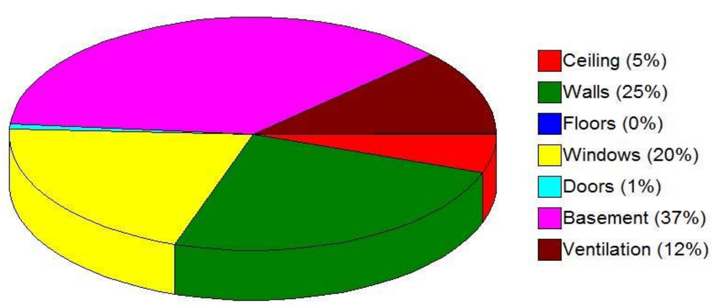
Client:	[redacted]	Audit Date:	**09/07/2012**
Address:	[redacted]	Auditor:	[redacted]
City:	**Toronto**	File ID:	[redacted]
Province:	**Ontario**		
Code:	[redacted]		
Phone:	[redacted]		

Your house was analysed using a computer program developed by Natural Resources Canada. The following charts show the components of yearly energy consumption and heat loss for your home.

COMPONENTS OF ANNUAL ENERGY CONSUMPTION

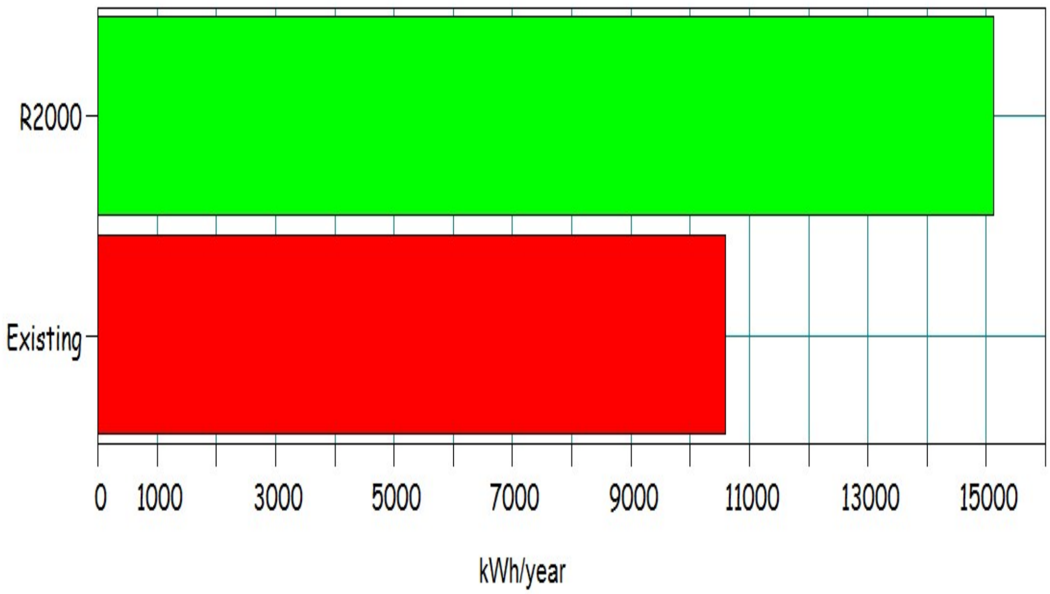


COMPONENTS OF ANNUAL HEAT LOSS



Your house currently uses approximately 10590.9 kWh for space and hot water heating in an average year. The following chart illustrates the relationship between the energy used by your house and the energy used by an equivalent R2000 home.

ANNUAL HEATING + HOT WATER ENERGY CONSUMPTION (kWh)



Notice to Homeowner

Your house was analysed using a computer program developed by Natural Resources Canada. Natural Resources Canada makes no warranty, expressed or implied, with respect to the energy consumption figures included in this assessment. In no event will Natural Resources Canada nor its minister, officers, employees or agents have any obligations or liability arising from tort, or for loss of revenue or profit, or for indirect, special, incidental or consequential damages as a result of the homeowner's use of the assessment report.

