Blue House In Sisimiut, Greenland

Initial investigation of the Blue House

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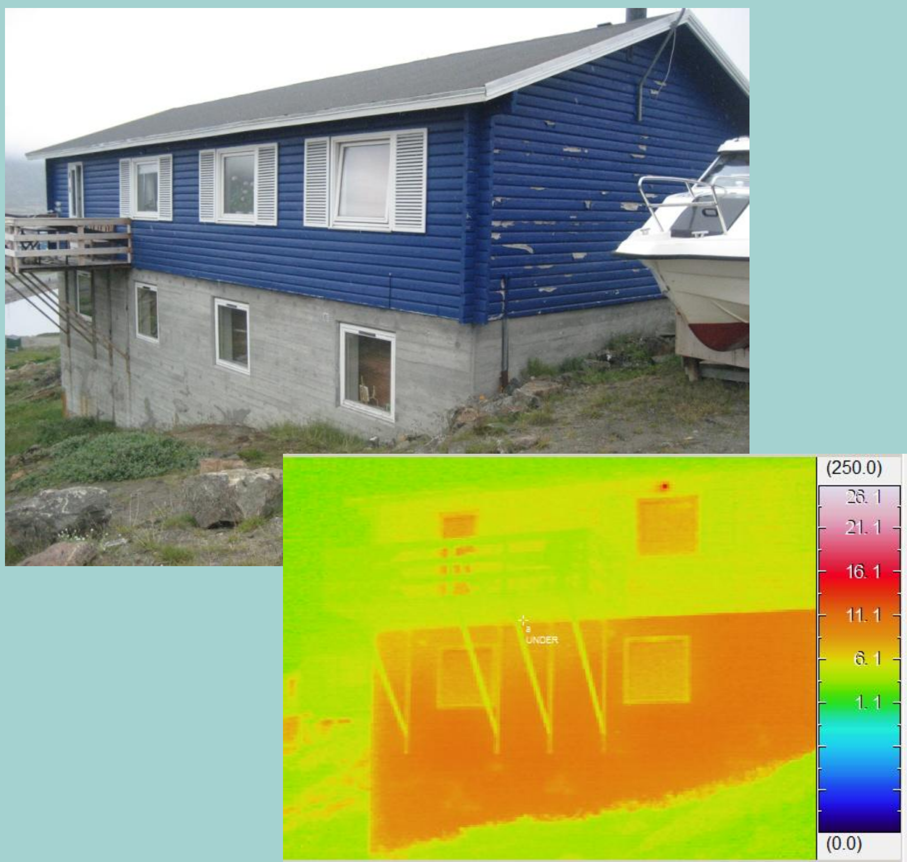

TECHNICAL UNIVERSITY OF DENMARK

Report SR 10-07
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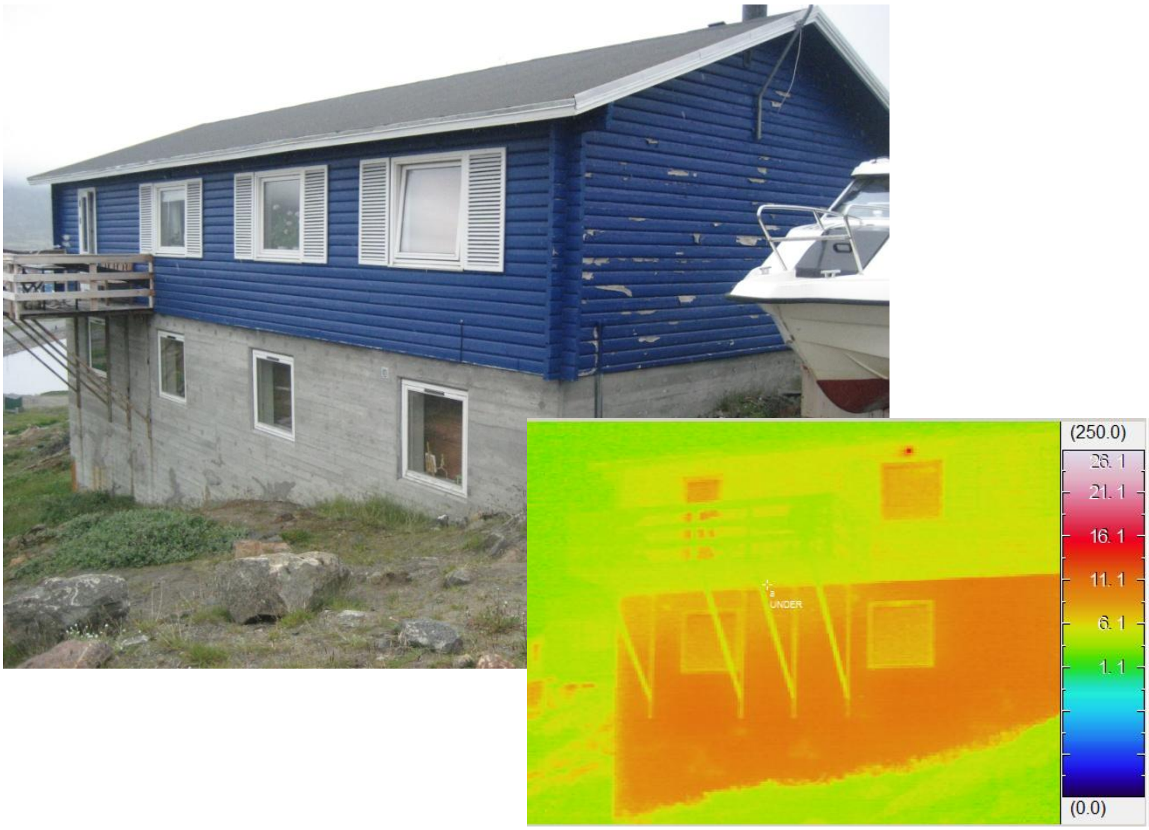

Report SR 10-07

August, 2011

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Preface

The Blue House is part of the NEES project (Natural Energy Efficiency and Sustainability) as part of the Northern Periphery Programme. The task of the NEES project is to identify and promote products and services which aim to improve energy efficiency in existing domestic buildings, which make use primarily of renewable and/or recycled materials and services based on natural processes, which originate and are normally accessible in the Arctic regions. The project also focuses on the survey of practises, dissemination of knowledge through learning in Greenland and other Arctic regions.

The Blue House is one of the examples where the paper insulation will be installed. The results of energy savings and safe implementation of paper insulation will be documented. This report will serve as documentation regarding the house and its initial state. This report summarizes the survey of the Blue House in Sisimiut, Greenland. The survey was performed in August, 2011. The initial state of the Blue House with possible problems is reported in the report. Furthermore, possible issues and solutions for paper insulation are proposed.

The person responsible for evaluation of results and writing this report is Petra Vladykova. Jing Qu was advising and correcting the report.

Content

1 Information about the Blue House

Name: Blue House, blå hus, Axel´s house
Type: Panbo Typehus 1
Address: Qajasat 19, B-1158, 3911 Sisimiut, Greenland

Fig. 1. The Blue House

The house has been built in 1985 as one of the typehouse produced by Panbo Huse A/S, Denmark (Panbo Huse, 2011) and it is made from a special construction from timber structure. There are only few of these typehouses located in Sisimiut. Former owner and purchaser of the house was Hans Martin Johansen, doctor. Today, the house is owned by the Municipality of Qeqqata and administrated by INI A/S (Fig. 1).

For the past 4, the house is rented to Axel Lund Olsen and his family for 4.513,- DKK/month not including the utility and other bills. Currently there are 3 people living in the house (two adults, one child). The house is built on the top of the small hill above the lake in the middle of city of Sisimiut (Fig. 2).

Fig. 2. Location of the house in Sisimiut

2 Methods of investigations in the Blue House

The investigation includes the review of the history of the house regarding the original design of the house, ownership and occupancy. Furthermore, the investigation and measurements of the house was the base for creation of new documentation. At the time of investigation, there were available only drawings for one-storey PANBO house, and, thus, the Blue house had to be measured again to make sure that there were no changes. And the measurements and documentation of basement floor together with first floor were obtained (AutoCAD). The original drawings, further documentation and drawing documenting current state of the house are attached in Annex A, B and C.

The information about the building´s structure was taken to register building elements such as walls, floor, roof, windows and doors. Furthermore, the technical systems in the house were registered. The investigation of the Blue House includes the visual investigation, inspection for mould, inspection of basement, and occupancy in the house along with data collection from inhabitants. Furthermore, the collected data about the house and from measurements are evaluated based on the interview with inhabitants and questionnaire, the usage and problems with the house were registered.

Furthermore, the indoor climate measurements are providing data for temperature and relative humidity for the period from Dec 2010 until Aug 2011. These data are evaluated and the use of the house and possible problems with the sensors are listed. The measurements in the house also include the blower-door and thermography testing. The results of the air tightness of the building envelope from the blower-door tests along with infiltration heat loss are evaluated and compared to several Standards and actual buildings in Sisimiut, Greenland. Thermography investigation shows some problems with the coldness of the house and thermal bridges in the structure. Furthermore, based on the collected bills for heating and hot water consumption, the actual energy consumption in the house is investigated. Approximation of monthly energy consumption is represented together with estimation of hot water consumption. These data are compared to the requirements from the Building Regulations.

Each chapter contains theoretical explanations of necessary background information; if necessary the equations and reference sources are listed. Furthermore, each chapter contains a presentation of results, processing of the obtained results and conclusion regarding the analyses.

The final chapter describes some issues connected to the paper insulation installation along with possible problems, further evaluations and future monitoring.

3 Results from investigations and measurements

3.1 History of the house

Originally, the house has been designed as a one-storey house where the following rooms were located: entrance, hall, bathroom, 3 bedrooms, living room, and kitchen along with technical/utility room (Fig. 3, Fig. 4 and Fig. 5). Originally, the house has been designed as a building with open ventilated basement (crawl space underneath the house) with the foundation made of concrete and the open ventilated attic (see Annex A and B). Originally, the gross heated area of the house was 109 m^2.

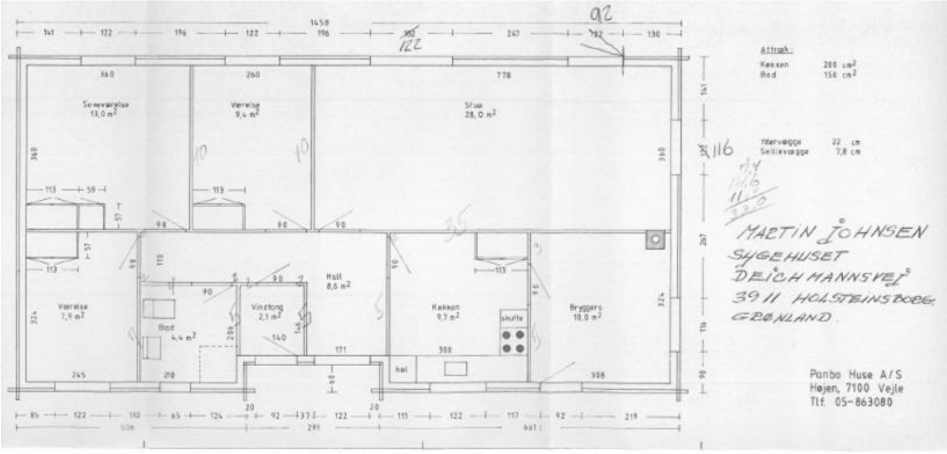

Fig. 3. Original plans of the floor plan

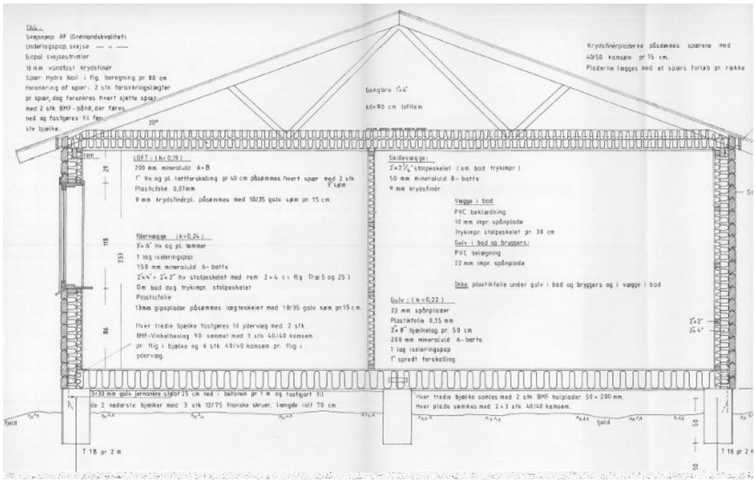

Fig. 4. Original plan of the cross-section

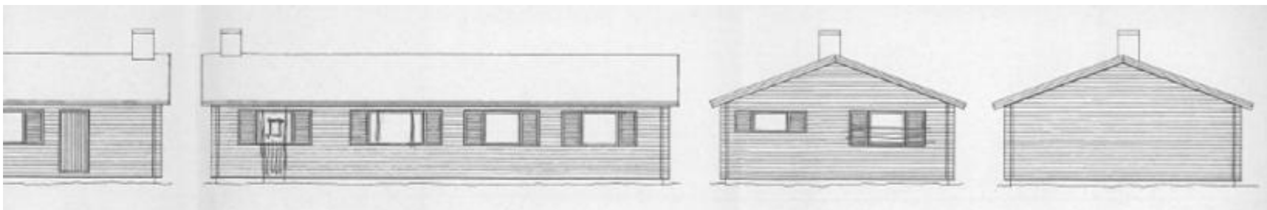

Fig. 5. Original plans of the views of the facades

3.2 Drawing and current state of the house

Adding the whole storey, which is now referred to as a basement floor, has doubled the living area of the house. This is a change compared to the original design with one storey. And until almost recently, the house has been used as two unit house; where one unit in the basement with own entrance from north has been rented out to the students and the second unit with own entrance from west was usually rented to a family. Couple of years ago, the interior wooden staircase has been added to the house, and, thus, the first floor and basement floor have been connected.

In the current state, the house has a first floor and a heated basement floor which extents underneath the whole first floor. The first floor has an entrance with hall connecting bathroom, office, large bedroom, and living room connected with dining room and kitchen (Fig. 6). There is a staircase to the basement floor which has two bedrooms, technical room with boiler (not intentionally heated), storage room, utility room, office, cold entrance (not heated) and bathroom (Fig. 7). The two storey of the house are thermally connected and are considered as one thermal zone (Fig. 8). The house has one catwalk leading to the main entrance to the house and a balcony orientated towards west (Fig. 9 and Fig. 10). For more details see Annex C.

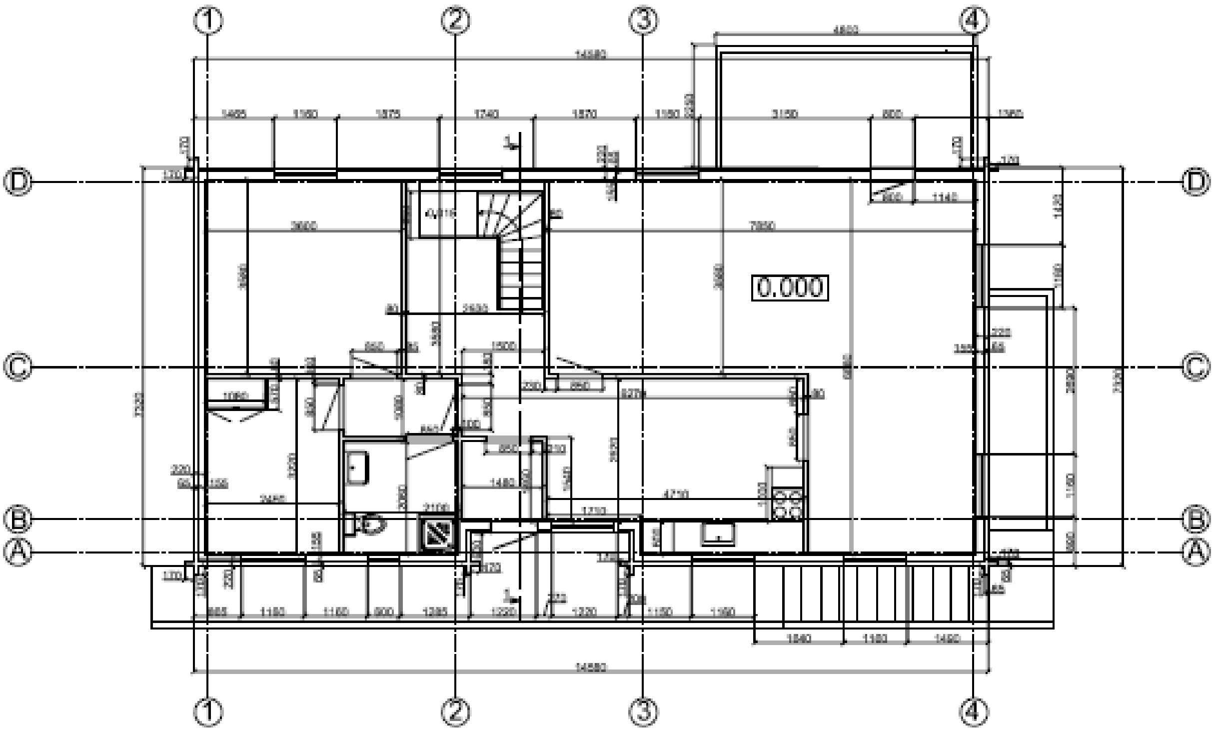

Fig. 6. Floor plan of the first floor – current situation

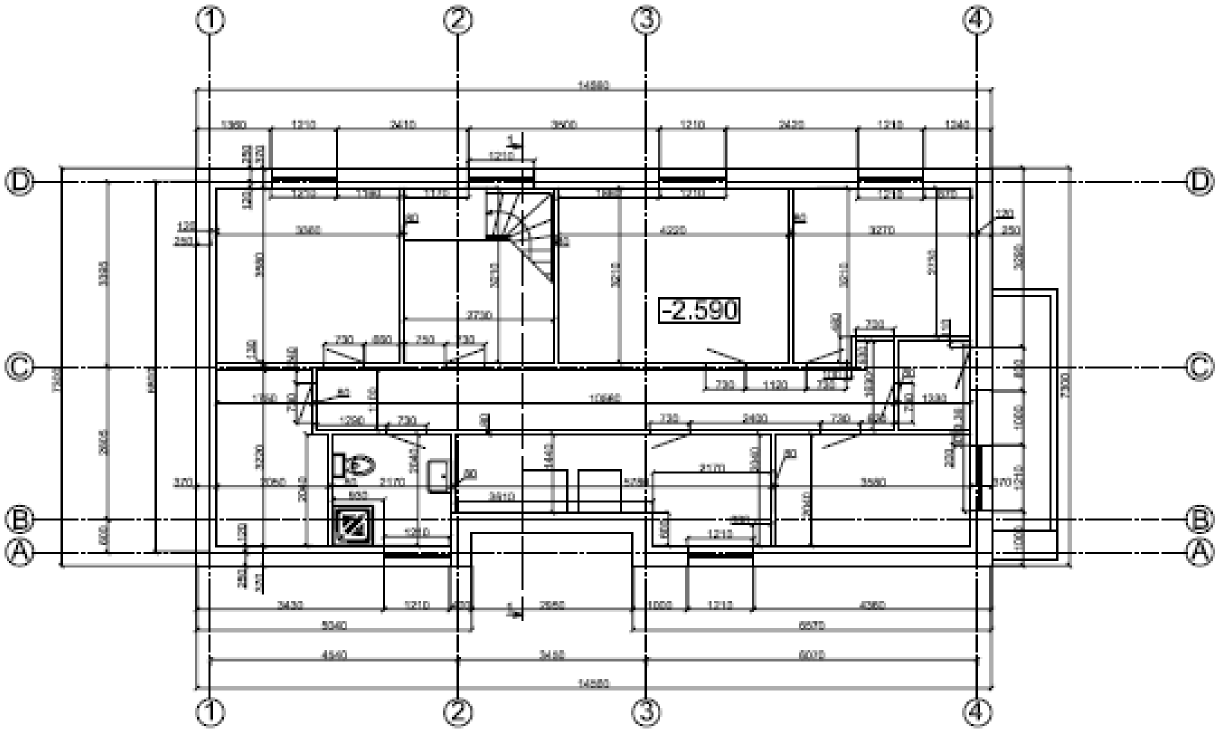

Fig. 7. Floor plan of the basement floor – current situation

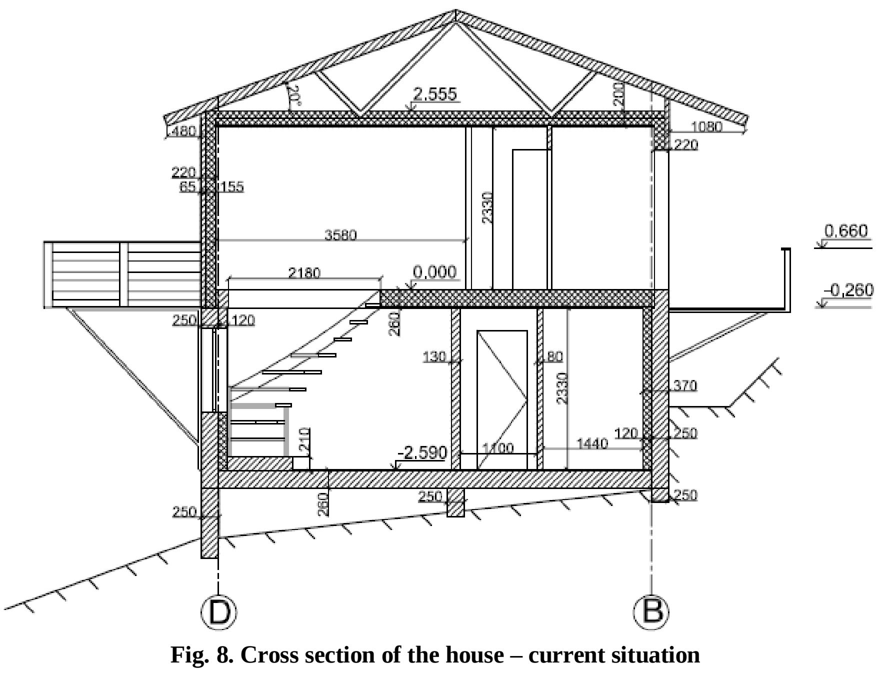

Fig. 8. Cross section of the house – current situation

Fig. 9. South and north view of the Blue House

Fig. 10. East and west view of the Blue House

The key data of the house are listed in Table 1.