Some of the assumptions within the computer program may, or may not, be applicable to your household. Where assumptions have been made, they are based on an average appliance usage rate.

H2Kv9.2-Mar2004

HOT2000
Natural Resources CANADA
Version 10.51

File: [redacted]
Application Type: R-2000

Weather Library: C:\H2KV10~1\Dat\Wth100.dir

Weather Data for TORONTO MET RES STN, ONTARIO

Builder Code:

Data Entry by:
Date of entry: 7/9/2012
Company:

Client name: [redacted]
Street address:

City: Toronto **Region:** Ontario
Postal code: [redacted] **Telephone:**

Mailing address [redacted]
City: **Region:** Ontario
Postal Code: [redacted]

GENERAL HOUSE CHARACTERISTICS

House type:	Single Detached		
Number of storeys:	Two storeys		
Plan shape:	Rectangular		
Front orientation:	West		
Year House Built:	2001		
Wall colour:	Default	**Absorptivity:**	0.40
Roof colour:	Medium brown	**Absorptivity:**	0.84
Soil Condition:	Normal conductivity (dry sand, loam, clay)		
Water Table Level:	Normal (7-10m/23-33ft)		

House Thermal Mass Level: (A) Light, wood frame

Effective mass fraction 1.000

Occupants : 2 Adults for 50.0% of the time
2 Children for 50.0% of the time
0 Infants for 0.0% of the time

Sensible Internal Heat Gain From Occupants: 2.40 kWh/day

HOUSE TEMPERATURES

Heating Temperatures

Main Floor:	21.0 °C
Basement:	19.0 °C
TEMP. Rise from 21.0 °C:	2.8 °C

Basement is- Heated: YES **Cooled:** NO **Separate T/S:** NO
Fraction of internal gains released in basement : 0.150

Indoor design temperatures for equipment sizing

Heating:	22.0 °C
Cooling:	24.0 °C

WINDOW CHARACTERISTICS

Label	Location	#	Overhang Width (m)	Header Height (m)	Tilt deg	Curtain Factor	Shutter (RSI)
South							
W6	South Wall	1	0.00	0.00	90.0	1.00	0.00
W7	South Wall	1	0.00	0.00	90.0	1.00	0.00

Label	Type	#	Window Width (m)	Window Height (m)	Total Area (m^2)	Window RSI	SHGC
South							
W6	413206	1	3.66	2.13	7.80	1.266	0.2625
W7	413206	1	3.66	2.13	7.80	1.266	0.2625

WINDOW CODE SCHEDULE

Name	Internal Code	Description (Glazings, Coatings, Fill, Spacer, Type, Frame)
413206	413206	TG with 2 coatings, Low-E .04 (soft), 13 mm Argon, Insulating, Picture, Fibreglass, RE* = -2.995, Eff. RSI= 1.13

* Window Standard Energy Rating estimated for assumed dimensions, and Air tightness type: CSA - A1; Leakage rate = 2.790 m^3/hr/m

BUILDING PARAMETER DETAILS

CEILING COMPONENTS

	Construction Type	Code Type	Roof Slope	Heel Ht.(m)	Section Area (m^2)	R. Value (RSI)
R1 - under deck	Flat	User specified	0.000/12	0.13	11.64	19.33
R3 - main roof	Flat	User specified	0.000/12	0.13	41.19	19.33

MAIN WALL COMPONENTS

Label	Lintel Type	Fac. Dir	Number of Corn.	Number of Inter.	Height (m)	Perim. (m)	Area (m^2)	R. Value (RSI)
East Wall Type: User specified	N/A	East	1	0	3.71	4.22	15.66	12.03
North Wall Type: User specified	N/A	North	1	0	3.71	9.75	36.17	12.03
South Wall Type: User specified	N/A	South	1	0	3.71	9.75	36.17	12.03
West Wall Type: User specified	N/A	N/A	1	0	3.71	4.22	15.66	12.03