Table 1. Buildings´ basic parameters (current state)

Information		Area	Unit
Dimensions of the footprint area		14.58 x 6.84	[m]
Clear height of the room		2.33	[m]
Gross heated area (1)	A_{gross}	209	[m^2]
Envelope surface area	$A_{envelope}$	379.7	[m^2]
Net volume area of a building	V_{net}	452.4	[m^3]

(1) Not including the cold entrance in the basement floor.

3.3 Building´s structure

The first floor of the house is made of a special timber structure with mineral wool insulation and the basement floor is made of concrete with insulation placed on interior side. It is assumed that the house is built as a Panbo house in the first floor with the original structure of walls, ceiling, floor, and roof. The basement floor is an additional structure further described below. The actual foundations of the house are made from reinforced concrete bands on rock bed, and there is an assumption that the foundations are filled with soil and the wooden casting cladding has been left in. The sloped roof has inclination of 20º made of self-carrying roof structure and the roof is oriented towards west and east. The height of the ceiling in the first floor and basement is identical, i.e. 2.33 m of clear height (Fig. 8). The construction and layers of each building element are described further and the important technical values are listed in Table 2.

The external walls of the first floor consist of painted timber members with dimensions of 75 x 150 mm (3”x 6”) as external weather proof cladding, 1 layer of insulation paper, 150 mm of mineral wool insulation (batts), combined structure of wooden members 50 x 50 mm (2” x 2”) with 50 mm of mineral wool insulation, plastic foil working as a vapour airtight membrane and on the inside is one layer of gypsum board of 13 mm (Fig. 11). The external walls of basement floor are made of concrete of 250 mm, 80 mm of insulation, air gap and vertical board of 12 mm and 13 mm of gypsum board on the interior. The total thickness of the basement walls is 370 mm (Fig. 12).

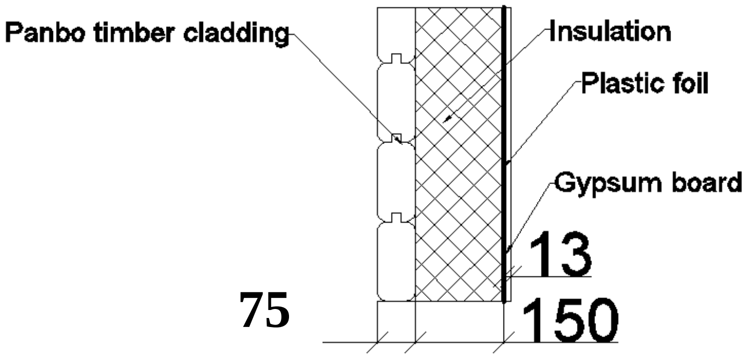

Fig. 11. Construction of original wall (first floor)

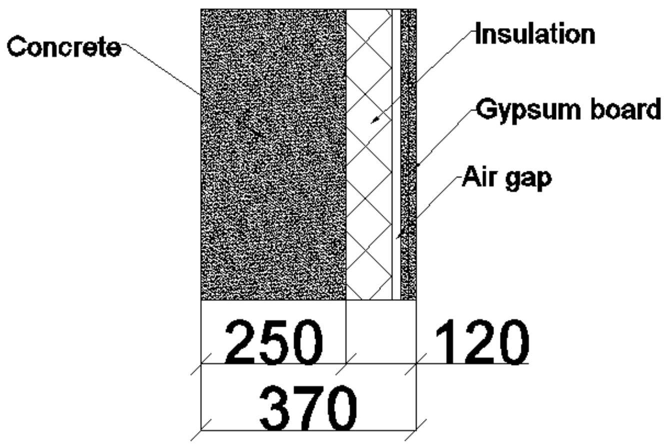

Fig. 12. Construction of basement wall (basement floor)

The external roof is made of asphalt water tight layers (bitumen), 16 mm of water tight plywood, and the wood load bearding structure for the roof. The internal ceiling above 1st floor to the attic consists of 200 mm of mineral wool insulation laid freely on the ceiling toward the exterior and wooden members 50 x 200 mm (2"x 8"), and 9 mm gypsum board on the interior side. The external floor towards the cold crawl space bewlo the house is assumed to be made of flooring structure (carpet or wooden floor), plastic foil 0.15 mm, timber structure 50 x 200 mm (2" x 8") and 200 mm of insulation (A-batts), layer of insulation paper and boards.

The internal walls are made of gypsum board on both sides and insulation with timber wooden structure in middle. The internal non load bearding walls have thickness of 80 mm. Approximately in the middle of the house along the long side of the house runs the internal load bearing wall throughout the basement and first floor (Fig. 8). Thickness of load bearing internal wall is 100 mm.

The internal ceiling above the basement floor to the first floor is 260 mm thick and it is made wooden girders of 50 x 200 mm (2"x 8") and 200 mm of insulation, and gypsum boards at bottom side and wooden flooring of 22 mm on the top side (Table 2).

Table 2. Calculated / estimated U-values for buildings elements

Building element	**Insulation thickness [mm]**	**U-value [W/(m^2·K)]**
External wall – first floor	150 + 50	0.24 (1)
External wall - basement	80	0.38 (3)
Floor	200	0.22 (1)
Ceiling	200	0.19 (1)
Door	-	2.0 (2)
Window	-	1.8 - 2.0 (2)

(1) Obtained from original drawings. (2) Estimated values based on GBR 1982 and 2006. (3) Calculated in accordance with (EN ISO 6946, 2005).

The external doors are wooden insulated door but there is no further technical description, there are total of 3 external doors to a terrace and balconies (Table 3). The internal doors are classic wooden door (dimensions: 850 x 2,000 in the first floor; 730 x 2,000 in the basement floor). The internal doors to the technical room are partly tight with rubber sealer. There is a hatch to the cold attic.

Table 3. Windows types and door dimensions

Windows / doors	**Dimensions of opening [m]**
V1	1.160 x 0.650
V2	1.220 x 1.220
V3	0.650 x 1.220
D1	0.920 x 2.000

The windows have a frame from wood and double glazing. Windows in the basement have been installed when the house was built (85/11, PANALOOK 160~DS~10940 TF GAR). The windows in the first floor have been changed approximately 14 years ago (12/97, 190~DS~10940~1AT-class). All windows are a type of awning window with top-hung or side-hung (Fig. 13). Most of the windows have a natural exhaust vent placed next to them. There are three main types of the windows which are listed in Table 3.

Fig. 13. Windows used in the Blue House

Static problems were discovered at the time when few of Panbo houses were built in 1980s and the supplementary static calculation due to the strong wind and pressure was provided by a local building company. Based on this static calculation, the house was further more strengthen and restructurized, i.e. additional new fittings and plywood panels. This information was obtained based on the discussion with Jørn Hansen from Rambøll during the NEES meeting on 13.8.2011.

3.4 Technical systems in the building

The space heating is provided with a oil-boiler (type HS Hedler TARM) with an expansion vessel and a hot water storage tank. The conventional hydronic heating system is located in the house with 8 radiators with thermostatic valves in the first floor and 6 radiators with thermostatic valves in the basement floor. The oil-boiler also supplies hot water. The tank for the oil is located in the technical room in the basement floor (Fig. 14).

Fig. 14. Oil tank and oil-boiler in the technical room

The fresh air is provided through the natural ventilation with vents (6 opening vents in the first floor with diameter 120 mm and 5 opening vents in the basement floor with diameter 200 mm) and they are placed in each room close to the top of the window (Fig. 15). There is a mechanical exhaust in kitchen (kitchen exhaust hood) and in bathrooms (electrical exhaust vents along with natural ventilation vent). The mechanical exhaust vents in the bathrooms are based on a “switch on / off” together with light, meaning that there is no delay after switching the light off and, thus, the release of humidity. The cold attic is ventilated through the natural vents through facade (Fig. 16).

Fig. 15. Natural vents in the first and basement floor

Fig. 16. Mechanical vent in the bathroom and natural ventilation in cold attic

There are many domestic electrical appliances in the house such as: coffee maker, kettle, various small kitchen appliances, microwave, CD/DVD/radio players, TV´s, freezer, fridge, oven, wash machine and dryer. The lighting is provided with energy saving light bulbs.

The water is supplied to the house from the city water supply. The black and grey water is lead from the house to the district sewage system.

3.5 Problems in the house

This information is based on the investigation and discussion with current inhabitants. Some information was also supplied from the questionnaire provided by Martin Kotol for the Ph.D. project: "Energy use and indoor environment in new and existing dwellings in arctic climates", see Annex D.

- Inclined and squeaky floor in the 1st floor.
- The frames of the windows and doors are affected and they are not at 90° angle. There exists a suspicion of static problems with the house (foundation problems or settling of the house).
- There were found cracks in the basement walls and some traces of leaking water from beneath the house from the crawl space (Fig. 17).
- Problems with a squeaking sound from the building´s structure when the there is a big windstorm.
- The exterior facade is stripping off and needs repainting. The stripping off is possibly caused by demanding weather conditions and possibly by a vapour transfer driven from interior to the exterior (Fig. 17).
- The mechanical ventilation in the bathrooms only is switched on when the lights are on, there is a need for a delayed mechanism after the light is switched off.
- The doors on the north side to the basement are not tight and there has been observed 40 mm of frost at the bottom in the winter by occupants.
- Mould problems in the house were registered by the occupants and it has been repaired by INI, but further documentation is missing.
- Floor in the bathroom in the basement often gets flooded.
- The inhabitants often complained about the cold floors, especially in the basement floor.
- There are also some problems with temperature in the house, i.e. overheating in summer and cold in winter, and uneven distribution of the temperature in the both floors.
- Occasionally, there is also a condensation on the windows in winter.

Fig. 17. Cracks in the basement walls (on the left) with water leakages through the foundations and the exterior painting

3.6 Indoor climate

3.6.1 TinyTags sensors and locations

The indoor climate is measured continuously from December 7, 2010, onward (first readout from April 5, 2011; second readout from August 8, 2011). The Tiny Tags loggers were used to measure interior temperature and relative humidity. The logging time is every 20 minutes. For downloading the data the software Tinytag Explorer is used (6-week demo version, http://www.geminidataloggers.com). The locations of the sensors are as follows (Fig. 18, Fig. 19): bathroom (basement floor), bedroom (first floor), children´s bedroom (basement floor), and living room (first floor) and exterior temperature (Fig. 20, Fig. 21).

Fig. 18. Location of Tiny Tags in living room (1) and bedroom (2) (first floor) and outside (3)

Fig. 19. Location of Tiny Tags in bathroom (4) and child´s bedroom (5) (basement floor)

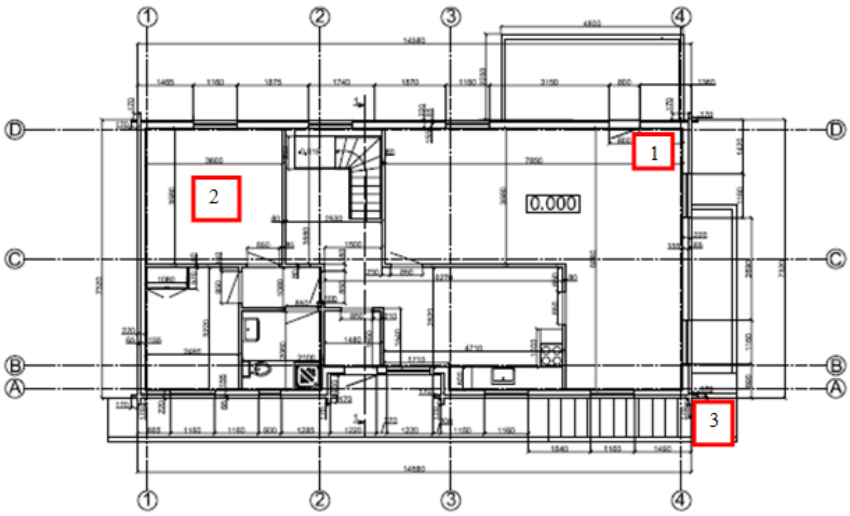

Fig. 20. Location of sensors - first floor

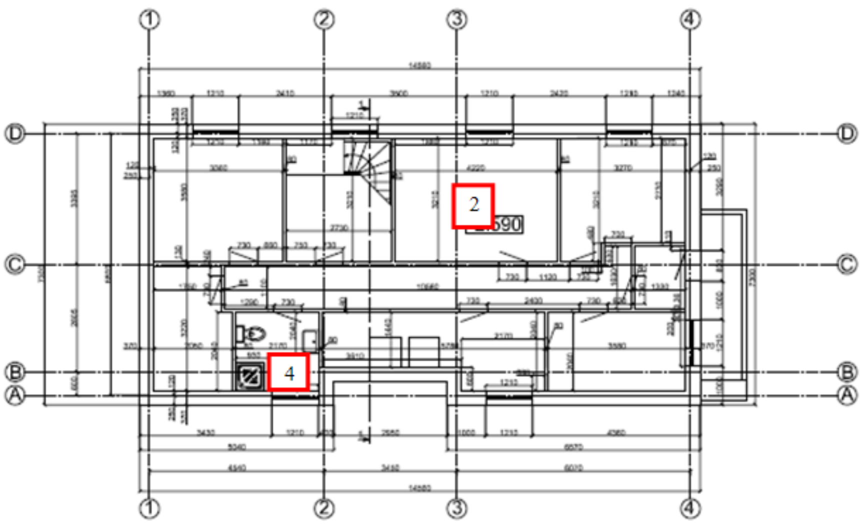

Fig. 21. Locations of sensors – ground floor

3.6.2 Measured data of temperature and relative humidity

Table 4. Average measured temperature and relative humidity from Dec 12, 2010, to Aug 8, 2011

Space	Average temperature [°C]	Average relative humidity [%]
Outdoor	-2.2	72.7
Bathroom (basement floor)	19.6	35.9
Bedroom (basement floor)	14.3	42.4
Bedroom (first floor)	20.7	32.2
Living room (first floor)	18.6	38.4

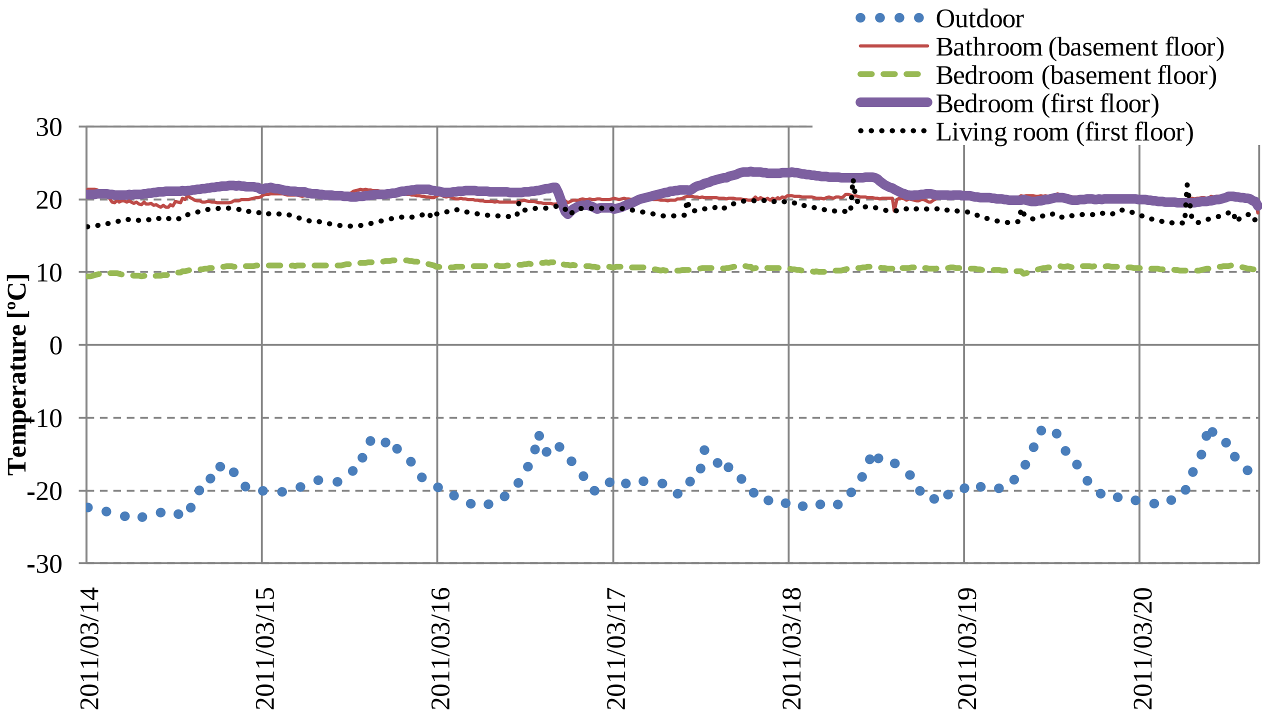

Fig. 22. Measured temperature in the coldest week of 2011 (based on a coldest hourly temperature measured outdoor, -23.8ºC)

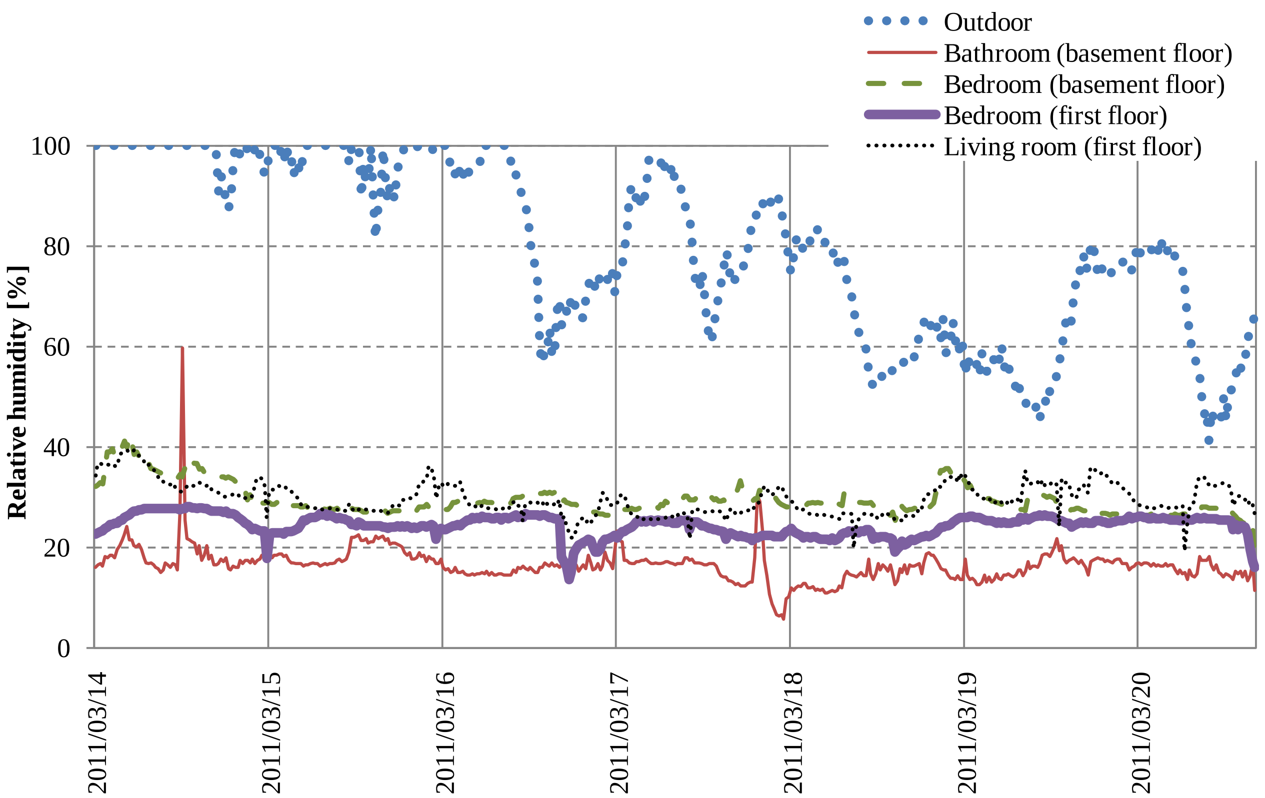

Fig. 23. Measured relative humidity in the coldest week of 2011 (based on a coldest hourly temperature measured outdoor, -23.8ºC)

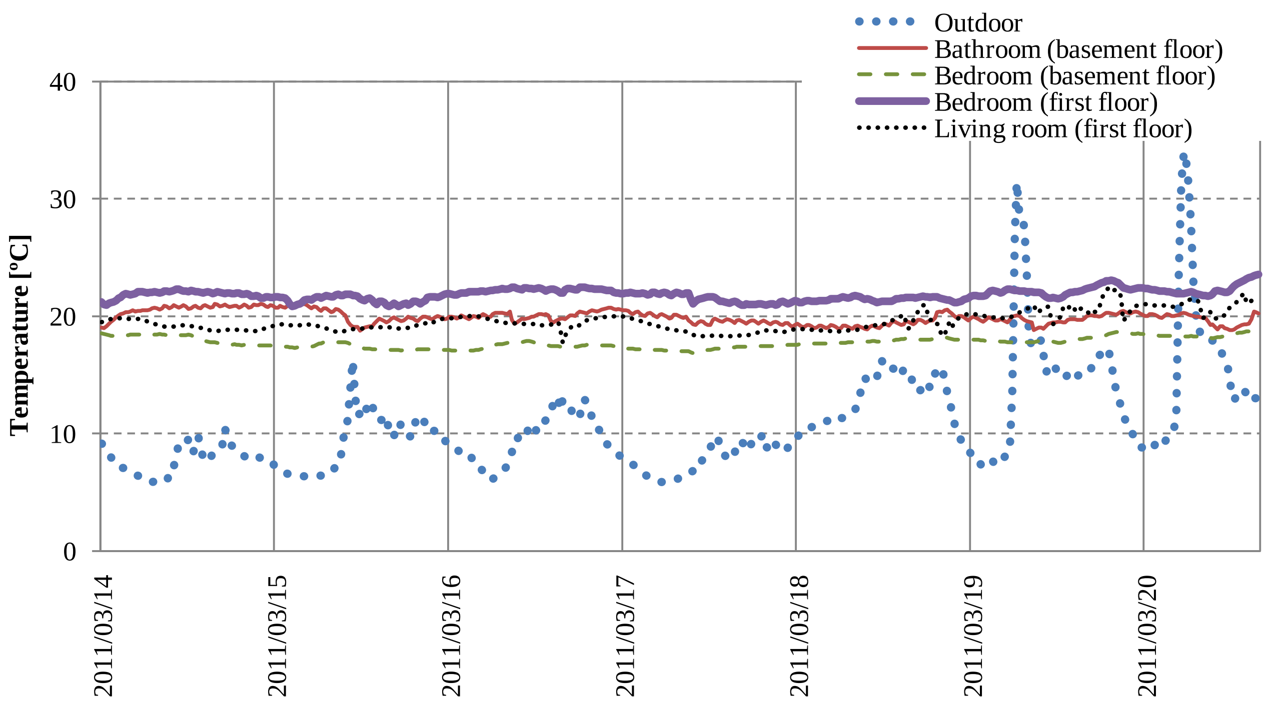

Fig. 24. Measured temperature in the warmest week of 2011 (based on a warmest hourly temperature measured outdoor, 33.9°C)