DOORS

Label	Type	Height (m)	Width (m)	Gross Area (m^2)	R. Value (RSI)
D1 Loc: East Wall	User specified	2.10	0.98	2.05	2.73

FOUNDATIONS

Foundation Name: Foundation
Foundation Type: Basement
Data Type: Library

Volume: 168.9 m^3
Opening to Main Floor: 0.00 m^2

Total Wall Height: 3.20 m
Depth Below Grade: 1.52 m

Rectangular
Floor Length: 12.51 m
Floor Width: 4.22 m

Interior wall type:	User specified	**R-value:**	14.34 RSI
Exterior wall type:	User specified	**R-Value:**	0.00 RSI
Number of corners :	4		
Lintel type:	N/A		
Added to slab type :	User specified	**R-Value:**	9.53 RSI
Floors Above Found.:	User specified	**R-Value:**	0.34 RSI

Exposed areas for: Foundation
Exposed Perimeter: 33.46 m

Configuration: BCIB_1
- concrete walls and floor

- interior surface of wall insulated over full-height
- sub-surface of floor slab fully insulated but no insulation under footings
- any first storey construction type

FOUNDATION CODE SCHEDULE

ROOF CAVITY INPUTS

Sloped Roof		**Total Area:**	0.00 m^2
Sheathing Material	Plywood/Part. bd 12.7 mm (1/2 in)		0.11 RSI
Exterior Material:	Asphalt shingles		0.08 RSI
Total Cavity Volume:	0.0 m^3	**Ventilation Rate:**	0.50 ACH/hr

BUILDING ASSEMBLY DETAILS

Label	Construction Code	Nominal (RSI)	System (RSI)	Effective (RSI)

BUILDING PARAMETERS SUMMARY

ZONE 1 : Above Grade

Component	Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ	% Annual Heat Loss
Ceiling	52.83	52.83	19.33	831.61	4.24
Main Walls	103.66	86.00	12.03	2839.85	14.48
Doors	2.05	2.05	2.73	323.58	1.65
South Windows	15.61	15.61	1.27	5305.87	27.06
		ZONE 1 Totals:		**9300.90**	**47.44**

INTER-ZONE Heat Transfer : Floors Above Basement

Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ
52.79	52.79	0.340	2786.83

ZONE 2 : Basement

Component	Area m^2 Gross	Area m^2 Net	Effective (RSI)	Heat Loss MJ	% Annual Heat Loss
Walls above grade	56.21	56.21	-	2674.11	13.64
Below grade foundation	103.65	103.65	-	4835.85	24.67
		ZONE 2 Totals:		**7509.96**	**38.30**

Ventilation

House Volume	Air Change	Heat Loss MJ	% Annual Heat Loss
321.30 m^3	0.186 ACH	2794.966	14.26

AIR LEAKAGE AND VENTILATION

Building Envelope Surface Area: 316.35 m^2

Air Leakage Test Results at 50 Pa.(0.2 in H_2O) = 0.60 ACH

Equivalent Leakage Area @ 10 Pa = 87.80 cm2

Terrain Description	**Height**	**m**
@ Weather Station : Open flat terrain, grass	Anemometer	10.0
@ Building site : Suburban, forest	Bldg. Eaves	5.5

Local Shielding:	**Walls:**	Very heavy
	Flue :	Light

Leakage Fractions- **Ceiling:** 0.200 **Walls:** 0.650 **Floors:** 0.150

Normalized Leakage Area @ 10 Pa:	0.2775 cm^2/m^2
Estimated Airflow to cause a 5 Pa Pressure Difference:	14 L/s
Estimated Airflow to cause a 10 Pa Pressure Difference:	22 L/s

F326 VENTILATION REQUIREMENTS

Kitchen, Living Room, Dining Room	3 rooms @ 5.0 L/s: 15.0 L/s
Utility Room	1 rooms @ 5.0 L/s: 5.0 L/s
Bedroom	1 rooms @ 10.0 L/s: 10.0 L/s
Bedroom	1 rooms @ 5.0 L/s: 5.0 L/s
Bathroom	1 rooms @ 5.0 L/s: 5.0 L/s
Basement Rooms	: 10.0 L/s

CENTRAL VENTILATION SYSTEM

System Type: HVI Certified HRV
Manufacturer:
Model Number:

Fan and Preheater Power at 0.0 °C:	46 Watts
Fan and Preheater Power at -25.0 °C:	46 Watts
Preheater Capacity:	0 Watts
Sensible Heat Recovery Efficiency at 0.0 °C	90%
Sensible Heat Recovery Efficiency at -25.0 °C	57%
Total Heat Recovery Efficency in Cooling Mode	25%
Low Temperature Ventilation Reduction:	0%
Low Temperature Ventilation Reduction: Airflow Adjustment	0 L/s (0.0%)

Vented combustion appliance depressurization limit: 5.00 Pa.

Ventilation Supply Duct

Location:	Basement	**Type:**	Flexible
Length:	1.5 m	**Diameter:**	152.4 mm

Insulation:	0.7 RSI	**Sealing Characteristics:**	Very tight

Ventilation Exhaust Duct

Location:	Basement	**Type:**	Flexible
Length:	1.5 m	**Diameter:**	152.4 mm
Insulation:	0.7 RSI	**Sealing Characteristics:**	Very tight

Operating schedule for

Month	% of Time	Added Vent. Rate (L/s)	Month	% of Time	Added Vent. Rate (L/s)
Jan	92.75	21.55	Jul	0.00	0.00
Feb	93.26	21.67	Aug	0.00	0.00
Mar	95.16	22.11	Sep	0.00	0.00
Apr	98.11	22.80	Oct	100.00	23.24
May	0.00	0.00	Nov	96.92	22.52
Jun	0.00	0.00	Dec	94.32	21.92

SECONDARY FANS & OTHER EXHAUST APPLIANCES

	Control	Supply (L/s)	Exhaust (L/s)
Dryer	Continuous	-	1.20

Dryer is vented outdoors

AIR LEAKAGE AND VENTILATION SUMMARY

F326 Required continous ventilation:	50.000 L/s (0.56 ACH)
Central Ventilation Supply Rate ():	23.239 L/s (0.26 ACH)
Total house ventilation is Balanced	
Gross Air Leakage and Ventilation Energy Load:	9707.793 MJ
Seasonal Heat Recovery Ventilator Efficiency:	87.820 %
Estimated Ventilation Electrical Load: Heating Hours:	813.221 MJ
Estimated Ventilation Electrical Load: Non-Heating Hours:	2.427 MJ
Net Air Leakage and Ventilation Load:	3201.576 MJ

SPACE HEATING SYSTEM

Primary Heating Fuel:	Natural Gas
Equipment:	Condensing furnace/boiler
Manufacturer:	Carrier
Model:	58UVB060-14
Specified Output Capacity:	17.58 kW
AFUE:	95.00
Steady State Efficiency:	96.42
Fan Mode:	Auto
ECM Motor:	Yes
Low Speed Fan Power:	0 watts
High Speed Fan Power:	210 watts

DOMESTIC WATER HEATING SYSTEM

Primary Water Heating Fuel:	Natural gas
Water Heating Equipment:	Direct vent (sealed)
Energy Factor:	0.830
Manufactuer:	Superflue
Model:	8G40NVH-ES-02

Tank Capacity =	151.40 Litres	**Tank Blanket Insulation**	0.00 RSI
Tank Loacation:	Basement		
Pilot Energy =	0.00 MJ/day	**Flue Diameter**	0.00 mm

ANNUAL DOMESTIC WATER HEATING SUMMARY

Daily Hot Water Consumption:	225.00 Litres
Hot Water Temperature:	55.00 °C
Estimated Domestic Water Heating Load:	15687 MJ
Primary Domestic Water Heating Energy Consumption:	18868.77 MJ
Primary System Seasonal Efficiency:	83.14%