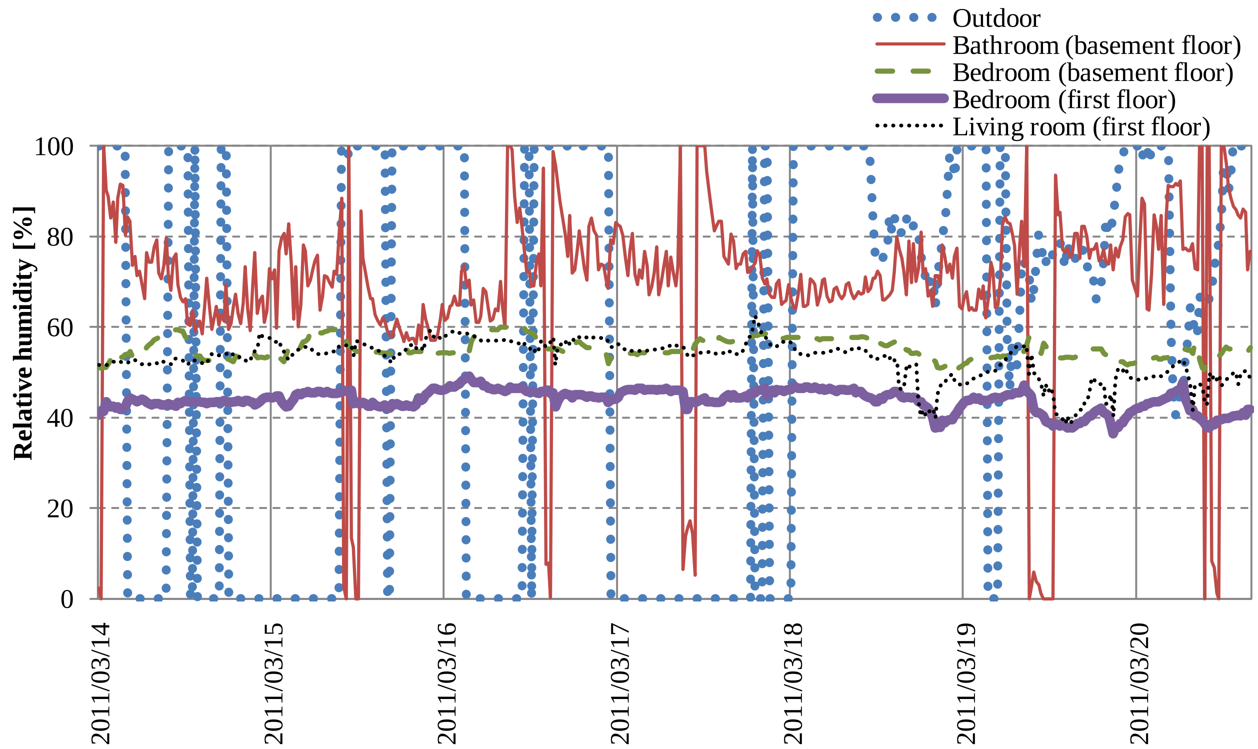

Fig. 25. Measured relative humidity in the warmest week of 2011 (based on a warmest hourly temperature measured outdoor, 33.9°C)

3.6.3 Interpretation of the results related to the indoor climate

The two weeks have been chosen to see the monitored temperature and relative humidity in the Blue House in period from Dec 12, 2010, to Aug 8, 2011. As example were chosen: one week with the coldest hourly temperature and one week with the warmest hourly temperature. Also the average temperatures and relative humidity during the whole period are shown. The coldest week shows the usage of the house and the warmest week shows possible problems with overheating.

The results from the coldest week show the following. The inhabitants probably do not use the bathroom in the basement floor, as the temperature is around 10ºC in the coldest month March, 2011 (Fig. 22). The bedroom in the basement floor is probably not much used during winter time, i.e. the average temperature in the coldest week was approximately 10ºC. The temperature in the living room fluctuates in relation to the outdoor temperature and there is a visible trend of the sunshine entering the room but there could be also influence of sun heating external wall where the sensors is located (Fig. 22). The smaller fluctuation of relative humidity shows that the bathroom in the basement floor is less used in winter time (Fig. 23) although it seems to be heated in winter (Fig. 22). The average temperature in the house is between 19ºC and 21ºC, and relative humidity in the house in winter varies between 20 - 40% (Table 4).

The results from the warmest week show the following. The relative humidity measured outside shows a probable malfunction of the sensor as the reading from the sensor shows 100% (Fig. 25). The humidity in the bathroom in the basement floor shows that the bathroom is used daily and that the temperature averages around 20ºC. The average relative humidity in the bathroom is high even though the bathroom is not used, i.e. approximately between 65 - 75%. The temperature in the bedrooms differ approximately 4 - 5ºC in the summer on the first and basement floor, i.e. varying from 18ºC in the bedroom in the basement and around 22ºC in the first floor (Fig. 24).

There are some problems with the TinyTags sensors regarding the position and obtained results. Although the sensor monitoring the outdoor is placed on the north façade, the sensor still can be influenced by the sun and moisture. The sensors in the interior are placed too close to the floor; ideal height and distances would be between 1 or 2 m of the floor and walls. At this point, the sensors measure more the surface temperatures.

3.7 Blower-door

3.7.1 Theory and equipment

The blower-door test is non destructive method used for determination of the air change rate of the houses through the building envelope. The test has to be made in depressurize and pressurize state to ensure that all openings in the building envelope are revealed. Further information about testing procedure and guidelines can be found in related manuals and the European Standard (EN 13829, 2001).

Testing equipment used for measuring of the air tightness of a building envelope of the Blue House is RETROTEC 2000 DOOR FAN with digital gauge DM-2 together with software Door Fan 3.0 Enclosure Leakage Analysis Software (version 3.247). The results are evaluated in accordance with EN Standard (EN 13829) and Danish Building Regulation as Greenlandic authorities has yet to introduce the limits on air tightness of the building envelope.

The infiltration rate is a volumetric flow of the outside air into a building V_{50} (m^3/h) and the air change is the number of interior volume air changes that occurs per hour ACH (h^{-1}). The blower-door supplies the number to calculate the air change at 50 Pa pressure difference, i.e. n_{50} (h^{-1}). The air change is calculated in accordance with (1) where V_{net} is the internal volume (m^3) for EN Standard comparison and/or as using (2) as defined as "SBi anvisning 213" method in the Danish Building Regulations (DBR, 2008) where q_{50} is the leakage rate ($l/s/m^2$) and A_{gross} is the heated gross area (m^2) (Aggerholm and Grau, 2008). The air change rate can be calculated using the Sherman method (3) with the internal floor area A_{net} (m^2) and the corrected air flow ($m^3/h/m^2$ or $l/s/m^2$) (Sherman, 1987).

$$n_{50} = \frac{V_{50}}{V_{net}} \qquad (1)$$

$$q_{50} = \frac{V_{50}}{A_{gross}} \qquad (2)$$

$$w_{50} = \frac{V_{50}}{A_{net}} \qquad (3)$$

The actual air change rate can be calculated using EN Standard method as in (4) where V_{n50} (m^3) is the net air volume, V_{RAX} (m^3) is the net air volume for pressurisation test, *e* is the wind screening coefficient according to EN 832 (*e* = 0.05) ((EN 832, 2000) and (EN 13829, 2001)). The actual air change rate (h^{-1}) at normal pressure can be calculated in accordance with (5) with the factor "*20*" using the "Princeton method" (Meier, 2011). This method gives reasonable estimates, but ignores many details of the infiltration process, such as stack effect, windiness and wind shielding and type of leaks. In comparison with the "Princeton method", the "Sherman method" takes into account the different parameters influencing the infiltration (6) where *C* is the climate correction factor (26 (hot) < C < 14 (cold)); *H* is the height factor (1 = one-storey, 0.9 = 1.5 storey, 0.8 = 2- storey, etc.); *L* is the leakiness factor (1.4 = tight, 1 = average, 0.7 = not tight); *S* is the shielding factor (1.2 = well shielded, 1 = average, 0.9 = exposed). The values for the Blue House are: C = 14, H = 2, L = 1 and S = 0.9). The SBi method of finding the infiltration air change is by using the leakage rate at 50 Pa, q_{50}, and conversion (7) to a normalized pressure state (Aggerholm and Grau, 2008). The infiltration air change rate (h^{-1}) at normalized pressure is than found using the internal volume of the building V_{net} (m^3) and the following equation (8).

$$n_{v,\mathrm{Res}} = n_{50} \cdot e \cdot \frac{V_{n50}}{V_{RAX}} \qquad (4)$$

$$q_{\inf} = \frac{n_{50}}{20} \qquad (5)$$

$$q_{\inf} = \frac{w_{50}}{C \cdot H \cdot L \cdot S} \qquad (6)$$

$$q = 0.04 + 0.06 \cdot q_{50} \qquad (7)$$

$$q_{\inf} = \frac{A_{gross} \cdot q}{V_{net}} \cdot 3.6 \qquad (8)$$

3.7.2 Analyses of the blower-door results

The blower-door tests were performed on 8.8.2011, 9:00 (GMT -2, summertime) with the following initial data and boundary conditions (Table 5). The testing of air change was done using 12 steps with each step of 4.2 Pa, starting from 10 Pa to 60 Pa. There were total of 4 tests performed, i.e. two sets of pressurize and depressurize as a "Method A" with vents only closed, and "Method B" with vents sealed and taped over as in accordance with EN 13829. The three tests (depressurize "Method B"; pressurize "Method B"; pressurize "Method A") were performed with range C6 and the fourth test (depressurize "Method A") was done with range C8. The correlation factors were around 99%.

Table 5. Initial data and boundary conditions for blower-door tests

Initial data		**Boundary conditions**	
Net floor area A_{net}	183.76 m^2	Interior temperature	22.8ºC
Internal surface area A_E	382 m^2	Outside temperature	14.0ºC
Internal volume V	453.89 m^3	Wind speed	5 m/s
Elevation	37 m	Weather	sunny

Measured results from the blower-door tests with closed and taped vents ("Method B") and with just closed vents ("Method A") are the following (Table 6, Table 7). See attached blower-door tests in Annex E.

Table 6. Results from the blower-door test "Method A"

Data	**Symbol**	**Result for "Method A"**			**Unit**
		Depressurize	**Pressurize**	**Average**	
Air flow at 50 Pa	V_{50}	469.0	479.0	474.0	[l/s]
Air change at 50 Pa	n_{50}	3.72	3.80	3.76	[h^{-1}]
Permeability at 50 Pa	q_{50}	1.23	1.25	1.24	[l/s/m^2]
Specific leakage rate at 50 Pa	w_{50}	2.55	2.61	2.58	[l/s/m^2]

Table 7. Results from the blower-door test "Method B"

Data	**Symbol**	**Result for "Method B"**			**Unit**
		Depressurize	**Pressurize**	**Average**	
Air flow at 50 Pa	V_{50}	386.0	401.0	393.5	[l/s]
Air change at 50 Pa	n_{50}	3.06	3.18	3.12	[h^{-1}]
Permeability at 50 Pa	q_{50}	1.01	1.05	1.03	[l/s/m^2]
Specific leakage rate at 50 Pa	w_{50}	2.10	2.18	2.14	[l/s/m^2]

Furthermore, the infiltration heat loss was calculated to estimate the annual infiltration heat loss through the building envelope using the results from the blower-door test and the following equations. The total infiltration (EN 13790, 2004) throughout the year Q_{inf} (kWh/a) is expressed in (9) where V_{net} is the internal volume of the house (m3), q_{inf} is the calculated infiltration air change rate (h^{-1}), c_P is the thermal capacity of the air (1,005 J/(kg·K)), ρ is the air density (1.2 kg/m^3) and *HDH* is the heating degree hours from Sisimiut.dry for Sisimiut (208 kKh/a).

$$Q_{\inf} = V \cdot q_{\inf} \cdot \frac{c_P \cdot \rho}{3{,}600} \cdot HDH$$

Table 8. Calculated air change (ACH) in neutral pressure using different methods and infiltration heat loss

Method	Air change [h^{-1}]		Infiltration heat loss [kWh/a]	
	"Method A"	"Method B"	"Method A"	"Method B"
EN Standard	0.19	0.17	6011	5378
Princeton	0.19	0.15	6011	4745
Sherman	0.20	0.16	6327	5062
SBi Anvisning 213	0.16	0.19	5062	6011

3.7.3 Results for the blower-door

The results of air tightness of the building envelope show that the Blue House fulfils the Danish Standard request where the air permeability, or respectively q_{50} at 50 Pa pressure difference, must be below 1.5 l/s/m^2 (DBR, 2008). The air change rate at 50 Pa of the Blue House is approximately n_{50} = 3.1 h^{-1} which is approximately 5 times worse than the requirements for a passive house (Passive House, 2011). Comparing with the standard wooden family houses in Greenland built in 1960s which have the air tightness varying from n_{50} = 11. 3 – 18.5 h^{-1}, the Blue House presents a higher quality of younger buildings in Greenland (Bjarløv and Vladykova, 2011). In comparison to a newly built Low-energy house in Sisimiut with mechanical ventilation system with n_{50} = 3.1 h^{-1} (Rode et. al, 2010), the Blue House represents a good example of a house with natural ventilation system.

Regarding to the Standards and the listed buildings in Greenland, the air tightness of the Blue House is quite high as it has a vapour airtight layer at the first floor and the concrete walls are rather tight themselves. For better comparison, it would be recommended to measure the air tightness using a tracer gas method which measures the natural infiltration at the normalized pressure state.

Results of the air change at neutral pressure are difficult to calculate from 50 Pa pressure difference to neutral pressure state. The presented methods have some boundaries but the results in Table 8 shows that the results are comparable. Furthermore, the infiltration heat loss is calculated and show in Table 8 showing that the infiltration heat loss varies from 4,700 – 6,300 kWh/a. This number should be compared to the ventilation and transmission heat losses. The air flow through the natural exhaust vents when closed is between 633 - 1265 kWh/a. This heat loss could be eliminated when the mechanical ventilation system would be installed in the Blue House.

According the blower-door testing using pressurize and depressurize, the building envelope of the Blue House is more open when the pressurize test is performed, i.e. when the outside air is taken through the building envelope and blown out through the fan, see Table 6 and Table 7. The tightness of the sealing of the natural vents (only when they are closed but not taped over) can be simply estimated as difference between method A and B. These results in the following: air flow at 50 Pa of 82.5 l/s, or air change rate at 50 Pa as 0.64 h^{-1} respectively (Table 8).

3.8 Thermography

3.8.1 Theory and equipment for thermography

Thermography testing is non invasive method for detection of the irregularities in the buildings structure and the detection of surface temperatures, i.e. heat loss sources, mould problems, irregularity of building insulation, location of defects in the ducting, etc.

The testing equipment used for performing a thermography test was an infrared camera HotFind-D and digital camera. The results were evaluated using ThermoView software and were evaluated in accordance with EN 13187 (EN 13187, 2011).

Two thermography tests were performed on: 8.8.2011, 12:00 (GMT -2, summer time) of the interior of the house with depressurizing of 50 Pa and the second test of the exterior of the house with neutral pressure was performed on 15.8.2011, 3:00 (GMT -2, summer time). The boundary conditions for both tests are listed in Table 9.

Table 9. Boundary conditions for thermography test

Elements	Thermography from inside	Thermography from outside
Interior temperature	22.8ºC	22.0ºC
Outside temperature	14.0ºC	5.0ºC
Wind speed	5 m/s	-
Weather - current	sunny	at night
Weather - 12 prior	sunny	cloudy
Temperature difference	8.8ºC; not OK	17.0ºC; OK

3.8.2 Results of thermography testing

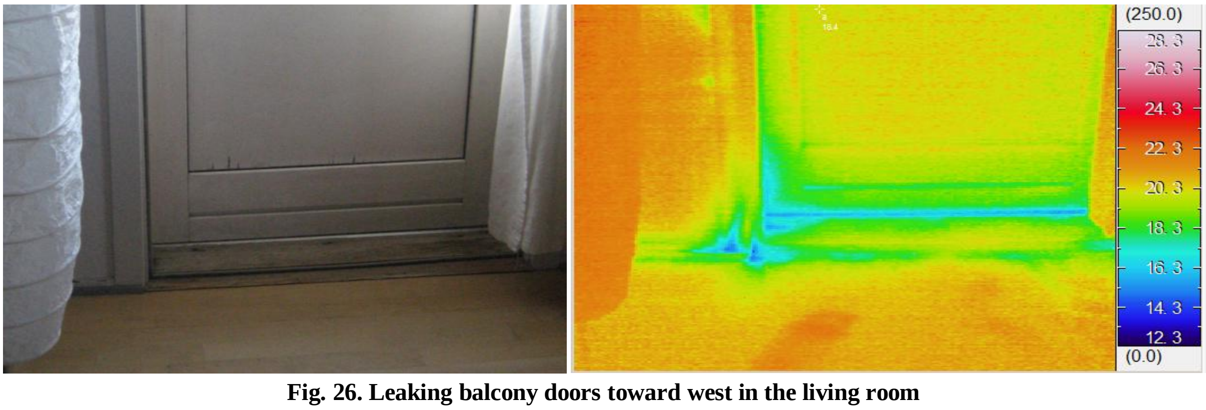

Fig. 26. Leaking balcony doors toward west in the living room

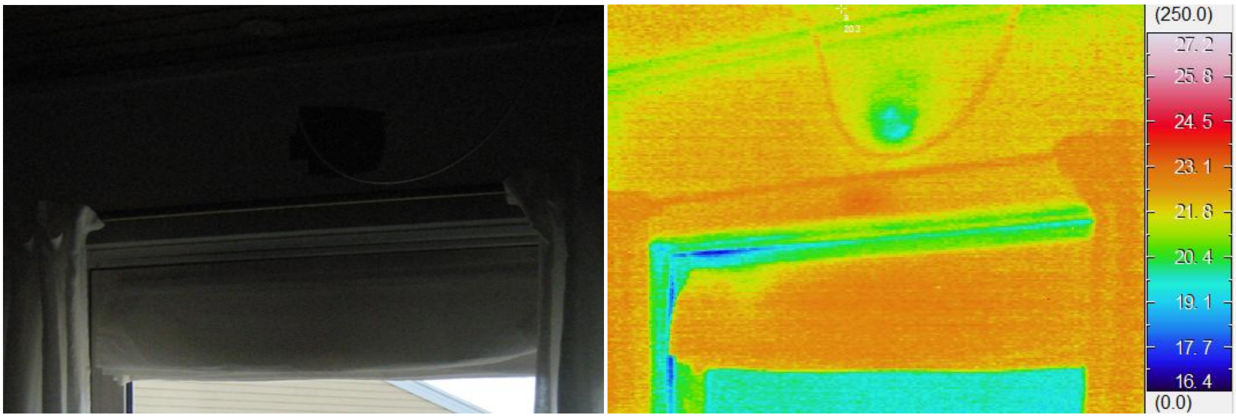

Fig. 27. Problematic window, natural vent and joints between wall and ceiling

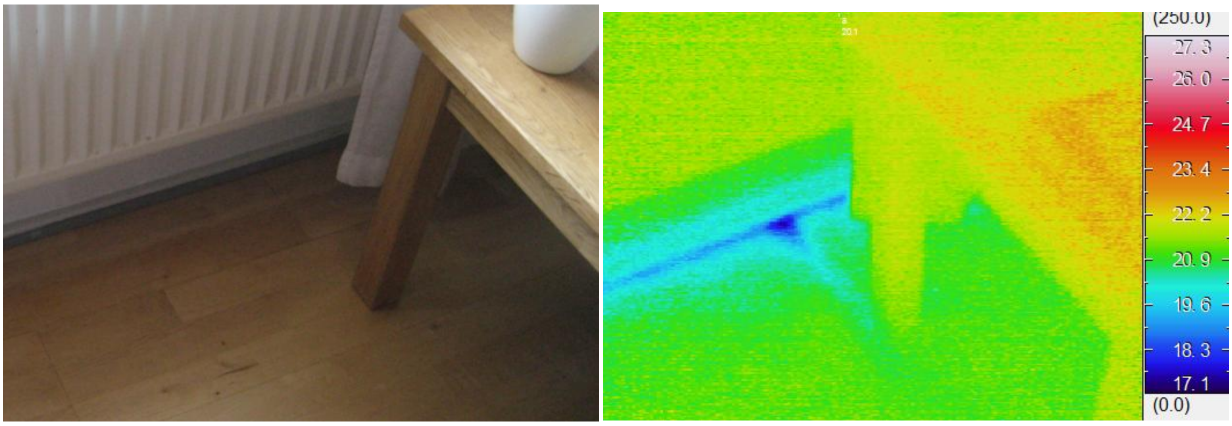

Fig. 28. Un tightness of the floor between concrete and wooden part of the structure in the living room

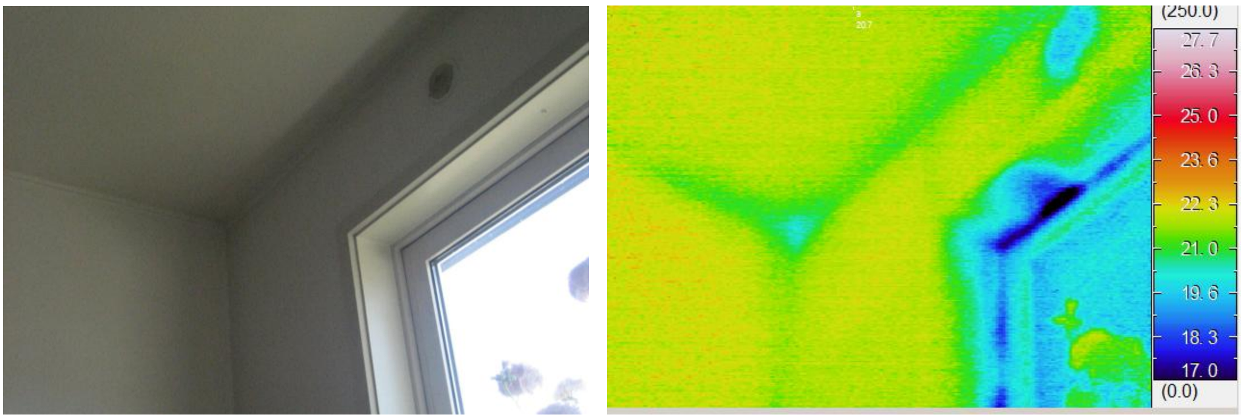

Fig. 29. Untight window and cold corner around the window in the basement / staircase

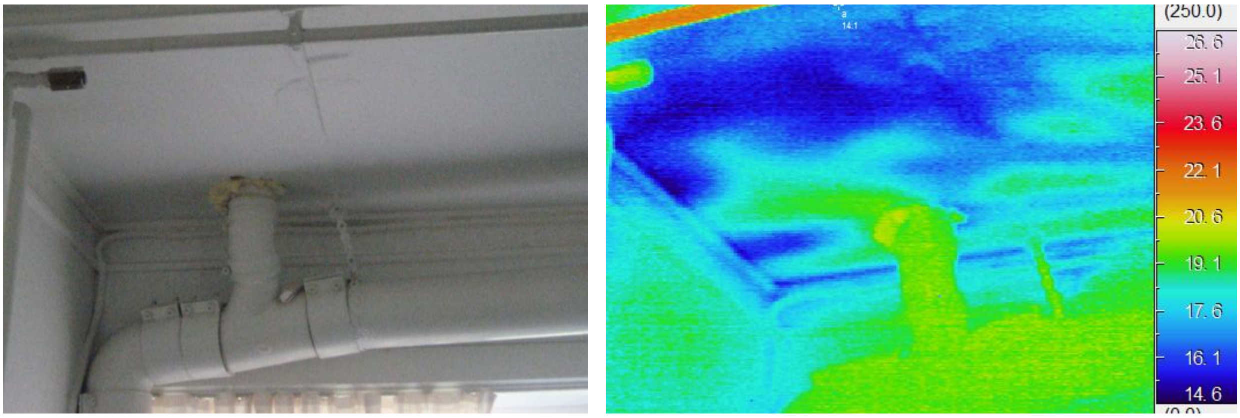

Fig. 30. Ceiling between two bathrooms, possibility of the humidity problems and cold floor

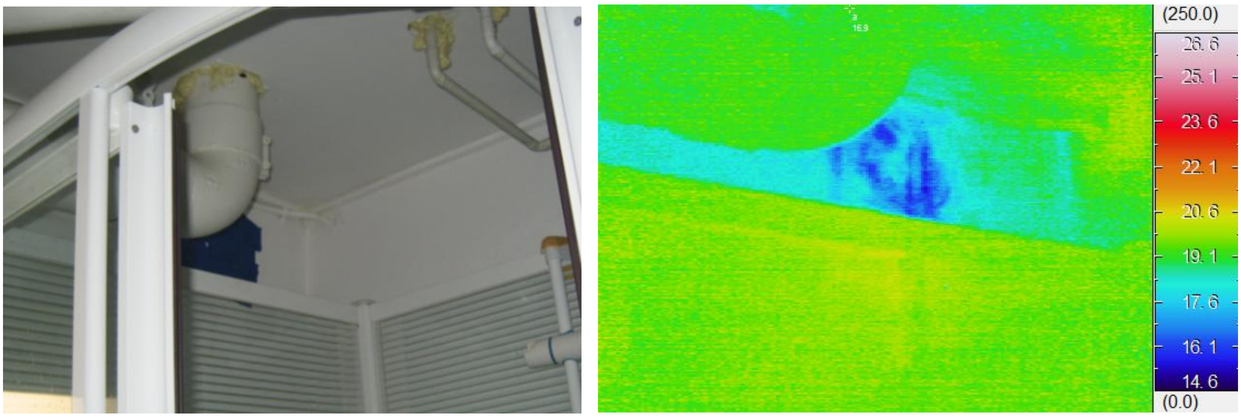

Fig. 31. Un tightness of the natural vent in the bathroom in the basement floor

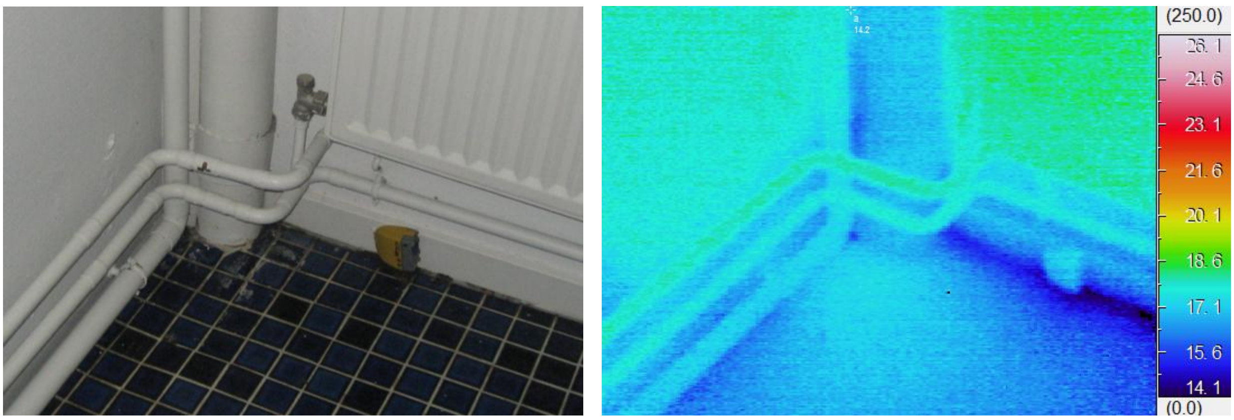

Fig. 32. Thermal bridge and cold floor along with corner in the bathroom in the basement floor

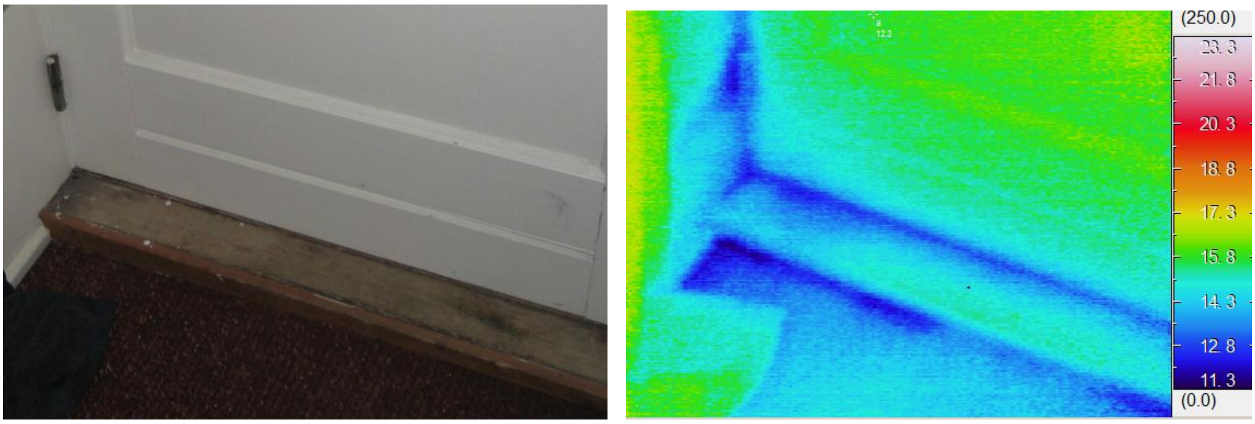

Fig. 33. Image of the problematic doors in the basement to the terrace (toward North, problem with freezing)

Fig. 34. View of the west facade of the Blue House

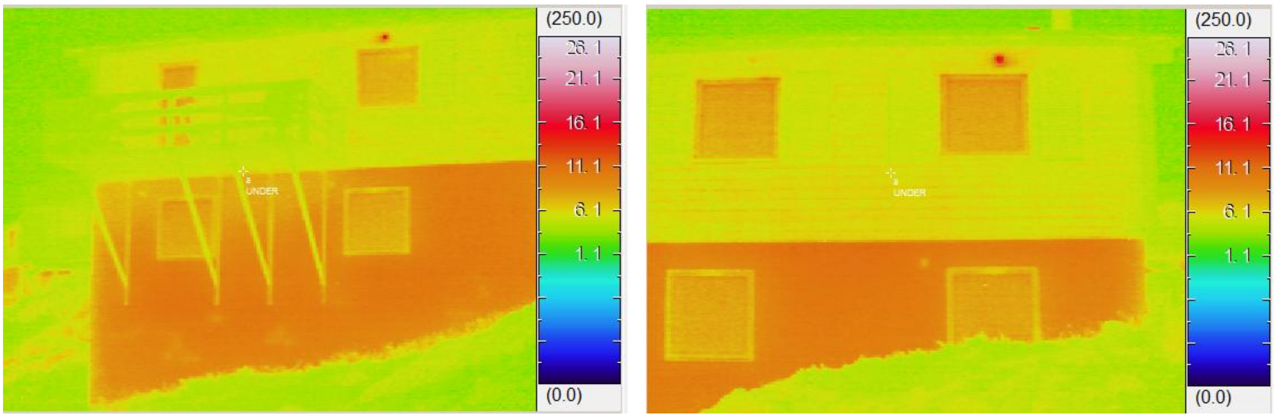

Fig. 35. Thermographic images of the west facade of the Blue House

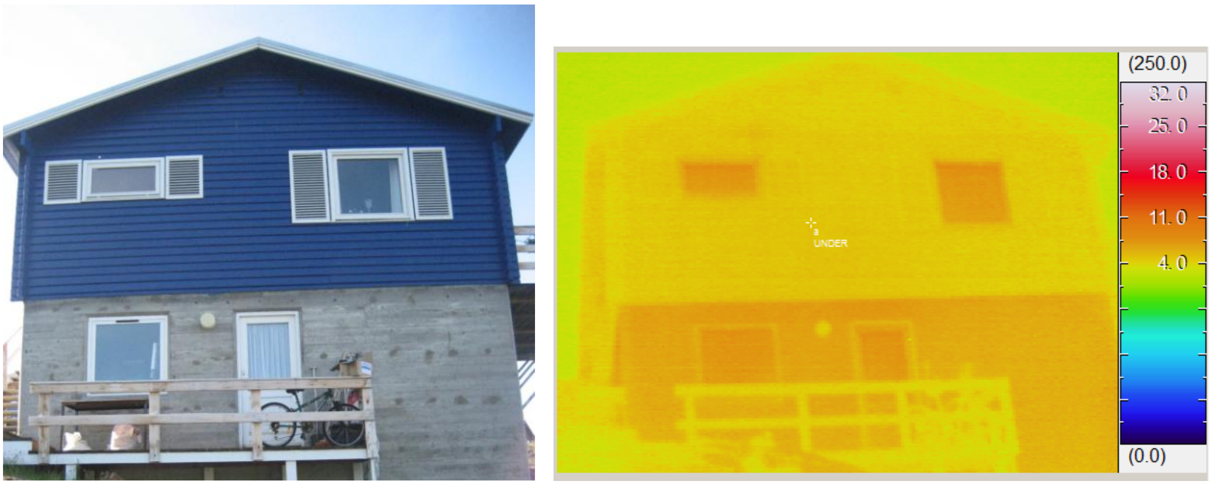

Fig. 36. View and thermographic image of the northern facade of the Blue House

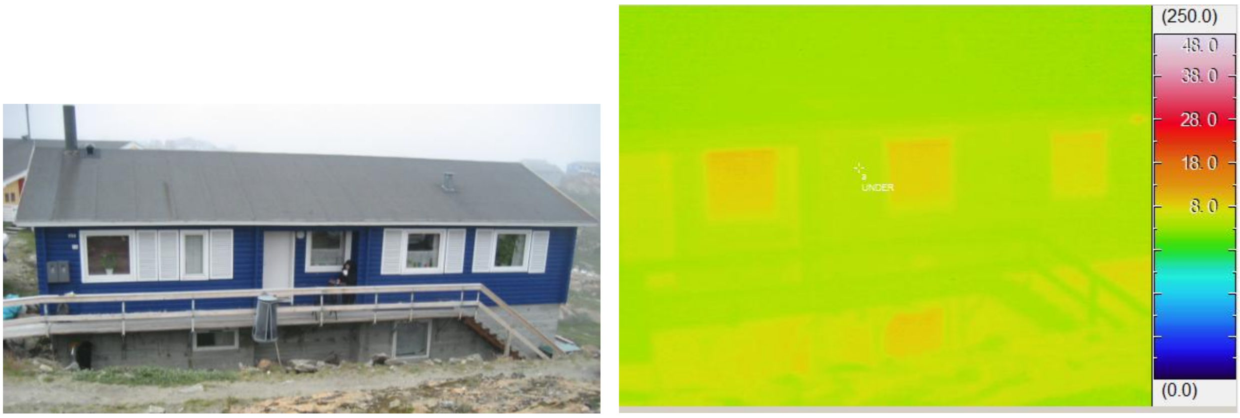

Fig. 37. View and thermographic image of the eastern facade of the Blue House

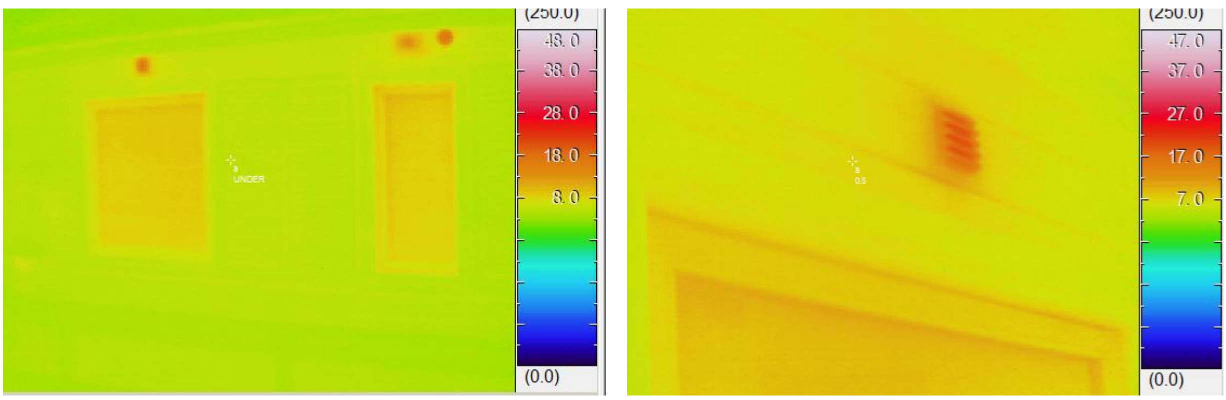

Fig. 38. Thermographic images of the details of the eastern facade

3.8.3 Evaluation of thermographic results

More pictures can be found in report (Vasilevskis and Silins, 2011). The results of the thermography investigation from the inside and outside show the following problems:

- the house has problems with the natural vents as they are sources of heat loss when they are closed and are not air tight and insulated as required (Fig. 38)
- the connection between upper wooden structure and lower concrete structure seems to be not air / wind tight and it is a source of heat loss, not continuance / sealling against the wind / air tight layer from wooden part to the concrete part (Fig. 28)
- there seem to be some problems in the floor in the upper bathroom / ceiling of the lower bathroom, possibility of the moisture in the construction (Fig. 30)
- cold floor in the basement, especially in the bathrooms (Fig. 32)
- untight balcony doors in the basement where there is a freezing problem in the winter (Fig. 26, Fig. 33)
- difference between wooden and concrete parts of the house (Fig. 35, Fig. 36)
- south facade was not diagnosed as it is mostly shielded from a boat

All problems revealed during thermographic investigation lead to a potentially high heat loss during the whole year with especially high heat loss during storms. The house seems to be rather tight but there is a significant difference between temperatures of basement floor and first floor, i.e. very cold floor of the basement. There are several untight and heat leaking windows and doors in the Blue house. The technical room and cold entrance in the basement are also sources of thermal heat loss and infiltration heat loss. It seems that the wind / air tight layer in the wooden part is working and basement floor is naturally air tight, but the connections / joints are the weakest points. Improvement of the wind / air tight layer and stabilisation of the whole structure is necessary before further insulation.

The temperature difference of minimum 10ºC difference was not fulfilled but the thermographic test was used more as a guidance method to locate possible problems in the house such as air leakage or mould problems. Also, the house should have been retested in the winter period.

3.9 Energy consumption

3.9.1 Theoretical consumption

The theoretical consumption based on the Greenlandic Building Regulations (GBR, 2006) estimates that the house (located in Zone 2, north of the Polar Circle) with gross heated area of $A_{gross} = 209\ m^2$ should consume approximately 140.5 kWh/(m^2·a). This theoretical energy frame (MJ/(m^2·a)) in for buildings is in accordance with (10) where e is calculated as heated area divided by a foot print area of a building.

$$Zone2 = 510 + \frac{320}{e} \quad (10)$$

The oil consumption for the year 2010 was calculated from oil bills and it amounts to 2,935 litres per year. Yet, the year 2010 has been exceptionally warm, i.e. HDH = 162 kKh/a compared to DRY in which HDH =

208 kKh/a. The heating degree days were expressed using the following equation (11) where $T_{amb,out}$ is the average ambient temperature in each month and t_m is the number of hours in each month.

$$HDH = \sum (20 - T_{amb,out}) \cdot t_m \qquad (11)$$

3.9.2 Oil bills and approximation of monthly oil consumption

The approximation of oil consumption based on information obtained from the oil bills (Annex F) is showed in Fig. 39. The approximation is based on the calculation of daily oil consumption which is calculated from dates of between two deliveries, and amount of delivered oil is divided by the number of days between two deliveries. This daily oil consumption in a relevant month is multiplied by number of days in relevant month. The oil consumption includes the space heating and domestic hot water consumption.

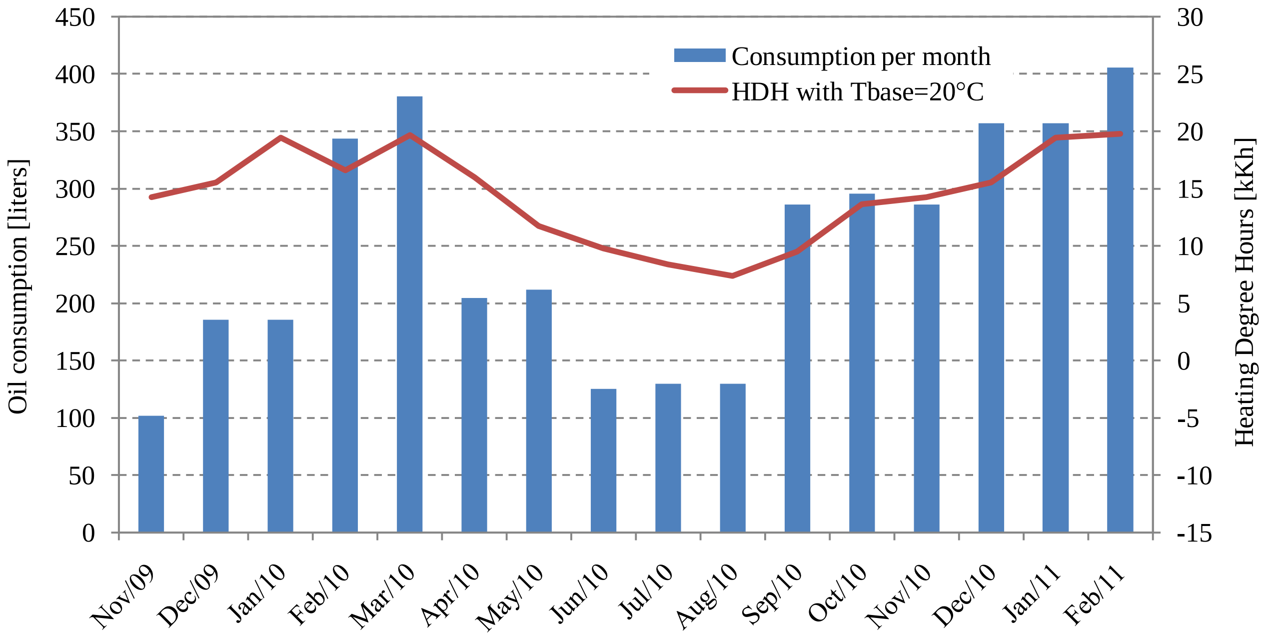

Fig. 39. Approximation of oil consumption based on oil delivered to the house

The current price for the oil is 4.27 DKK/litre (obtained from the heating bills), there has been an increase in the prices for oil of 1,10 DKK/litre in summer of 2011. The electricity is 3.28 DKK/1 kW. Assuming that 1 litre of oil gives 10 kWh, the house needs approximately 29,350 kWh/a for space heating and domestic hot water in the warmer year, i.e. 140.4 kWh/(m^2·a) respectively. The hot water consumption is not measured separately therefore it can be only estimated based on standard consumption in Danish's homes as 250 l/m^2 per household per year (Aggerholm and Grau, 2008), ΔT = 45ºC, and it is on average to 2.7 kWh/(m_2·a) respectively. Only the heating consumption amounts to approximately 137.7 kWh/(m^2·a) which is comparable to the today´s GBR requirement but it is still rather high consumption.

4 Proposal of renovation using paper insulation

4.1 Application of paper insulation and problematic issues

Installation of paper insulation and additional buildings envelope layers will need to be designed and applied very carefully based on the experiences with weather conditions in Greenland, experiences with paper insulation and also based on the static security, moisture safety, etc. There are several issues related to the Blue House and the ambitious paper insulation listed as the following.