ANNUAL SPACE HEATING SUMMARY

Design Heat Loss at -22.00 °C (9.18 Watts / m3):	2949.10 Watts
Gross Space Heat Loss:	19605.82 MJ
Gross Space Heating Load:	16253.59 MJ
Usable Internal Gains:	12919.11 MJ
Usable Internal Gains Fraction:	65.89 %
Usable Solar Gains:	2466.20 MJ
Usable Solar Gains Fraction:	12.58 %
Auxilary Energy Required:	868.28 MJ

Space Heating System Load:	868.14 MJ
Furnace/Boiler Seasonal efficiency:	96.45 %
Furnace/Boiler Annual Energy Consumption:	889.80 MJ

BASE LOADS SUMMARY

	kwh/day	**Annual kWh**
Interior Lighting	3.40	1241.00
Appliances	9.00	3285.00
Other	7.60	2774.00
Exterior Use	4.00	1460.00
HVAC Fans		
HRV/Exhaust	0.62	226.57
Space Heating	0.01	2.85
Space Cooling	0.00	0.00
Total Average Electrical Load	24.63	8989.42

R-2000 Energy Credits

Energy Efficient Lighting Credits	
Kitchen	110 kWh
Main hallway	70 kWh
Living room	65 kWh
Ventilation system	
Total	652 kWh

FAN OPERATION SUMMARY (kWh)

Hours	**HRV/Exhaust Fans**	**Space Heating**	**Space Cooling**
Heating	225.9	2.8	0.0
Neither	0.7	0.0	0.0
Cooling	0.0	0.0	0.0
Total	226.6	2.8	0.0

R-2000 HOME PROGRAM ENERGY CONSUMPTION SUMMARY REPORT

Estimated Annual Space Heating Energy Consumption	= 900.05 MJ	= 250.01 kWh
Ventilator Electrical Consumption: Heating Hours	= 813.22 MJ	= 225.89 kWh
Estimated Annual DHW Heating Energy Consumption	= 18868.77 MJ	= 5241.33 kWh
ESTIMATED ANNUAL SPACE + DHW ENERGY CONSUMPTION	= 20582.04 MJ	= 5717.23 kWh
ANNUAL R-2000 SPACE + DHW ENERGY CONSUMPTION TARGET	= 54461.74 MJ	= 15128.26 kWh

Estimated Greenhouse Gas Emissions 5.515 tonnes/year

ESTIMATED ANNUAL FUEL CONSUMPTION SUMMARY

Fuel	Space Heating	Space Cooling	DHW Heating	Appliance	Total
Natural Gas (m3)	23.88	0.00	506.42	0.00	530.30
Electricity (kWh)	228.74	0.00	0.00	8760.67	8989.41

ESTIMATED ANNUAL FUEL CONSUMPTION COSTS

Fuel Costs Library = Embedded

RATE	Electricity (Toronto)	Natural Gas (Toronto)	Oil (Ottawa08)	Propane (Ottawa08)	Wood (Sth Ont)	Total
$	665.22	215.33	0.00	0.00	0.00	880.55

Fuel Costs Library Listing

Filename = Embedded

Record # 1	Fuel: Electricity		
Rate ID = Ottawa08	Hydro Rate Block		
Rate Block		Dollars	Charge
	kWhr	Per kWhr	($)
Minimum	0.0		9.540
1	600.0	0.0926	
2	99999.0	0.1016	
Record # 2	Fuel: Natural Gas		
Rate ID = Toronto	these are not real rates		
Rate Block		Dollars	Charge
	m3	Per m3	($)