Before application of paper insulation

- The exterior painting needs to be sanded off (or removed with high water pressure equipment) before the application of paper insulation will begin as the painting now functions as vapour airtight membrane.
- Recommendation to make static investigation because of strong winds and so the new facade is not blown off. The static stability of old structure should be secured by fixed and tight iron cross beams where the wooden and concrete parts of the house will be fixed together with steel bar profiles.
- The floor in the living room has to be even up; approximately 50 mm in total of new layers for the floor has to be applied. The decision has to be made about the levelling of the basement floor.
- The thermal performance of the additional layer of paper insulation should be investigated using a detailed energy analyses. Furthermore, there is a recommendation to analyse the potential for condensation and drying off in the new structure at different locations in the building envelope.

Application of the new facade

- Cement-fibre profiles will be used for fixing of the current balconies and catwalk. They transfer less heat loss than normal steel members.
- The paper insulation will be blown in into the attic and applied to the external walls. There needs to be a decision if the crawl space beneath the house should be insulated.
- There is a goal of approximately additional 150 or 170 mm of additional layer of paper insulation. The thickness of the layer will be decided upon the physical possibilities of the current structure.
- As outer layer after paper insulation layer should be used a diffuse open material (towards outside) with good stiffness characteristics (composite material); this material will serve as a wind stopper; suggestions are such as a cement-chip board or a Cembrit board of 9 mm thickness or Amroc board of 8 mm from HBC (Holbæk Byggevare Center) or TyveK boards
- Paper insulation will be installed using the thermal breakers to lower the transmission heat loss and possible condensation around the fixings (Fig. 40).
- Along edges and around doors and windows and other openings shall be used sealant of a glue to make it wind tight, otherwise the air will come in between the board and wood when the structure will dry out. Also the profiles for assembling have to be sealed with sealant.
- It is the most important that no humidity will have access to the constructions, including penetration of fine drift snow.
- EPS insulation close to the ground will be installed to secure that the moisture from the ground will not be transported through the paper insulation, approximate height of 300 - 500 mm along the whole foundations.
- Possibly new windows depending on the budget will be fixed as the floating windows using the thermal breakers. Doors will be changed as they are not airtight, also depending on the budget.

- Possibly the heat exchanger should be installed in the house to provide a fresh air and save energy using recuperation. The corresponding bathroom and kitchen exhausts should be also fixed.

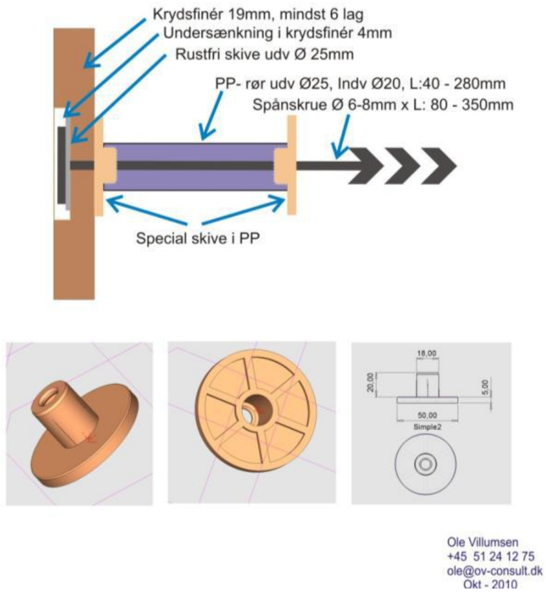

Fig. 40. Thermal bridge breaker for fixing the paper insulation and additional outer layer

4.2 Future follow-ups

Monitoring of paper insulation performance

The future follow-up on the performance of the paper insulation is recommended using a simple monitoring system. The additional paper insulation should be measured using a simple online system with in-built sensors which should monitor temperature, dew point and humidity at the different levels of the paper insulation, e.g. between today´s outer surface of the concrete and new additional layer of the insulation; also the same for today´s wooden part and new additional paper insulation; around windows, etc.

Documentation of energy savings and indoor climate

Furthermore, there should be continues collection of measured data in the Blue House (temperature, relative humidity, oil bill, questionnaires, etc.) to ensure the further documentation of energy savings achieve by application of the paper insulation and other building systems in the Blue House.

5 Acknowledgments

The gratitude is expressed to the Olsen family for letting us into the house and to all participants in measuring and documenting the house, namely Ulvis Silins, Sandijs Vasilevskis, Martin Kotol and Poul Linnert Christiansen. The gratitude is expressed to Ole Villumsen for his help with investigation.

The Blue House is part of the NEES project at ARTEK, Technical University of Denmark.

6 References

Aggerholm S., Grau K. (2008). SBi-anvisning 213. Bygningers energibehov. Pc-program og beregningsvejledning. Statens Byggeforskningsinsitut. Horsholm. Denmark (in Danish).

Bjarløv S.P., Vladykova P. (2011). The potential and need for energy savings in standard family detached and semi-detached wooden houses in arctic Greenland. Building and Environment 46-8, pg. 1525-1536.

Danish Building Regulation. DBR. Bygningsreglement (2008). Ehrvervs- og Byggestyrelsen. http://www.ebst.dk/bygningsreglementet.dk. Accessed online 11-08-2011 (in Danish).

Greenlandic Building Regulation. GBR. (1982). Grønlands Hjemmestyre. Bygningsreglement 1982. (in Danish).

Greenlandic Building Regulation. GBR. (2006). Grønlands Hjemmestyre. Bygningsreglement. Grønlands Selvstyre. http://dk.nanoq.gl/Emner/Erhverv/Erhvervsomraader/Bygge-oganlaeg/Bygningsreglement%202006.aspx. Accessed online 29-08-2011 (in Danish).

EN 832 (2000). Thermal Performance of Buildings. Calculation of Energy Use for Heating. Residential Buildings. European Committee of Standardization.

EN ISO 6946 (2005). Building components and building elements. Thermal resistance and thermal transmittance. Calculation method. European Standard. European Committee of Standardization.

EN 13187 (1998). Thermal performance of buildings. Qualitative detection of thermal irregularities in building envelopes. Infrared method. European Committee of Standardization. 1998.

EN 13790 (2004). Thermal performance of buildings. Calculation of energy use for space heating and cooling. European Standard.

EN 13829 (2001). Thermal performance of building. Determination of air permeability of buildings. Fan pressurization method. European Committee of Standardization. 2001.

Meier A. (2011). Infiltration: Just ACH50 divided by 20? HomeEnergy. http://www.homeenergy.org/show/article/filter/1994/id/1015. Accessed online 29-08-2011.

Panbo Huse A/S (2011), http://www.panbo.dk, Accessed online 11-08-2011 (in Danish).

Passive House (2011).. Information on Passive House. Passive House Institute. http://www.passivhaustatung.de/. Accessed online 29-08-2011.

Rode C., Vladykova P., Kotol M. Air Tightness and Energy Performance of an Arctic Low-Energy House. 5th International Symposium on Building and Ductwork Air-tightness. 2010.

Sherman, M. (1987). Estimation of Infiltration for Leakage and Climate Indicators. Energy and Buildings 10:1, pg. 81-86.

Vasilevskis S., Silins U. (2011). Blower door test and thermography in Blue house. Student report. Technical University of Denmark.

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Sandijs Vasilevskis Ulvis Silins	Bachelor students E-mail: sandijs.vasilevskis@gmail.com E-mail: ulvis.silins@gmail.com	drawings and investigations of the Blue House

8 Annex

A. Original drawings from Panbo A/S

Floor plan
Cross-section

B. Additional materials of the Panbo house provided by Panbo A/S

Material´s description
Building the house
Material´s list

C. New drawings

Floor plan of the first floor M 1:50
Floor plan of the basement floor M 1:50
Cross-section 1-1´ M 1:50
Facade views M 1:100

D. Questionnaire with tenants

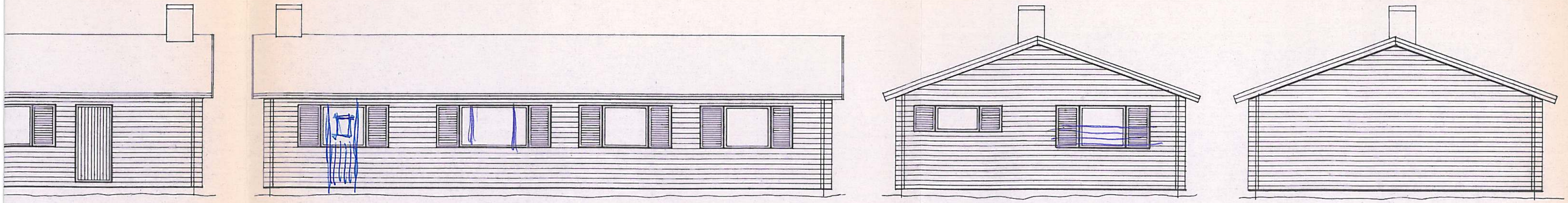
Provided by Martin Kotol, Ph.D. project: “Energy use and indoor environment in new and existing dwellings in arctic climates”

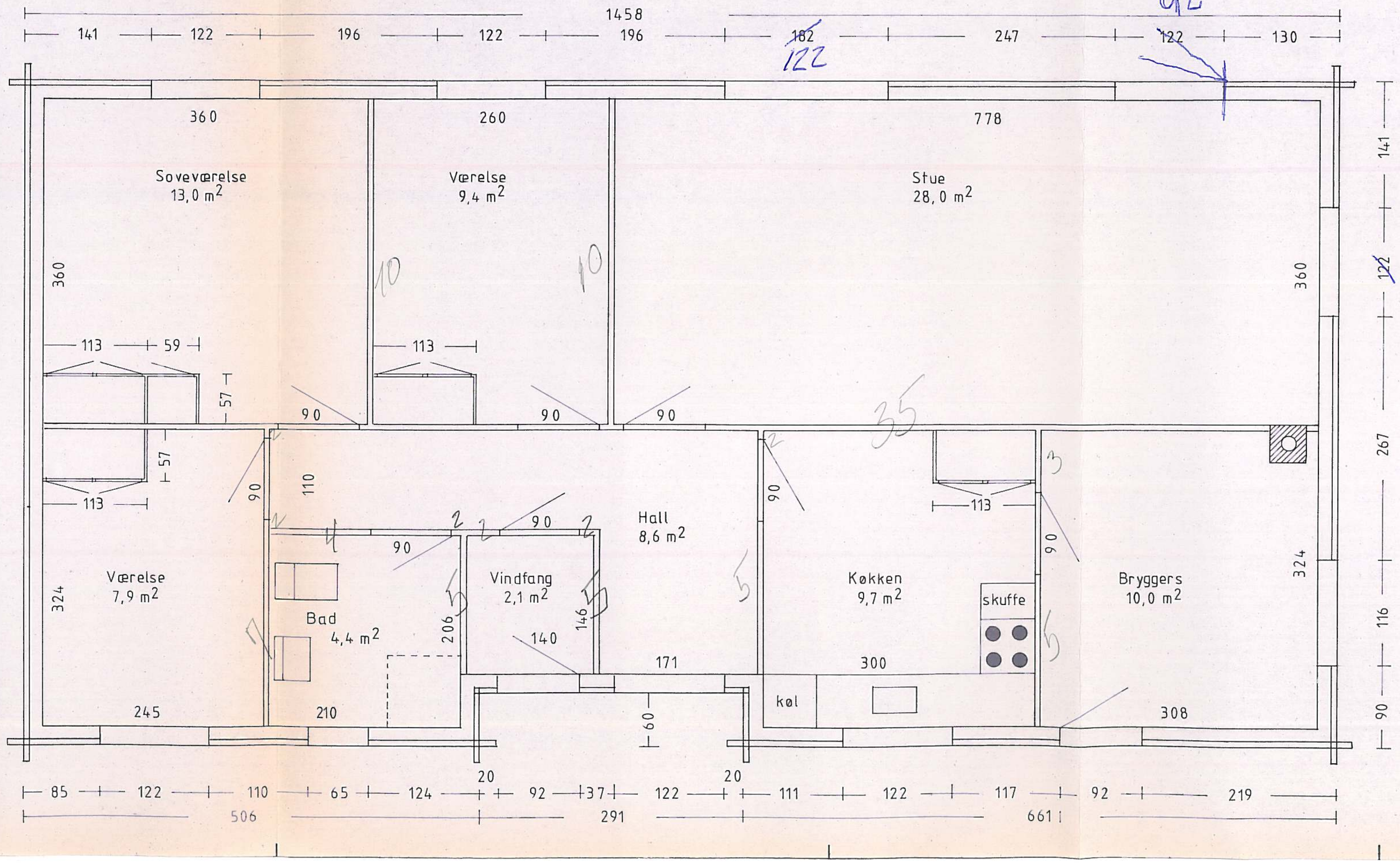
E. Blower-door tests

Depressurization, sealed, “Method B”
Pressurization, sealed, “Method B”
Depressurization, unsealed, “Method A”
Pressurization, unsealed, “Method A”

F. Oil bills for space heating and hot water consumption

Period from Sep 2009 until Mar 2011





Aftræk:

Køkken	200 cm^2
Bad	150 cm^2

Ydervægge	22 cm
Skillevægge	7,8 cm

MARTIN JOHNSEN
SYGEHUSET
DEICHMANNSVEJ
3911 HOLSTEINSBORG.
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Højen, 7100 Vejle
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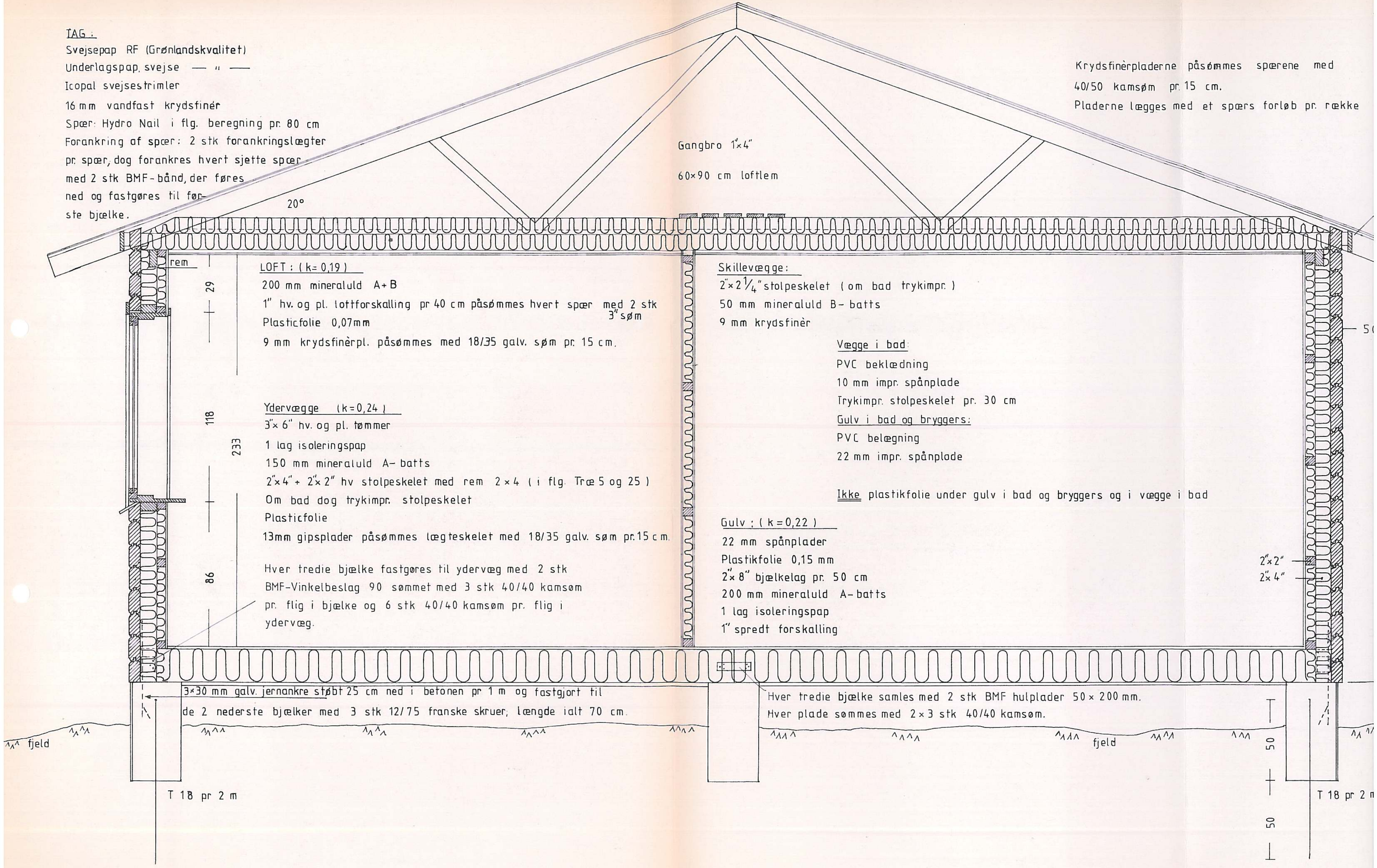


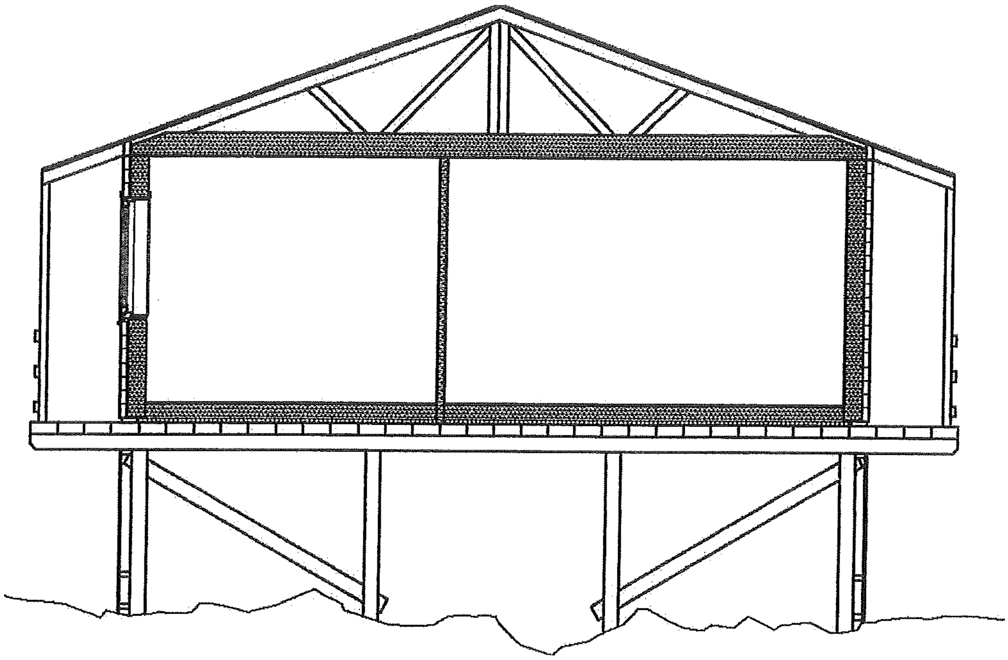
TAG:
Svejsepap RF (Grønlandskvalitet)
Underlagspap. svejse — " —
Icopal svejsestrimler
16 mm vandfast krydsfinér
Spær: Hydro Nail i flg. beregning pr. 80 cm
Forankring af spær: 2 stk forankringslægter pr. spær, dog forankres hvert sjette spær med 2 stk BMF-bånd, der føres ned og fastgøres til første bjælke.
20°
Gangbro 1"×4"
60×90 cm loftlem
Krydsfinérpladerne påsømmes spærene med 40/50 kamsøm pr. 15 cm.
Pladerne lægges med et spærs forløb pr. række
rem
29
118
233
86
LOFT: (k= 0,19)
200 mm mineraluld A+B
1" hv. og pl. lottforskalling pr 40 cm påsømmes hvert spær med 2 stk 3" søm
Plasticfolie 0,07mm
9 mm krydsfinérpl. påsømmes med 18/35 galv. søm pr. 15 cm.
Ydervægge (k=0,24)
3"× 6" hv. og pl. tømmer
1 lag isoleringspap
150 mm mineraluld A-batts
2"×4" + 2"×2" hv stolpeskelet med rem 2×4 (i flg. Træ 5 og 25)
Om bad dog trykimpr. stolpeskelet
Plasticfolie
13mm gipsplader påsømmes lægteskelet med 18/35 galv. søm pr.15 cm.
Hver tredie bjælke fastgøres til ydervæg med 2 stk BMF-Vinkelbeslag 90 sømmet med 3 stk 40/40 kamsøm pr. flig i bjælke og 6 stk 40/40 kamsøm pr. flig i ydervæg.
Skillevægge:
2"×2 1/4" stolpeskelet (om bad trykimpr.)
50 mm mineraluld B-batts
9 mm krydsfinér
Vægge i bad:
PVC beklædning
10 mm impr. spånplade
Trykimpr. stolpeskelet pr. 30 cm
Gulv i bad og bryggers:
PVC belægning
22 mm impr. spånplade
Ikke plastikfolie under gulv i bad og bryggers og i vægge i bad
Gulv: (k=0,22)
22 mm spånplader
Plastikfolie 0,15 mm
2"× 8" bjælkelag pr. 50 cm
200 mm mineraluld A-batts
1 lag isoleringspap
1" spredt forskalling
2"×2"
2"×4"
3×30 mm galv. jernankre støbt 25 cm ned i betonen pr 1 m og fastgjort til de 2 nederste bjælker med 3 stk 12/75 franske skruer; længde ialt 70 cm.
Hver tredie bjælke samles med 2 stk BMF hulplader 50 × 200 mm.
Hver plade sømmes med 2×3 stk 40/40 kamsøm.
fjeld
fjeld
50
50
T 18 pr 2 m
T 18 pr 2 m

Snit-mål 1:20

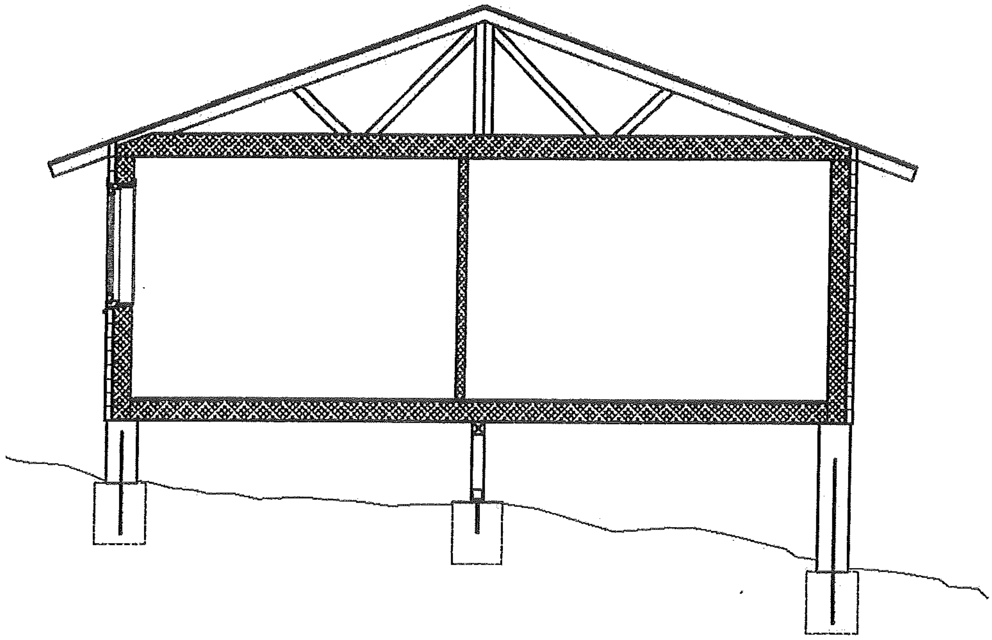
Materialebeskrivelse

Fundament:

1:
Fundamentet udføres som stolpefundament med bærebjælker og massivtræsdæk. Stolperne beklædes udvendigt med krydsfinerplader.



2.
Betonfundament. Gulvopbygning er da med bjælkelag, 200 mm isolering mellem bjælkerne og forskalling underneden til fastholdelse af isoleringen.



Gulve:
Gulvet udføres af 200 mm trykfast isolering og 22 mm spånplader. Gulve i stue, køkken og værelser belægges med laminatgulv. Gulvbelægning i bad og fyrrum/bryggers er vinyl.

Ydervægge:
Ydervæggene udføres med 70 mm ydervægsbjælker, 45x120 mm stolper og 45x45 mm vandret stræk. Indvendig beklædes med 8 mm krydsfiner og 13 mm gipsplader. Ydervægge isoleres med 165 mm mineraluld.

Skillevægge:
Skillevægge udføres af 45x55 mm skillevægsstolper isoleret med 45 mm mineraluld og beklædt på begge sider med 8 mm krydsfiner og 13 mm gipsplader.
Skillevægge indgår ikke i det stabiliserende system og kan derfor placeres efter ønske.

Loft- og tagkonstruktion:
Loftbeklædningen er 40x60 cm gipsfliser. Tagplader er krydsfiner med pålagt asfaltpap. Samlinger strimles og klæbes med kold asfalt. Overpappen svejses på. Gitterspær med 20° taghældning. Spærene leveres i 2 halvdele. Isoleringen er 215 mm mineraluld.

Vinduer:
Vinduer er CE mærkede og udstyret med Energiglas A. Vinduesbænke er limtræ.

Yderdøre:
Yderdørene er isolerede og plankebeklædte. Ruden i dørene er kvadratisk skråtstillet.

Indvendige døre:
Indvendige døre er lamel-egefinerede.

Skabs- og køkkenelementer:
Skabs- og køkkenelementer er lyse lamelfinér og slidstærke bordplader med tilhørende vask.

Malermaterialer:
Til udvendig træværk leveres oliebaseret maling i følgende farver: Almueblå, vogngrøn, svenskrød og skagengul.
Maling til indvendige overflader er lyse alkydprodukter.

Afløb:
Afløb er jernrør, som isoleres og føres uden for fundamentet i en udløbstud.

Vand:
Brugsvandsinstallationer er helådsvand eller vandtank forsynet med selvansugende Jetpumpe.
Det varme brugsvand produceres i en varmtvandsbeholder indbygget i centralvarmekedlen.

Varme:
Huset opvarmes ved hjælp af et centralvarmeanlæg forsynet med radiatorer. Kedlen er forsynet med oliefyr og cirkulationspumpe. Kedlen har røgafgang i toppen og skorstenen er en elementskorsten med rustfri stålkappe. Olietanken er på 600 liter.
Alle centralvarme- og olierør er kobberrør eller plexrør, som samles uden gevindskæring eller lodning, således at selvbyggeren selv kan samle rørene.

El-installationer:
El-installationer udføres med kabler i kabelbakker anbragt ved loftet.
Fra Panbo leveres materialer til el-installationer samt køleskab, komfur og emhætte.
El-installationer tilsluttes af autoriseret el-installatør.

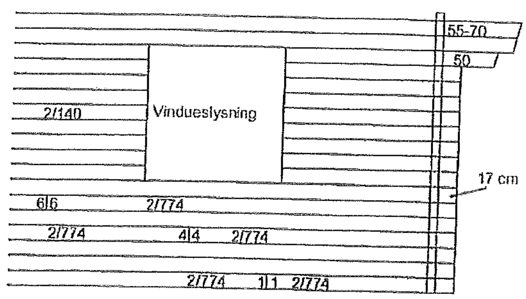
Værktøj:
Værktøj og sikkerhedsudstyr leveres til alle huse.

OPSTILLING AF HUSET.

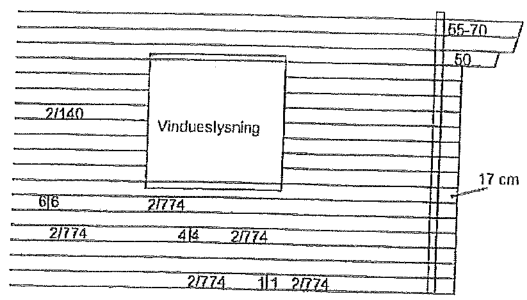
Når huset leveres, medfølger der en konstruktionstegning. Herpå er der en plan med et sidenummer til hver af husets sider. Et tilsvarende nummer står på bagsiden af ydervæggens tømmer, desuden er bjælkens længdemål og ved stødene også bjælkens nummer i højderetningen anført. Der kan f.eks. stå 2/774. Det første tal "2" angiver den side, hvor tømmeret hører til, og det sidste tal "774" angiver den samlede længde på bjælken. Se tegning nedenfor. Da ydervæggens tømmer ikke kan leveres i uendelige længden, vil der opstå enkelte sammenskæringer eller stød. Ved hvert stød er bjælkens højdenummer angivet. Sørg også for, at disse numre passer sammen. Se tegning. Ved sammenskæringerne er bjælkerne opslidsede i enderne. I disse slidser anbringes krydsfinersløjfer, som ligger i en af pakkerne med ydervægsbjælker.

Inden opstillingen begynder, må alle bjælker sorteres ud til de sider, hvor de skal bygges op. Læg alle numrene opad. Murfolien/sokkelpappen rulles ud til kanten af fundamentet. Herpå anbringes den første bjælke, som rager 2 cm ud over såvel sokkelpap som fundament. De vil nu opdage, at der ikke går lang tid, før huset er i rejsehøjde. Ved enfamiliehuse og sommerhuse har facadesiden 18 bjælker i højden. Vedrørende vindueslysning i facade – se nedenfor. I vindueshøjde skal der foretages en opretning af bjælkekonstruktionen. De må endelig bruge en lodstok, så opretningen bliver helt nøjagtig. Er huset nu lidt ude af lod, rettes det op ved at slå på de udragende bjælkeender, skiftevis i hver side, indtil alt er korrigeret. På samme måde drives evt. stød mellem bjælkeenderne sammen. De første 15 bjælker har en udragende ende på 17 cm, målt fra knudesamlingerne, bjælke nummer 16 har en udragende ende på 50 cm og bjælkerne 17 og 18 en udragende ende på 55-70 cm, der skal bruges til understøtning af udhængsspæret. Når hele konstruktionen er sat op og står lige, skal den afstives med skrålægter og 4,5x12,0 cm stolperne, der hæftes på ydervæggen eller fastholdes med skruetvinger ved vindues- og døråbningerne, se side 5. 4,5x12,0 cm stolperne skal først anvendes igen, efter taget er færdigt og isoleringspappen er hæftet på.

Vindueslysning ved gulv med strøer



Vindueslysning ved støbt gulv



Spær:

Inden oplægning af spærene, må man sørge for, at husets ydervægge både vandret og lodret er lige. Er det en lang væg, må der ud over skrålægter støttes med skråstivere og alm. afstivning. (Læs også nederst side 4 og se billeder side 5). Først afmærkes på begge ydervægge, hvor spærene skal stå. Afstand fra midte til midte af spær står på konstruktionstegningen, som følger med huset. Derefter skal der saves og stemmes ud for spærene i den øverste bjælke.

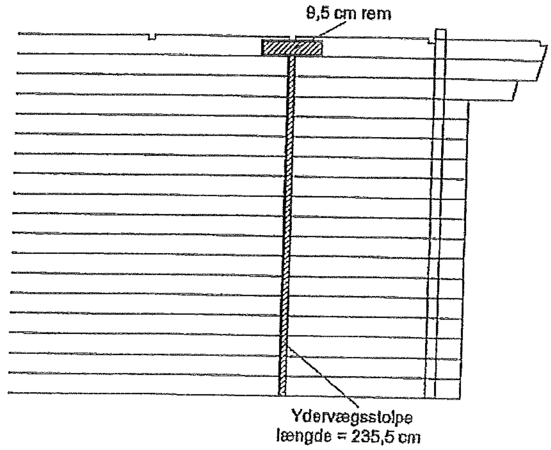
Vægstolper og rem måler: 235,5 + 9,5 = 245 cm.

Dette mål skal der være fra overkant fundament til underkant spær.

Til at fylde ud mellem spærene medfølger stykker af ydervægstømmer på ca. 1 meter. De skal saves til, så de passer i længden og placeres når alle spær er rejst.

Før De sætter spærene op, er det en god ide at strege af til lægtning. Her er det vigtigt, at De er MEGET nøjagtig, og at spærene ligger fuldstændig lige oven på hinanden. Gør de det, kan De nemlig strege af til lægtning på alle spærene på en gang, og De slipper for at afsætte stregerne, når spærene er sat op.

Rejsehøjde-afmærkning



Spæropsætning:

Spærene kommer samlet fra Panbo's fabrik.

Når det første spær er rejst, sørg da for, at det støttes godt til sidevæggene med et par lægter. Det første og det andet spær sømmes sammen med en lægte nær kippen, og der fortsættes med flere lignende lægter efterhånden som de øvrige spær kommer op. Kontroller også at afstanden mellem 2 spær er den samme ved kip og fod. Når man har oplagt 3 spær, er det klogt at give ekstra sidestivhed med en skrålægte på begge sider af taget - indvendig. (Se billede nederst side 7).

Vindgitter:

Når alle spærene er på plads, sømmes vindgitter på. Vindgitteret består af taglægter, som sømmes på spærhovedets <u>underside.</u> (Se skitse side 7).

Gavltrekanten:

Er alle spærene på plads, skal ydervæggens bjælker op i gavltrekanterne. Bjælkerne fastgøres fra den

Materialeliste over 1. levering til Grønland. *Hans Christian Johansen, Sygehuset, 3911 H.* imprægneret

Dato: *26.3.85.*

Type: *1* *107* m².

1	udvendig tømmer, høvlet og pløjet 3x6"	*til ca. 107 m² hus*			
2	spær 7,36 el. 8,00 m. pr. 80 cm. stk.	*19*			
3	udhængsspær 2x5"	*4/450*			
4	vindskeder 1x4"	*4/450*			
5	tagplader, 16 mm finer med not og fer	*~~52~~ – 54*			
6	pap A, svejse, overpap sort 1,00x10 m.	*17 ruller*			
7	pap, svejseunderlagspap 1,00x10 m.	*17 – " –*			
8	svejsestrimler 0,15x10 m.	*3 – " –*			
9	stolper til ydervæg *a 247 cm.* 2x4"	*80 stk.*	*6*		
10	vandret stræk til ydervæg 2x2"	*210 m.*	*15*		
11	rem over stolper 2x4"	*40 m.*	*4*		
12	mell.stk. over/under døre/vinduer 2x4"	*12/122 4/116 6/92 m.*	*2/65*		
13	mell.stk. til ydervæg 3/4x2"	*275 stk.*	*25*		
14	loftforskalling 1x2½"	*300 m.*			
15	mell.stk. til loftforskalling 1x2½"	*300 stk.*			
16	forankring af spær og gavle 5x5x40 cm.	*50 stk.*			
17	lægter til fastgørelse af vindpap	*70 m.*			
18	forskall. 3/4x4" fastgørel mell. spær	*30 m.*			
19	B.M.P. vindtrækbånd 2x40 mm.	*1 rulle*			
20	sokkelpap	*2½ – " –*			
21	vindpap til ydervæg og loft, i ruller.	*7 rull. 1*/papsøm			
22	plastikfolie 0,07 mm. ydervæg og loft	*3 ruller*			
23	forskalling under bjælkelag	*2~~5~~0 m.*	*260*		
24	bjælkelag pr. 0,50 m 2x8"	*60/360*			
	søm til tagplader, kamsøm 40/50	*8* pak. a 250 stk.			
	søm til stolper, skillev. og loftforsk.	*1800*/4" *4000*/3"			
	søm til vægbeklædning og gerikter	*3000*/18/35 *600*/1½ dyk.			
	søm til gulve	*1000*/3"			
	søm til isætning af vinduer og døre	*200*/4" dyk.			*Kjelly*
	søm til fodlister, samling af køkken skabe.	*400*/2" dyk.			*Dahl*

1. 1x5" [illegible] i [illegible], 35 m.
BMF. 10x90 vinkelbeslag, 20 stk.
" [illegible] til samling [illegible] – " –

Materialeliste over 2. levering til Grønland. *Hans Christian Johnsen, [illegible], 3911 Holsteinsborg* | dato: *26.8.85.*

Type: *1* | *107* m^2.

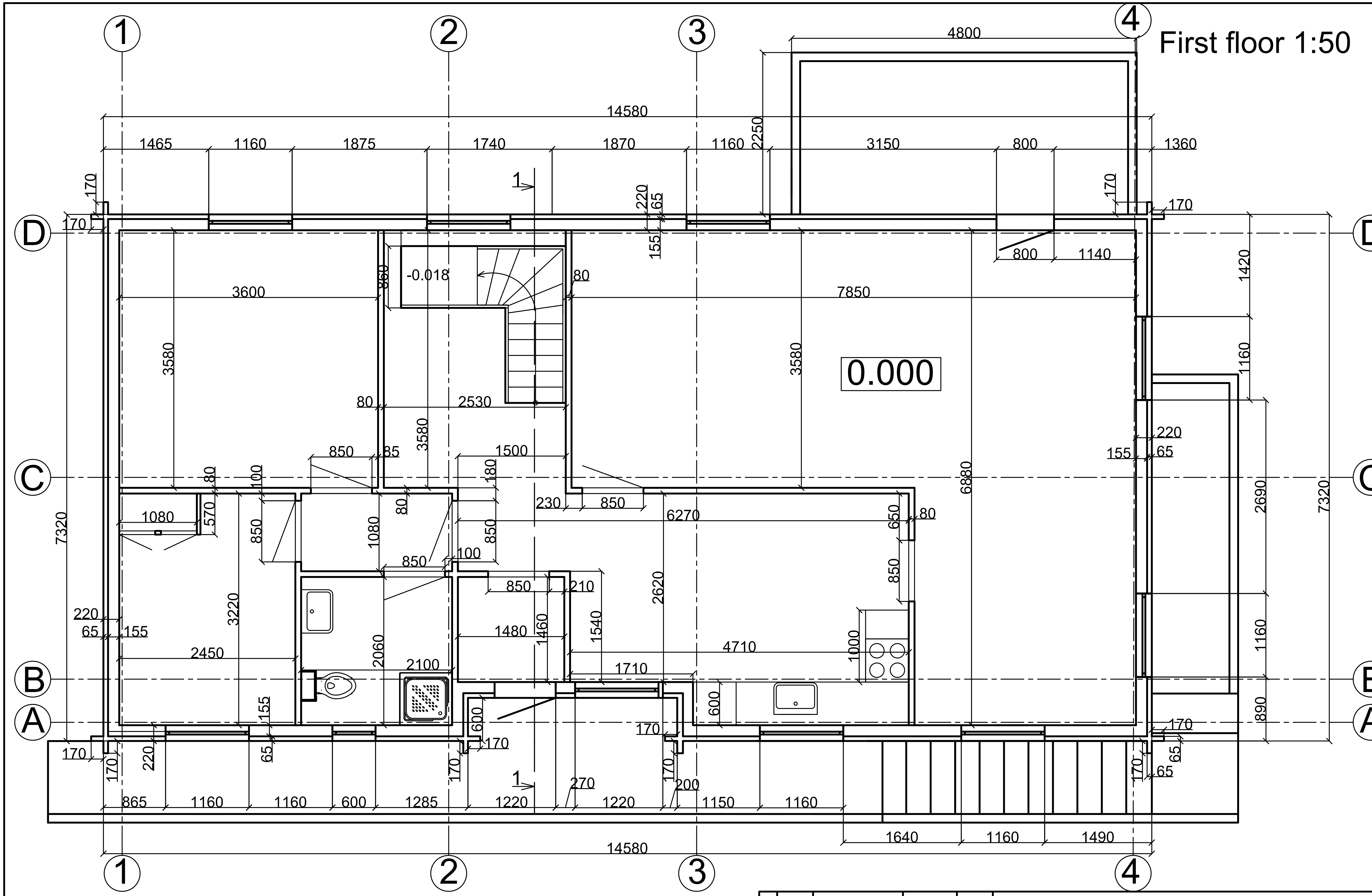
			empræg-neret		
30	skillevægsstolper 45x55x233 cm.	*84*	*20*		
31	mell.stk. skillevæg. og døroverliggere	*150 + 7/90*	*1/90* *30*		
32	lyber, over og under skillevægge	*66*	*14*		
33	isolering til skillevægge 50 mm. B.	*175*m^2 *7* pk. a 10,80 m^2			
34	isolering til ydervægge 50 mm. A.	*86*m^2 *8* pk. a 10,80 m^2			
35	isolering til ydervægge 100 mm. A.	*86*m^2 *16* pk. a 5,40 m^2			
36	isolering til loft 100 mm. A.	*108*m^2 *20* pk. a 5,40 m^2			
37	isolering til loft 100 mm. B.	*108*m^2 *20* pk. a 5,40 m^2			
38	isolering til gulv 2x100 mm. A.	*195*m^2 *36* pk. a 5,40 m^2			
39	krydsfiner til loft, 122 x 244, 9 mm.	*30 plader*			
40	krydsfiner til alle indv. vægge 9 mm.	*50 -"-*			
41	vandfast finer el. spånpl. i bad *til vægge* 9 mm.		*7*		
42	vinduer med thermoglas 180x114 cm.	*0*			
43	vinduer med thermoglas 120x114 cm.	*6*			
44	vinduer med thermoglas 63x114 cm.	*→ 1 + 2 liggende*			
45	glasklodser og gummistrimler	*50 stk. + 90 m.*			
46	saalbænke 1x3" med skruer *2/114*	*0*/180 *6*/120 *1*/63			
47	udv. dør m. rustikbekladn. 90x204 cm.	*2 = 1 H +*	*1 V. = [illegible]*		
48	udv. dør m. thermorude 90x204 cm.	*0*			
49	~~byggersdør~~ *[illegible]* med rustikbekl. 90x204 cm.	*1 V. m. glas i øverste halvdel*			
50	havedør m. thermogl. enkelt 90x204 cm.	*0*			
51	havedør m. thermogl. dobb. 130x204 cm.	*0*			
52	udvendige dørgreb *2*	/smedegreb *1* /alm.			
53	udvendige gerikter *6*/217 *0*/190	*0*/140 *22*/132 *6*/100	*5*/75		
54	tilsætninger til 22 cm. ydervæg *6*/217	*0*/190 *0*/140 *24*/132 *3*/100	*6*/75		
55	rustik til loft i vindfang	*37*/55 *0*/95			
56	loftlem	*1*			
57	værk, el. fugefilt, el. "Seco" skum,	*4 flasker*			
58	gipspl. 13 mm til bagside af ydervægge	*35 stk.*	*32.*		

Materialeliste over 3. levering til Grønland.

	Type:		m^2.	imprægneret		Dato:
60	skodder	58x125 cm.	11			
61	skodder	58x75 cm.	4			
62	skodder	62x212 cm.	0			
63	indvendige døre	90x208 cm. ~~80x208 cm.~~	8 ~~[illegible]~~ ~~[illegible]~~			
64	gulve, 22 mm spånplade m. fer og not		101 m^2 = 70 pl.			
65	lim til gulvenes fer og not, frostfri		4 flasker			
66	vindpap under gulv		5 ruller			
67	køkken med skuffebord,		0			
68	overskabe		0			
69	skabe enkelte	59x59x235 cm.	0 /h 1 /v			
70	skabe dobbelte	59x113x235 cm.	4 eg			
71	gavle	56x235 cm.	6			
72	hylder, store	54x112 cm.	8			
73	hylder, små	54x 58 cm.	5			
74	lister til samling ved skabe	235 cm.	1			
75	lister til afstivning af dobb. skabe		4 /170			
76	bøjlestanger + ophæng		4 /120 0 /60			
77	vinduesbænke, lamineret/massiv		0 /190 5 /130 0 /75			
78	hyldeknægte + skruer		12			
79	fod - og loftslister		~~110~~ + ~~110~~ –	130.	100	
80	fejelister	0 /130	19 /90 0 /80			
81	indvendige gerikter 38 /217	0 /190	0/140 24/132 19/100	6/73		
82	indvendige døgreb		8			
83	skabslåse		ja			
84	skuffegreb		ja			
85	22 mm spånplade til gulv i bad, 60 x 240,			4		
86	rustikbrædder til loftbeklædning i alt = 28 m^2 = 43 /810					
87	[illegible] til tag, [illegible] Band 4.					