Minimum	0.0		8.000
1	30.0	0.2265	
2	85.0	0.2219	
3	170.0	0.2183	
4	99999.0	0.2156	
Record # 3	Fuel: Oil		
Rate ID = Ottawa08	Oil Rate Block		
Rate Block		Dollars	Charge
	Litre	Per Litre	($)
Minimum	0.0		0.000
1	99999.0	1.1750	
Record # 4	Fuel: Propane		
Rate ID = Ottawa08	Propane Rate Block		
Rate Block		Dollars	Charge
	Litre	Per Litre	($)
Minimum	0.0		0.000
1	99999.0	0.7200	
Record # 5	Fuel: Wood		
Rate ID = Sth Ont	Cord Rate		
Rate Block		Dollars	Charge
	Cord	Per Cord	($)
Minimum	0.0		0.000
1	99999.0	210.0000	
Record # 6	Fuel: Natural Gas		
Rate ID = Ottawa08	Gas Rate Block		
Rate Block		Dollars	Charge
	m3	Per m3	($)
Minimum	0.0		14.000
1	30.0	0.5338	
2	85.0	0.5277	
3	170.0	0.5229	
4	99999.0	0.5194	
Record # 7	Fuel: Electricity		
Rate ID = Toronto	Hydro Rate Block		
Rate Block		Dollars	Charge
	kWhr	Per kWhr	($)
Minimum	0.0		0.000
1	1000.0	0.0740	
2	99999.0	0.0870	

MONTHLY ENERGY PROFILE

Month	Energy Load (MJ)	Internal Gains (MJ)	Solar Gains (MJ)	Aux. Energy (MJ)	HRV Eff. %
Jan	3274.7	2278.0	646.3	350.4	86.2
Feb	2855.9	2031.0	555.3	269.6	86.9
Mar	2575.1	2071.0	397.7	106.4	88.2
Apr	1338.6	1207.2	131.4	0.0	88.6
May	636.0	628.3	7.6	0.0	0.0
Jun	115.9	115.9	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0
Sep	226.3	226.3	0.0	0.0	0.0
Oct	876.3	847.1	29.1	0.1	88.7
Nov	1556.1	1349.7	206.3	0.0	88.5
Dec	2798.7	2164.4	492.5	141.7	87.7
Ann	16253.6	12919.1	2466.2	868.3	87.8

FOUNDATION ENERGY PROFILE

			Heat Loss (MJ)		
Month	Crawl Space	Slab	Basement	Walkout	Total
Jan	0.0	0.0	52.0	0.0	52.0
Feb	0.0	0.0	40.0	0.0	40.0
Mar	0.0	0.0	15.8	0.0	15.8
Apr	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.0	21.0	0.0	21.0
Ann	0.0	0.0	128.8	0.0	128.8

FOUNDATION TEMPERATURES & VENTILATION PROFILE

	Temperature (Deg °C)			Air Change Rate		Heat Loss
Month	Crawl Space	Basement	Walkout	Natural	Total	(MJ)
Jan	0.0	19.3	0.0	0.045	0.300	617.9
Feb	0.0	19.3	0.0	0.044	0.300	510.3
Mar	0.0	19.6	0.0	0.039	0.300	387.9
Apr	0.0	20.1	0.0	0.031	0.300	194.2
May	0.0	21.0	0.0	0.021	0.034	90.6
Jun	0.0	22.0	0.0	0.014	0.027	34.3
Jul	0.0	23.3	0.0	0.010	0.024	16.2

Aug	0.0	22.8	0.0	0.010	0.024	20.3
Sep	0.0	21.7	0.0	0.017	0.030	58.0
Oct	0.0	20.8	0.0	0.026	0.300	128.8
Nov	0.0	20.2	0.0	0.034	0.300	267.3
Dec	0.0	19.7	0.0	0.041	0.300	469.1
Ann	0.0	20.8	0.0	0.028	0.186	2795.0

SPACE HEATING SYSTEM PERFORMANCE

Month	Space Heating Load (MJ)	Furnace Input (MJ)	Pilot Light (MJ)	Indoor Fans (MJ)	Heat Pump Input (MJ)	Total Input (MJ)	System Cop
Jan	350.4	359.2	0.0	4.1	0.0	363.3	1.0
Feb	269.6	276.3	0.0	3.2	0.0	279.5	1.0
Mar	106.4	109.1	0.0	1.3	0.0	110.3	1.0
Apr	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jun	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oct	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nov	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	141.7	145.3	0.0	1.7	0.0	147.0	1.0
Ann	868.1	889.8	0.0	10.2	0.0	900.0	1.0

MONTHLY ESTIMATED ENERGY CONSUMPTION BY DEVICE (MJ)

	Space Heating		DHW Heating		Lights &	HRV &	Air
Month	**Primary**	**Secondary**	**Primary**	**Secondary**	**Appliances**	**FANS**	**Conditioner**
Jan	359.2	0.0	1748.3	0.0	2678.4	119.6	0.0
Feb	276.3	0.0	1599.6	0.0	2419.2	108.0	0.0
Mar	109.1	0.0	1747.4	0.0	2678.4	119.7	0.0
Apr	0.0	0.0	1633.8	0.0	2592.0	118.2	0.0
May	0.0	0.0	1604.2	0.0	2678.4	0.0	0.0
Jun	0.0	0.0	1471.1	0.0	2592.0	0.0	0.0
Jul	0.0	0.0	1458.6	0.0	2678.4	0.0	0.0
Aug	0.0	0.0	1436.1	0.0	2678.4	0.0	0.0
Sep	0.0	0.0	1411.6	0.0	2592.0	0.0	0.0
Oct	0.0	0.0	1520.2	0.0	2678.4	124.5	0.0
Nov	0.0	0.0	1552.5	0.0	2592.0	116.8	0.0
Dec	145.3	0.0	1685.4	0.0	2678.4	119.1	0.0
Ann	889.8	0.0	18868.8	0.0	31536.0	825.9	0.0

ESTIMATED FUEL COSTS (Dollars)

Month	Electricity	Natural Gas	Oil	Propane	Wood	Total
Jan	57.51	20.69	0.00	0.00	0.00	78.20
Feb	51.95	19.31	0.00	0.00	0.00	71.26
Mar	57.52	19.19	0.00	0.00	0.00	76.71
Apr	55.71	17.87	0.00	0.00	0.00	73.58
May	55.06	17.69	0.00	0.00	0.00	72.75
Jun	53.28	16.90	0.00	0.00	0.00	70.18
Jul	55.06	16.83	0.00	0.00	0.00	71.88
Aug	55.06	16.69	0.00	0.00	0.00	71.75
Sep	53.28	16.54	0.00	0.00	0.00	69.82
Oct	57.61	17.19	0.00	0.00	0.00	74.81
Nov	55.68	17.38	0.00	0.00	0.00	73.06
Dec	57.50	19.04	0.00	0.00	0.00	76.55
Ann	665.22	215.33	0.00	0.00	0.00	880.55

The calculated heat losses and energy consumptions are only estimates, based upon the data entered and assumptions within the program. Actual energy consumption and heat losses will be influenced by construction practices, localized weather, equipment characteristics and the lifestyle of the occupants.