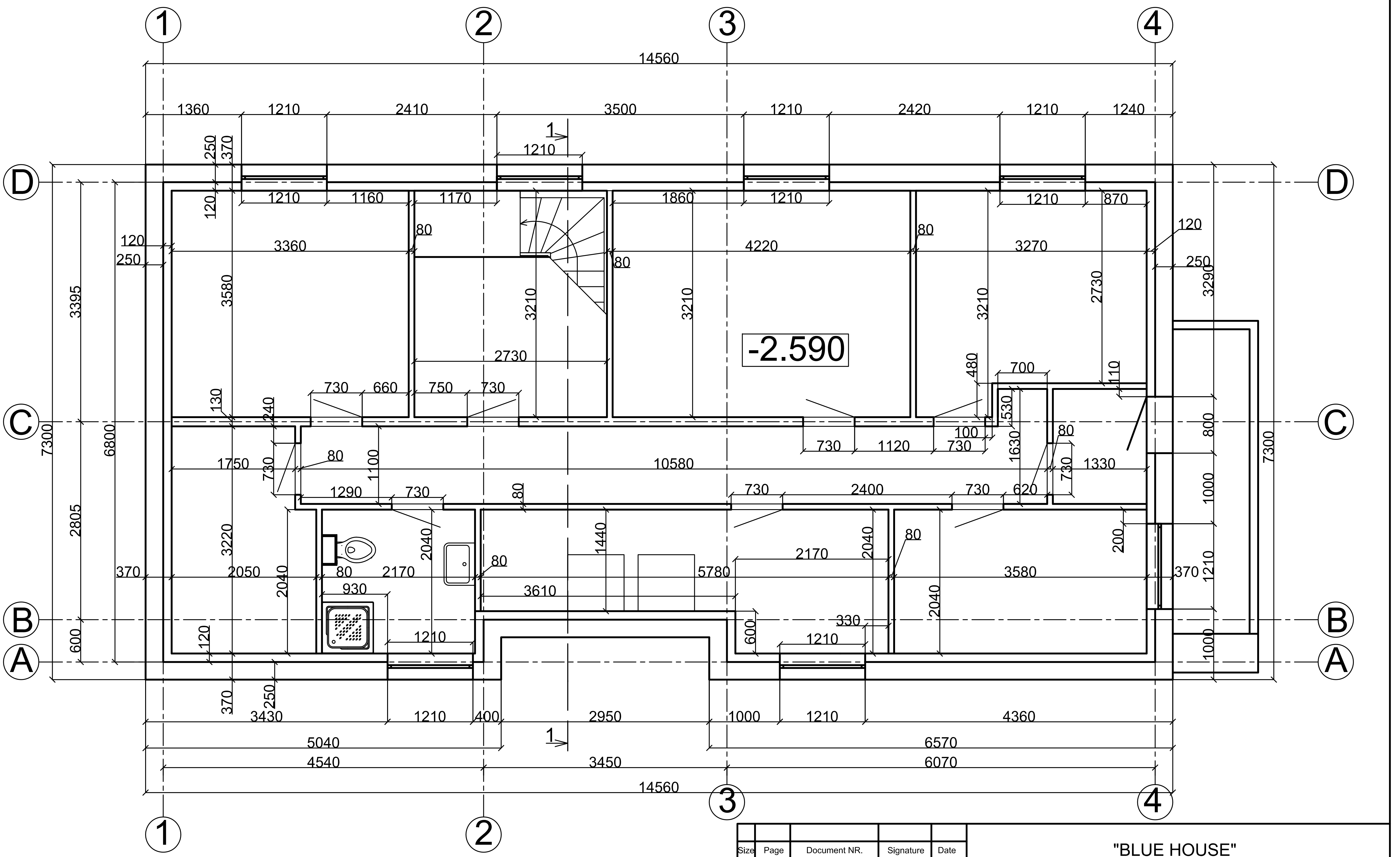
7 Stk. Side. Udluftninger (Ventiler)

First floor 1:50



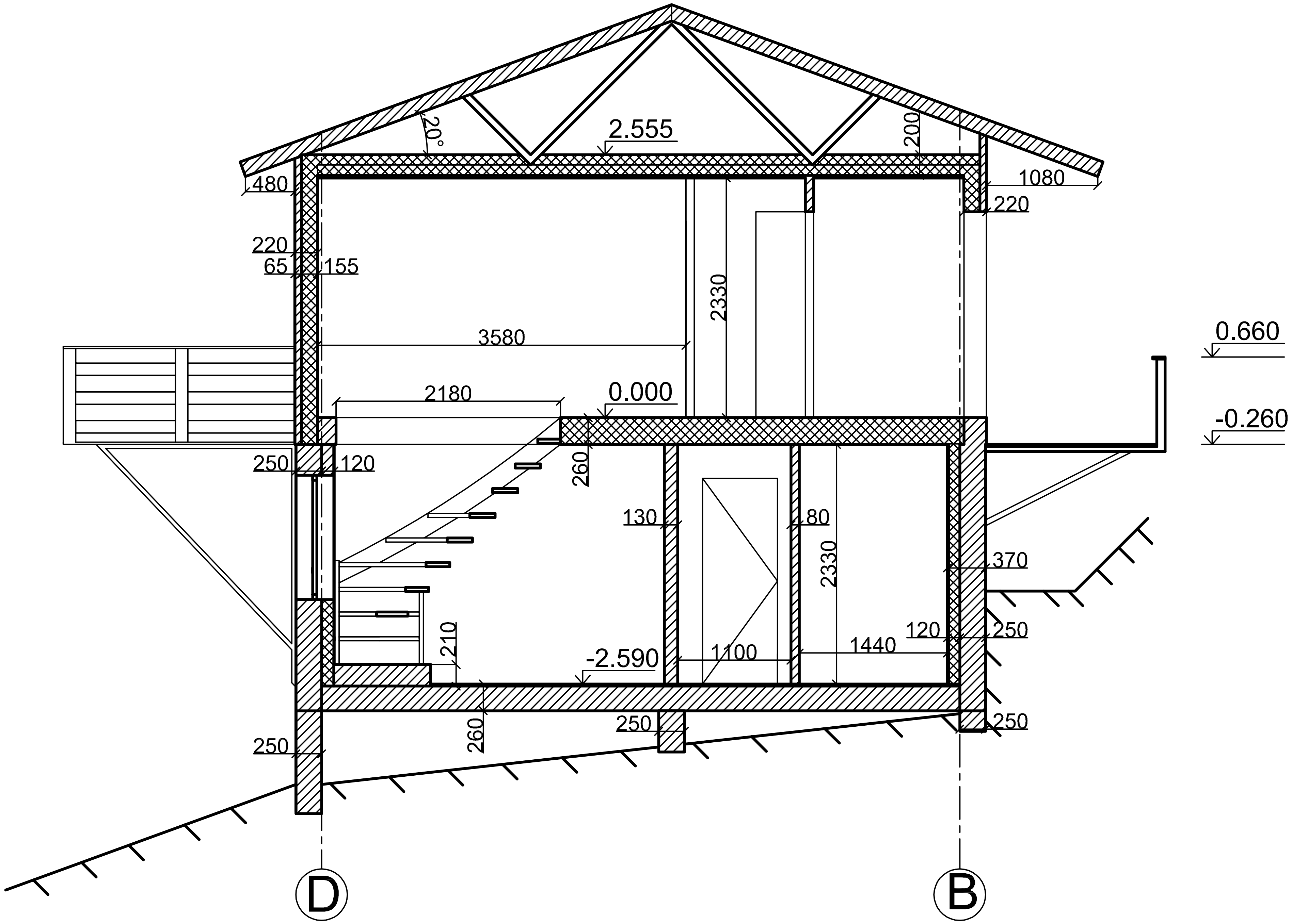
Size	Page	Document NR.	Signature	Date	"BLUE HOUSE"		
Author		Ulvis Silins			First floor	Page	Scale

Basement floor 1:50



Size	Page	Document NR.	Signature	Date	"BLUE HOUSE"		
Author		Ulvis Silins			Basement floor	Page	Scale

Section "1-1" 1:50



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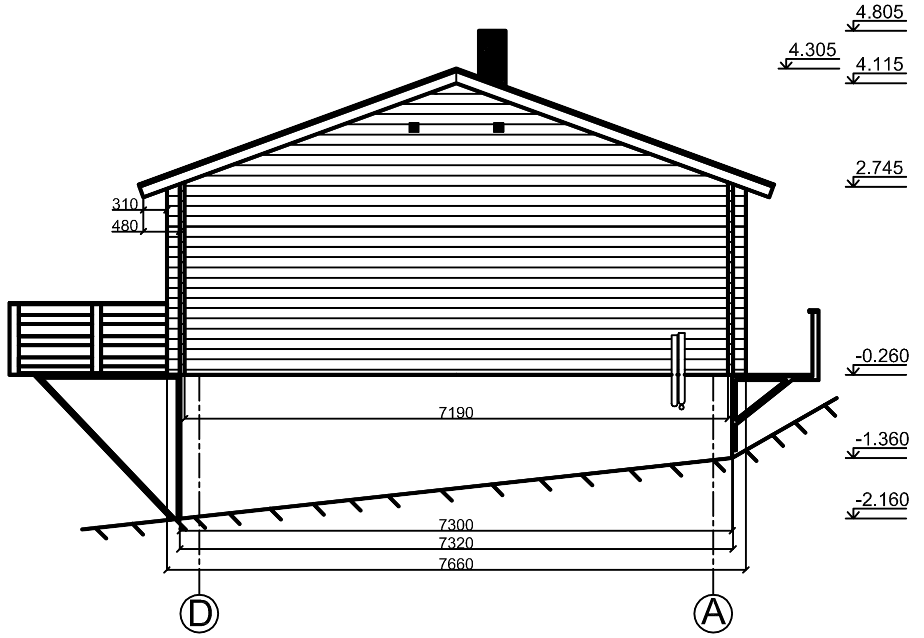
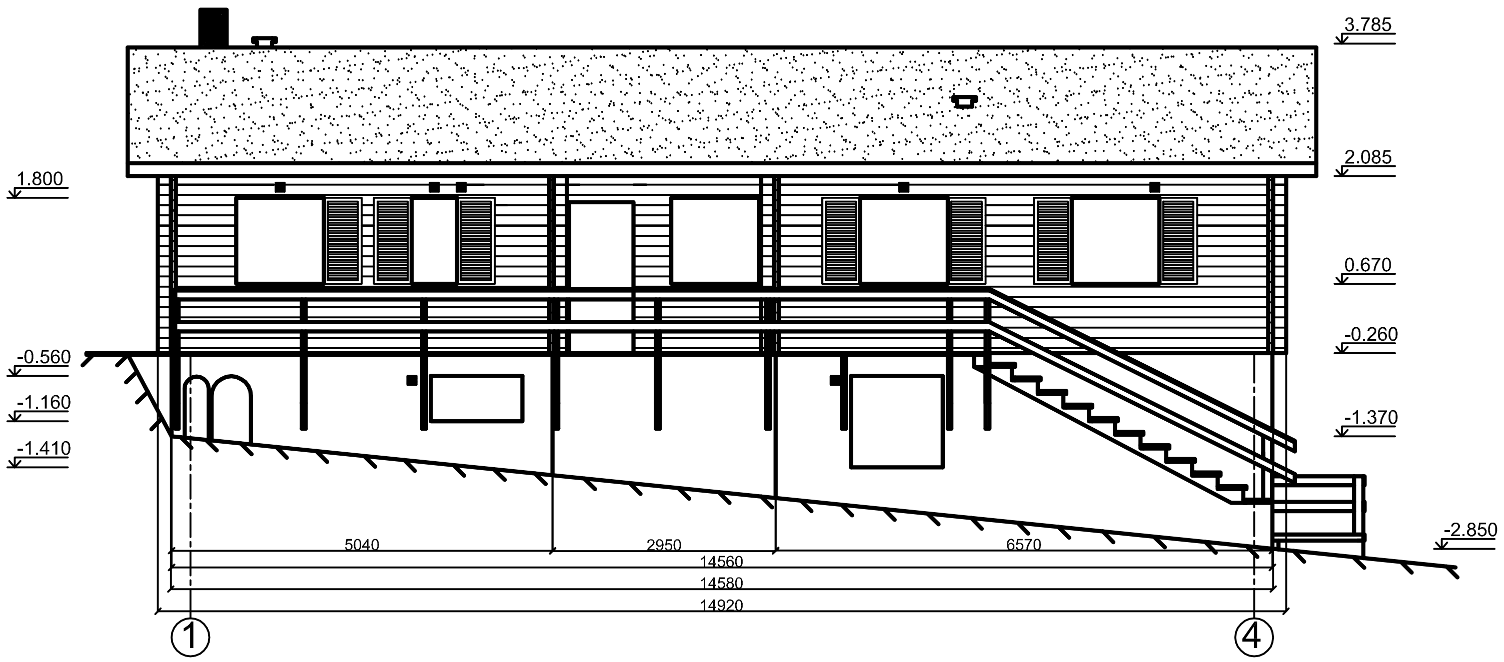
Author		Ulvis Silins				Page	Scale
					Section "1-1"		

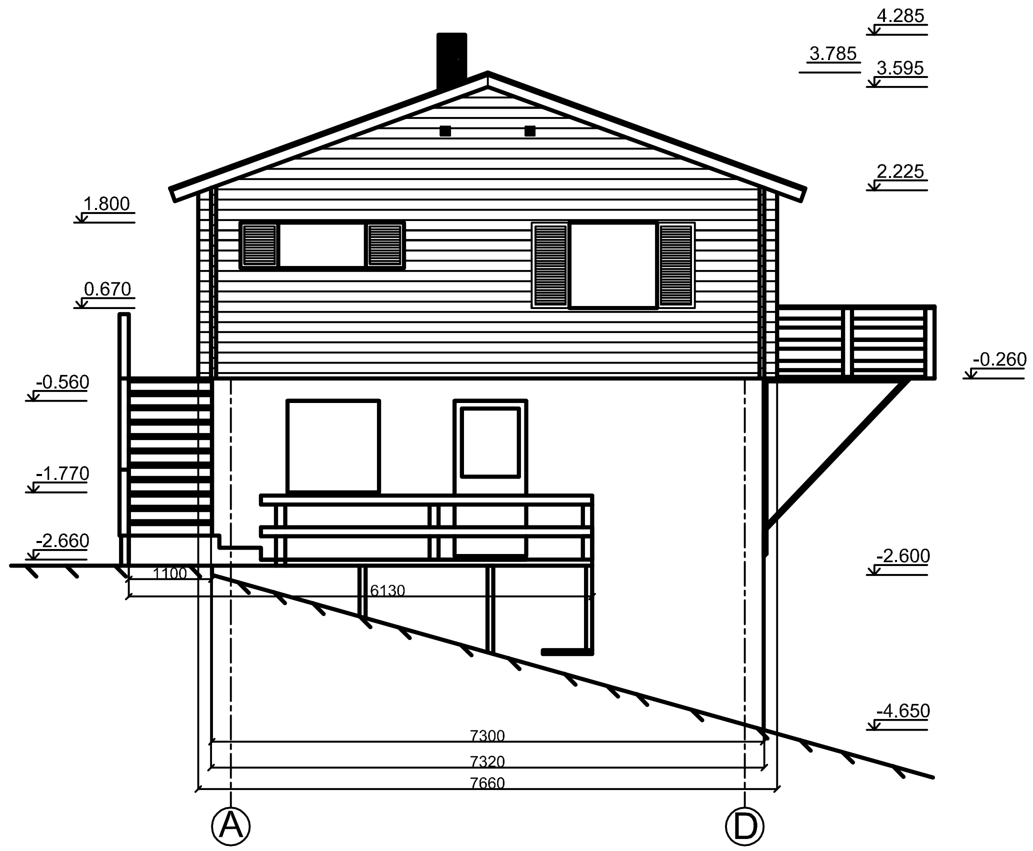
SOUTH 1:100



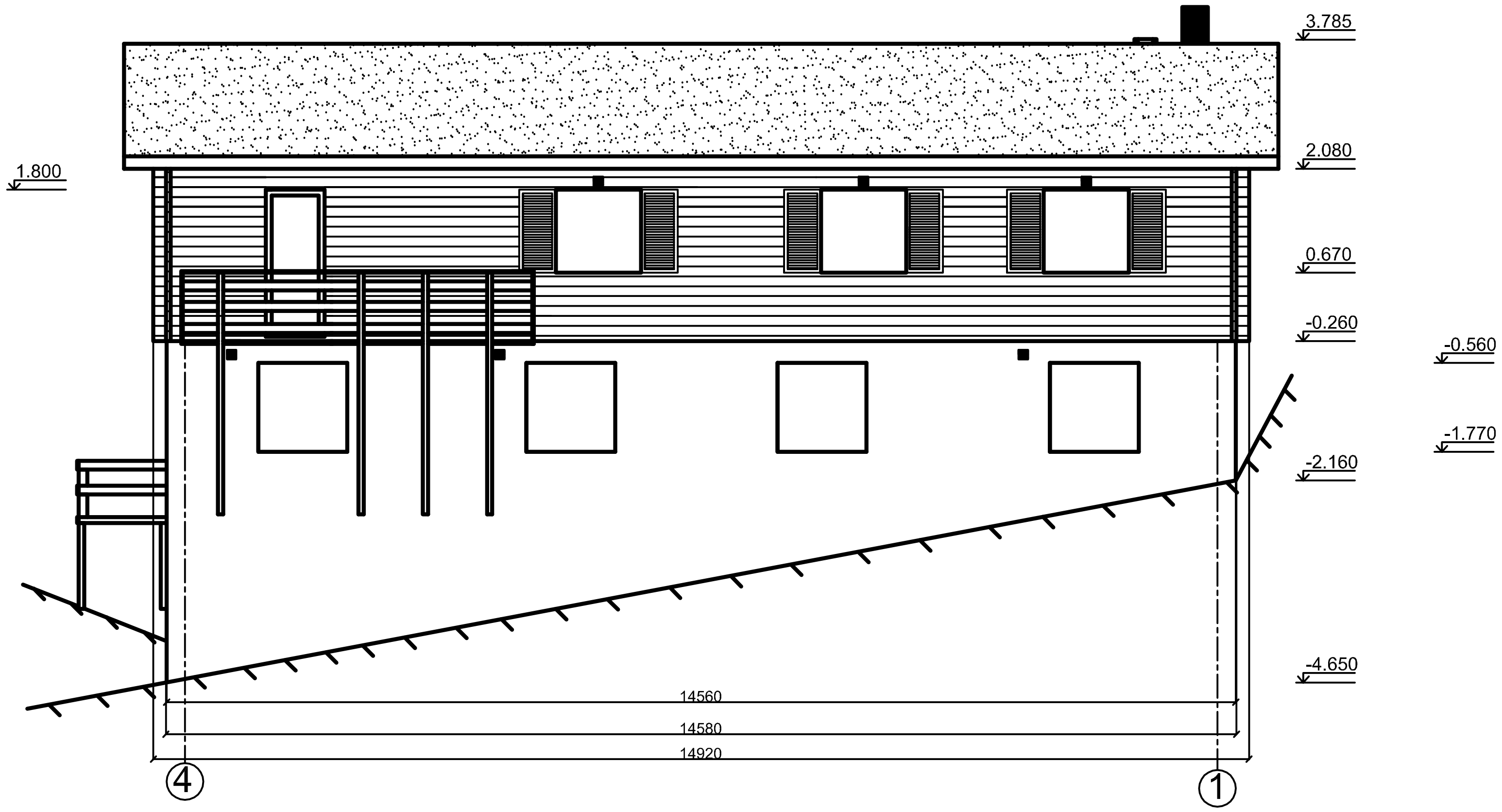
WEST 1:100



NORTH 1:100



EAST 1:100



Size	Page	Document NR.	Signature	Date	"BLUE HOUSE"		
Author		Ulvis Silins			Facades	Page	Scale

Danmarks Tekniske Universitet
e-mail: mrko@byg.dtu.dk
GL mobil: 487 533

Ilitsersuut / *Instruktioner*

- -Akissutissat eqqortoq krydsiliiffigiuk: ☒
  Sæt kryds i boksen udfor det ønskede svar:
- -Kukkuguit kukkusat titaruk taavalu eqqortoq krydsilerlugu:
  I tilfælde af forkert afkrydsning, fyld boksen helt ud foran det forkerte svar, og sæt kryds ud for det ønskede svar:
  Kukkuneq *Fejl* ■ — Eqqortoq *Korrekt svar* ☒
- -Allakkuit NAQINNERIT ANGISUUT atukkit.
  Skriv venligst med BLOK BOGSTAVER.
- -Nalunaarutigineqanngippat akissut ataasiinnaq toqqaruk.
  Hvis ikke andet er opgivet, så vælg kun et svar.
- -Pingaarutilimmik apeqqutissaqaruit attavigitigut.
  Hvis du har spørgsmål, så tøv ikke med at kontakte os.
- -Akissuteqarnikkut kukkussutissaqanngilatit, taamaallaat illit isummat naapertorlugu eqqorsorisat toqqaannassavat.
  Der er ingen rigtige eller forkerte svar. Vælg det svar, som bedst repræsenterer din holdning.

Immikkoortoq 1 - Najukkap ilisarnaatai / *Del 1 - Bolig karakteristika*

Q1.1 Qanoq ittumi najugaqarpit? / *Hvilken type bolig bor du i?*

Illumi *Parcelhus*	Illut uiguleriit *Dobbelthus*	Illu uiguleriiaat ilaat *Rækkehus*	Inissiaq *Lejlighed*	Alla *Andet*
☒	☐	☐	☐	☐

Q1.2 Najugat qassinik sinittarfeqarpa aammalu isersimaartarfeqarpa?
Hvor mange soveværelser og stuer findes der i din bolig?

1	2	3	4	5	>5
☐	☐	☐	☐	☒	☐

Q1.3 Najukkat qanga sananeqarpa? / *Hvornår blev din bolig opført?*

1960-i sioqqullugu *Før år 1960*	1960 - 1970	1970 - 1980	1980 - 1990	1990 - 2000	2000-ip kingorna *Efter år 2000*	Naluara *Ved ikke*
☐	☐	☐	☒	☐	☐	☐

Q1.4 Najukkat kimit pigineqarpa?/ *Hvem ejer den bolig du bor i?*

Uanga *Det gør jeg*	Inuup allap *Anden privatperson*	Kommune-p *Kommunen*	Namminersorlutik Oqartussat *Selvstyret*	Alla *Andet*	Naluara *Ved ikke*
☐	☐	☒	☐	☐	☐

Immikkoortoq 2 - Najugallit / *Del 2 - Beboere*

Q2.1 Qanoq amerlatigisut najukkanni najugaqarpat (illit ilanngullutit):
Hvor mange personer bor der i din bolig (inklusiv dig selv):

	0	1	2	3	4	5	6	7	Arfineq marluk sinnerlugit *Mere end 7*
Inersimasut (18 - 60 ukiullit) / *Voksne (18-60 år)*	☐	☐	☒	☐	☐	☐	☐	☐	☐
Meeqqat (3 - 18 ukiullit) / *Børn (3-18 år)*	☐	☒	☐	☐	☐	☐	☐	☐	☐
Meeraaqqat (0 - 3 ukiullit) / *Spædbørn (0 - 3 år)*	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utoqqaat (60-it sinnerlugit ukiullit) / *Ældre mennesker (Over 60 år)*	☐	☐	☐	☐	☐	☐	☐	☐	☐
Angutit qassit / *Antal hankøn?*	☐	☐	☐	☐	☐	☐	☐	☐	☐
Arnat qassit / *Antal hunkøn?*	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q2.2 Illit najukkanni najugallit qassit illup iluani pujortartarpat?
Hvor mange beboere i din bolig, ryger indendørs i din bolig?