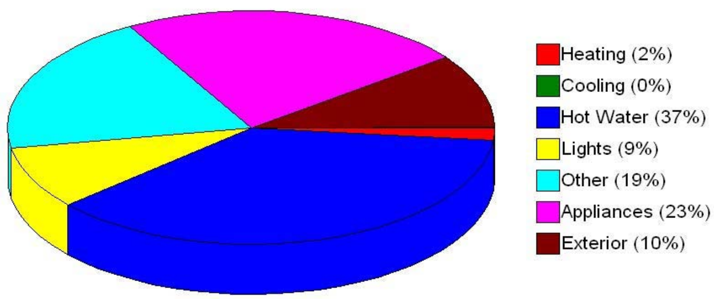
HOUSE REPORT

HOT2000
Natural Resources CANADA Version

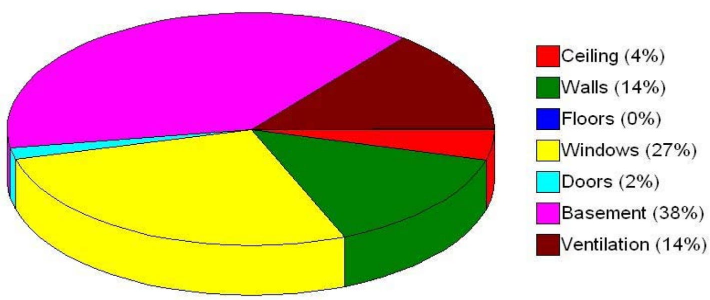
Client:	**,**	Audit Date:	**09/07/2012**
Address:	[redacted]	Auditor:	
City:	**Toronto**	File ID:	[redacted]
Province:	**Ontario**		
Code:	[redacted]		
Phone:			

Your house was analysed using a computer program developed by Natural Resources Canada. The following charts show the components of yearly energy consumption and heat loss for your home.

COMPONENTS OF ANNUAL ENERGY CONSUMPTION

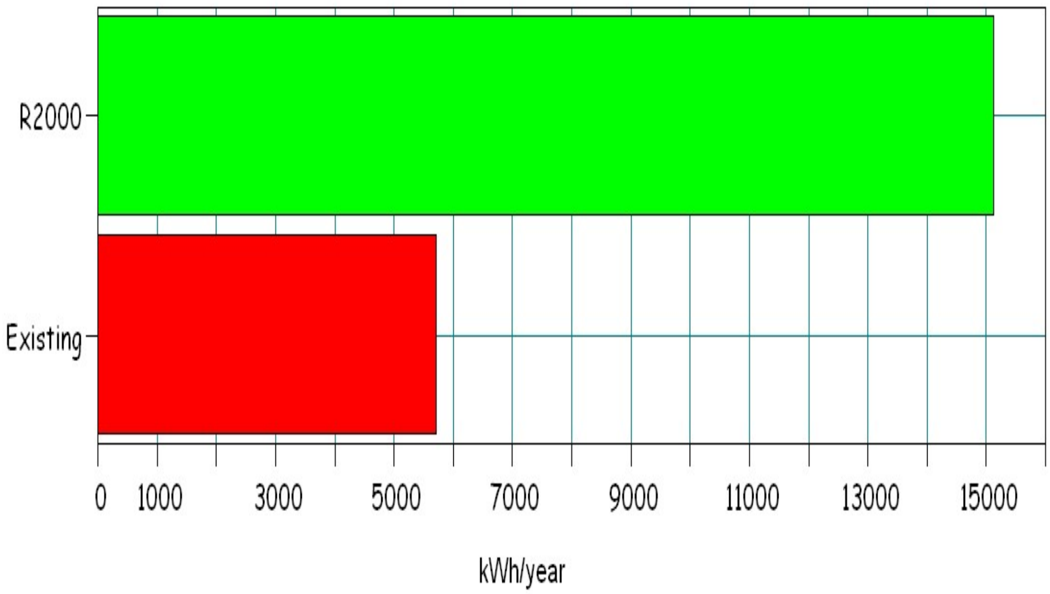


COMPONENTS OF ANNUAL HEAT LOSS



Your house currently uses approximately 5717.2 kWh for space and hot water heating in an average year. The following chart illustrates the relationship between the energy used by your house and the energy used by an equivalent R2000 home.

ANNUAL HEATING + HOT WATER ENERGY CONSUMPTION (kWh)



Notice to Homeowner

Your house was analysed using a computer program developed by Natural Resources Canada. Natural Resources Canada makes no warranty, expressed or implied, with respect to the energy consumption figures included in this assessment. In no event will Natural Resources Canada nor its minister, officers, employees or agents have any obligations or liability arising from tort, or for loss of revenue or profit, or for indirect, special, incidental or consequential damages as a result of the homeowner's use of the assessment report.

Some of the assumptions within the computer program may, or may not, be applicable to your household. Where assumptions have been made, they are based on an average appliance usage rate.

H2Kv9.2-Mar2004