0	1	2	3	4	5	6	7	Arfineq marluk sinnerlugit *Mere end 7*
☒	☐	☐	☐	☐	☐	☐	☐	☐

Immikkoortoq 3 - Ileqqut / *Del 3 - Vaner*

Q3.1 Atortut taaneqartut qanoq akulikitsigisumik suliassanut taaneqartunut atatillugit atortapigit?
Hvor ofte bruger du følgende apparater, når du laver de følgende aktiviteter?

	Tamatigut *Altid*	Tamatigungajak *Næsten altid*	Ilaatigut *Nogen gange*	Qaqutigut *Næsten aldrig*	Atorneq ajorpara *Aldrig*	Atortorissaarut piginngilara *Jeg har ikke dette apparat*
Aalap milluaasua - **Iganermi** *Emhætte - **Under madlavning***	☒	☐	☐	☐	☐	☐
Igap matua - **Iganermi** *Grydelåg - **Under madlavning***	☐	☒	☐	☐	☐	☐
Uffarfimmi silaannamik milluaasoq (silaannarissaat) - **Uffarnermi** *Udsugning fra badeværelse - **Når du tager et bad***	☒	☐	☐	☐	☐	☐
Igalaaq ammasoq - **Uffarnermi** *Åbner vinduet på badeværelset - **Når du tager et bad***	☐	☐	☐	☒	☐	☐
Erruissut - **Erruinermi** *Opvaskemaskine - **Når du vasker op***	☐	☒	☐	☐	☐	☐

Q3.2 Piffissaq **Ullormut** qanoq annertutigisoq ukununnga suliassanut atortarpiuk?
*Hvor meget tid bruger du **hver dag** på de følgende aktiviteter?*

	0 - 30 min.	30 - 60 min.	60 - 90 min.	90 - 120 min.	120 - 150 min.	150 - 180 min.	180 minuttit sinnerlugit *Mere end 180 minutter*
Iganermut / *Madlavning*	☐	☒	☐	☐	☐	☐	☐
Iffiornermut / *Bagning i ovnen*	☒	☐	☐	☐	☐	☐	☐

Q3.3 Qanoq ilillutit atisanik panersiinerusarpit - **aasami ukiumilu** ?
Hvordan tørrer du oftest dit vasketøj om sommeren og om vinteren?

	Silami *Udenfor*	Panersiivimmi *I tørretumbleren*	Najukkap iluani *Ophæng i eget beboelsesrum*	Ini panersiinermut atugassiaq *I et fælles tørrerum*	Alla *Andet*
Aasakkut / *Om sommeren*	☒	☐	☐	☐	☐
Ukiukkut / *Om vinteren*	☐	☒	☒	☐	☐

Q3.4 Ukunani **AASAKKUT** sorliit qanoq akulikitsigisumik iliuuserisarpigit?
*Hvor ofte gør du det følgende om **SOMMEREN?***

	Ullormut arlaleriarluni *Flere gange om dagen*	Ullormut ataasiarluni *En gang om dagen*	Sapaatip akunneranut arlaleriarluni *Flere gange om ugen*	Sapaatip akunnerani ataasiarlunga *En gang om ugen*	Qaammammut arlaleriarlunga *Flere gange om måneden*	Qaammammut ataasiarlunga ataallugulunniit *En gang om måneden eller mindre*	Naluara *Ved ikke*
Igalaaq ammarlugu/matullugu *Åbner / lukker vinduer*	☒	☐	☐	☐	☐	☐	☐
Kiappallaaraangat saagorluni/saaguerluni *Trækker gardiner for/fra fordi det er for varmt.*	☐	☐	☒	☐	☐	☐	☐
Silaannarissaat ikillugu/qamillugu *Tænder/slukker en bord- eller gulvventilator*	☐	☐	☐	☐	☐	☐	☒
Errorsineq *Vasker tøj*	☐	☐	☒	☐	☐	☐	☐
Uffarneq	☐	☐	☒	☐	☐	☐	☐

Q3.5 Ukunani **UKIUKKUT** sorliit qanoq akulikitsigisumik iliuuserisarpigit?

*Hvor ofte gør du det følgende om **VINTEREN**?*

	Ullormut arlaleriarluni *Flere gange om dagen*	Ullormut ataasiarluni *En gang om dagen*	Sapaatip akunneranut arlaleriarluni *Flere gange om ugen*	Sapaatip akunnerani ataasiarlunga *En gang om ugen*	Qaammammut arlaleriarlunga *Flere gange om måneden*	Qaammammut ataasiarlunga ataalluguluunniit *En gang om måneden eller mindre*	Naluara *Ved ikke*
Igalaaq ammarlugu/matullugu *Åbner / lukker vinduer*	☒	☐	☐	☐	☐	☐	☐
Kiassaat inissillugu *Justerer radiatoren*	☐	☐	☐	☐	☒	☐	☐
Errorsineq *Vasker tøj*	☐	☐	☒	☐	☐	☐	☐
Uffarneq *Tager et bad*	☐	☐	☒	☐	☐	☐	☐

Immikkoortoq 4 - Illup iluata silaannaa aamma pissutsit

Del 4 - Indeklima og præferencer

Q4.1 Ukunani sorliit najukkanni misigisarpigit aammalu qanoq akulikitsigisumik?

Hvilket af det følgende oplever du i din bolig og hvor ofte?

	Akulikitsuaqqamik *Meget ofte*	Akulikitsumik *Ofte*	Akulikippallaanngitsumik *Ikke så ofte*	Qaqutsikkut *Næsten aldrig*	Misigineq ajorpara *Aldrig*	Naluara *Ved ikke*
Oquk/aaneq *Mug/svamp*	☐	☐	☐	☐	☐	☒
Sueq *Koldt træk*	☒	☐	☐	☐	☐	☐
Nateq nillertoq *Koldt gulv*	☒	☐	☐	☐	☐	☐
Nipiliorneq silamit sanilinilluunniit *Støj udefra eller fra dine naboer*	☐	☒	☐	☐	☐	☐
Aasaakkut kiappallaartoq *For varmt om sommeren*	☐	☒	☐	☐	☐	☐
Ukiukkut nillerpallaartoq *For koldt om vinteren*	☐	☒	☐	☐	☐	☐
Najukkap iluani ullukkut qaamanikippallaartoq *For lidt dagslys i boligen.*	☐	☐	☐	☒	☐	☐
Igalaat ukiukkut aalartut *Kondensation på vinduer om vinteren.*	☐	☒	☐	☐	☐	☐
Peqqinnermut ajoqutit aatsaat angerlarsimagaagavit misigisartakkat (niaqorlunneq, kakkilertaneq, ameq panertoq, qasuneq allallu assingusut) *Helbredsproblemer, du kun oplever når du er hjemme (hovedpine, næse der løber, tør hud, træthed, etc.)*	☐	☒	☐	☐	☐	☐

Najukkanni allanik ajortoqarpat oqaatigerusutarnik taava uunga allakkit

Hvis der er andre problemer i din bolig, som du gerne vil nævne, så benyt venligst dette felt.

Q4.2 Uku qanoq akulikitsigisumik eqqarsaatigisarpigit?

Hvor ofte tænker du på det følgende?

	Tamatigut *Jeg tænker altid på det*	Akulikitsuaqqamik *Meget ofte*	Akulikitsumik *Ofte*	Akulikippallaanngitsumik *Ikke så ofte*	Eqqarsaatigineq ajorpara *Aldrig*	Naluara *Ved ikke*
Qanoq akulikitsigisumik kiassarnermut akiligassat eqqarsaatigisarpiuk illup iluata kiassusaa inissikkaagakku *Hvor ofte tænker du på varmeregningen, når du indstiller indendørstemperaturen?*	☐	☒	☐	☐	☐	☐
Qanoq akulikitsigisumik kiassarnermut akiligassat eqqarsaatigisarpiuk ukiukkut igalaat ammaraagakkit *Hvor ofte tænker du på varmeregningen, når du åbner vinduerne om vinteren?*	☐	☒	☐	☐	☐	☐
Qanoq akulikitsigisumik ilaquttavit peqqissusaat eqqarsaatigisarpiuk illup iluata kiassusaa inissikkaangakku? *Hvor ofte tænker du på dit/din families helbred, når du indstiller indendørstemperaturen?*	☐	☐	☒	☐	☐	☐
Qanoq akulikitsigisumik ilaquttavit peqqissusaat eqqarsaatigisarpiuk ukiukkut igalaat ammaraagakkit? *Hvor ofte tænker du på dit/din families helbred, når du åbner vinduerne om vinteren?*	☐	☐	☒	☐	☐	☐

Q4.3 Najukkanni uku qanoq misigisarpigit? / *Hvordan oplever du de følgende forhold i din bolig?*

	Ajungaatsiarpoq *Meget dårligt*	Ajorpoq *Dårligt*	Sullunarpoq *Ringe*	Ajorpianngilaq *Lidt godt*	Ajunngilaq *Godt*	Ajunngitsorujussuuvo *Meget godt*
Illu iluata kiassusaa / *Termiske forhold / Indendørs temperatur*	☐	☒	☐	☐	☐	☐
Silaannap pitsaassusaa / *Luftkvalitet*	☐	☐	☒	☐	☐	☐
Nipinut tunngasut / *Lydforhold*	☐	☒	☐	☐	☐	☐
Illup iluata silaannaa tamaat / *Generelt indeklima*	☐	☐	☒	☐	☐	☐

Q4.4 Takorlooruk **UKIUUSOQ** taavalu najukkat kiappallaarluni. Sussagaluarpit?

*Forstil dig det er **VINTER**, og du har alt for varmt inde i den bolig? Hvad vil du gøre?*

Igalaaq ammarlugu *Åbne vinduet*	Kiassaat inissillugu *Justere radiatoren*	Nillertumik imerlutit *Drikke noget koldt*	Inissisimanerit allanngortillugu *Skifter stilling*	Atisat taarserlugit *Skifte tøj*	Inimut allamut nuullutit *Går ind i et andet rum*	Naluara *Ved ikke*
☐	☒	☐	☐	☐	☐	☐

Q4.5 Takorlooruk **UKIUUSOQ** taavalu najukkat nillerpallaarluni. Sussagaluarpit?

*Forstil dig det er **VINTER**, og du har det for koldt inde i din bolig? Hvad vil du gøre?*

Kiassaat inissillugu *Justere radiatoren*	Kissartutorlutit *Drikke noget varmt*	Inissisimanerit allanngortillugu *Skifter stilling*	Atisat taarserlugit *Skifte tøj*	Inimut allamut nuullutit *Går ind i et andet rum*	Naluara *Ved ikke*
☐	☐	☐	☒	☐	☐

Q4.6 Uku qanoq ilinnut pingaaruteqartigippat najukkanni periafissaanissaat?

Hvor vigtigt er det for dig at have de følgende muligheder i din bolig?

	Pingaartorujussuuvoq *Meget vigtigt*	Pingaarpoq *Vigtigt*	Pingaarpallaanngilaq *Mindre vigtigt*	Pingaanngilaq *Ikke vigtigt*	Naluara *Ved ikke*
Igalaamik ammaasinnaaneq/matusisinnaaneq *At have mulighed for at åbne/lukke vinduer*	☐	☒	☐	☐	☐
Silaannaap aalarnerata maluginneqarsinnaanera *At mærke luftbevægelsen indendørs*	☐	☐	☐	☐	☒
Silaannarissarsinnaaneq sueq isaatinnagu *At kunne få frisk luft uden koldt træk*	☒	☐	☐	☐	☐
Silaannarissarsinnaaneq nillertinnagu *At kunne få frisk luft ind uden at det bliver for koldt*	☒	☐	☐	☐	☐
Silaannarittuarneq - silaannarisarfikkut *At altid kunne få frisk luft fra ventilationsanlægget*	☐	☒	☐	☐	☐
Silaannarissarsinnaaneq nipi isaatinnagu	☒	☐	☐	☐	☐

Immikkoortoq 5 - Aserfattaaliineq / Del 5 - Vedligeholdelse

Q5.1 Takorlooruk aningaasanik 200.000 kr-nik najukkannut iluarsartuussutissanik tunissutissillutit. Pisiassaq **ataaseq** toqqaruk aningaasanik atuiffiginiakkat.

Forestil dig at du får en donation på 200.000 DKK til at forbedre din bolig. Vælg venligst én ting, som du ville bruge pengene på.

Højtalerit nutaat *Nyt Hi-fi udstyr*	Isiginnaarut nutaaq *Nyt TV*	Pequtit nutaat *Nye møbler*	Silaannarissaat nutaaq *Nyt ventilationssystem*	Seqernup kissaanit nukiliuutit *Nye solpaneler*
☐	☐	☐	☐	☐
Igaffik nutaaq *Nyt køkken*	Uffarfik nutaaq *Nyt badeværelse*	Igalaat nutaat *Nye vinduer*	Qaliaq nutaaq *Nyt tag*	Alla *Andet*
☐	☐	☐	☐	☐

Q5.2 Qanoq ajornanngitsigiva paasiniassallugu qanoq teknikkikkut atortorissaarutit (silaannarissaatit, kissarsuut, kiassaatit) najukkanni atorneqarsinnaasut taavalu atorluarneqarsinnaanersut?

Hvor nemt er det at forstå hvordan de tekniske installationer (ventilation, fyr, radiator) fungerer i din bolig, og hvordan man kan udnytte dem bedst?

Nalunanngitsorujussuuvoq *Meget nemt*	Nalunanngilaq *Nemt*	Nalunarpoq *Svært*	Nalunartorujussuuvoq *Meget svært*	Naluara *Ved ikke*
☐	☐	☒	☐	☐

Q5.3 Isumaqarpit najukkanni atortorissaarutit (silaannarissaatit, kiassaatit allallu assingusut) atornissaanut siunnersuunneqartuuguvit ilitsersuunneqarlutillu iluaqutigissagit?

Tror du at du vil få gavn af at få råd og vejledning i at benytte de forskellige systemer (ventilation, opvarmning, etc.) i din bolig?

Aap *Ja*	Naamik *Nej*	Naluara *Ved ikke*
☒	☐	☐

Q5.4 Qaammammut qanoq annertutigisumik innaallagissamut akiliisarpit?

Hvor meget betaler du hver måned for elektricitet?

250 kr-nit ataallugit *Mindre end 250 kr*	250 - 500 kr	500 - 750 kr	750 - 1000 kr	1000 - 1250 kr	1250 - 1500 kr	1500 - 1750 kr	1750 kr-nit sinnerlugit *Mere end 1750 kr*	Naluara *Ved ikke*
☐	☐	☐	☐	☒	☐	☐	☐	☐

Immikkoortoq 6 - Oqaaseqaatit / *Del 6 - Kommentarer*

Q6.1 Najukkannut allanut tunngasunik oqaaseqaatissaqaruit (arlaannik iluaagisaqaruit iluarisaqaruilluunniit), uunga allaguk:

Hvis du har yderligere kommentarer omkring din bolig (noget der er irriterende, eller som du værdsætter), så skriv det i det følgende felt:

\+ God udsigt
Godt dagslys

÷ Huset har en opsamlingsbrønd til smelte/regnvand
Har for få stikkontakter
Gulvene knirker

Qujanaq immersugassaq immersorakku!
Immersuisimasut tunniussisimasullu tamarmik **3x 1000 kr-nik** makitsinermut peqataatinneqassapput.
Tak fordi du udfyldte dette skema!
*Der vil blive udtrukket **3x1000 DKK** i præmie imellem alle deltagere som udfylder og afleverer skemaet.*

Eqquissagaluaruit attavigissagutsigit, minnerpaamik ukunani ataaseq immersoruk:
For at kunne kontakte dig, i tilfælde af at du vinder, udfyld mindst et af de følgende felter:

MALUGIUK: *Paasissutissat allanut* ***ATORNEQARNAVIANNGILLAT.***
BEMÆRK: Disse data vil IKKE blive brugt til andre formål.

Najugaqarfik / *Adresse* .... Qajaasat 19
3911 Sisimiut

Oqarasuaatip normua / *Telefonnummer* .... +299 522507

E-mail .... axol@qeqqata.gl

Misissuinerup tullissaanut peqataarusuppit? Tassani najugaqartut 80-it toqqarneqariarlutik ukiumi sapaatip akunnera ataaseq aasamilu sapaatip akunnera ataaseq najukkami uuttortaanermut peqataatinneqassapput.
Kunne du eventuelt tænke dig at deltage i en opfølgning på dette forskningsprojekt, hvor ca. 80 boliger vil blive udvalgt til at få udført indeklima målinger i en uge om sommeren, og en uge om vinteren.

Misissuinermut tullinnguuttumut peqataasut misissuinermi inernerit **AKEQANNGITSUMIK** pissavaat. Taakkunani pineqarput illup silaannaata pitsaassusaa taavalu qanoq pitsaanerulersinnaanera, innaallagissamik atuineq annikillineqarsinnaaneralu kiisalu illup kiaffiisa nalunaarsornerat(Termografiske billeder).
Deltagerne i denne opfølgning, vil modtage en individuel rapport for deres bolig, med luftkvalitetsevaluering, energievaluering og termografiske billeder GRATIS!

Peqataaqqittunut **3x 1000 kr-nik** makitsisoqaqqissaaq.
Der vil også blive udtrukket 3x1000 DKK iblandt deltagende boliger i denne opfølgning

Aap, peqataarusuppunga aammalu najugaqarfiga paasisaqarfigerusuppara .... ☒
Ja, jeg vil gerne deltage og få et bedre overblik over min bolig.

Naamik, peqataarusunngilanga. .... ☐
Nej, jeg vil ikke deltage.

Malugiuk: *Apeqummut kingullermut* ***AAPPEERSIMAGUIT***, *eqqaamajuk attaviginninneqarnissamut paasissutissat ilanngunnissai, paasissutissanik tuneqqinniassagatsigit.*
Bemærk: *Hvis dit svar til det sidste spørgsmål er JA (hvilket vi sætter pris på!), så husk venligst at opgive dine kontaktoplysninger, så vi kan informere dig yderligere om opfølgningen.*

ANNEX F – BLOWER-DOOR TEST

1 Depressurization (sealed, "Method B")

Building Details

Building Address: Qajasat 19, B-1158, Sisimiut, Greenland

Test technician: **Ulvis Silins**
Test company: **DTU**

Elevation: **37 m**
Height above ground: **7.5 m**
Building Volume, V: **453.9 m³**
Total envelope area, $A_{T\ BAT}$ **382 m²**
Floor Area: **183.8 m²**
Building exposure to wind:
Accuracy of measurements: **100%**

Testing Details

Fan Model: **Retrotec 2000**	Fan SN:	Gauge Model: **DM-2**	Gauge SN: **202276**

Depressurize set

Date: **2011-08-08** Time: **15:27** to **15:45**

Environmental Conditions:

Barometric Pressure:**100.9** KPa from **Elevation**. **37**

Wind speed: **3: Gentle breeze**

Temperature: Initial: indoors **23 °C** outdoors **14 °C**.
Final: indoors **23 °C** outdoors **14 °C**.

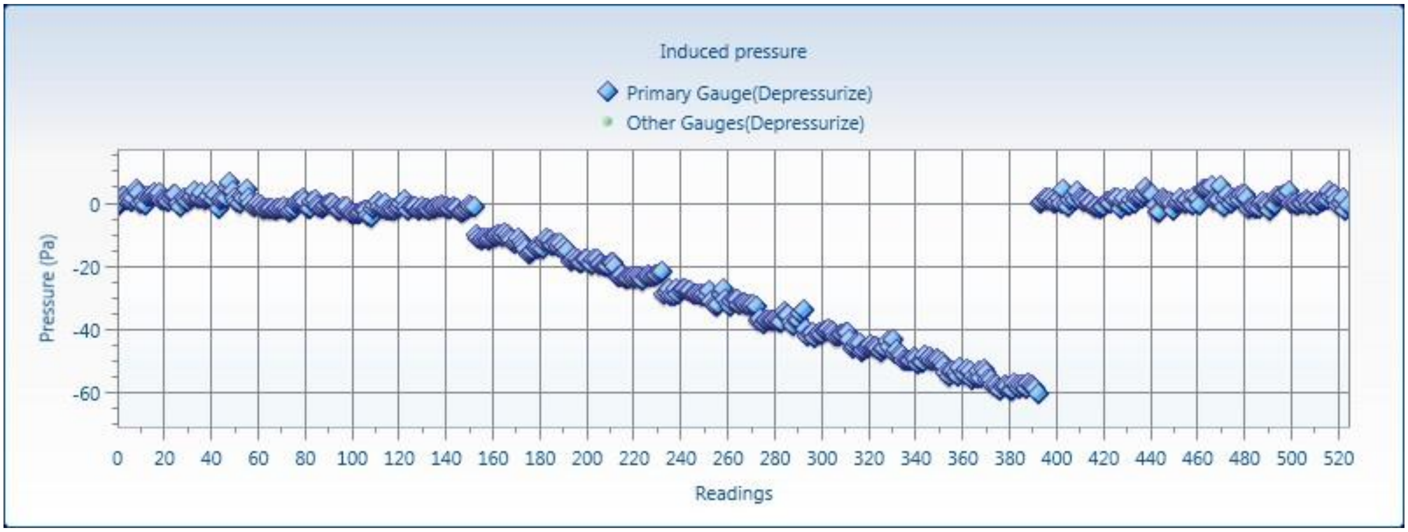
Test Data:

12Baseline pressures taken for **10** sec each.
12 building pressures taken for **20** sec each.

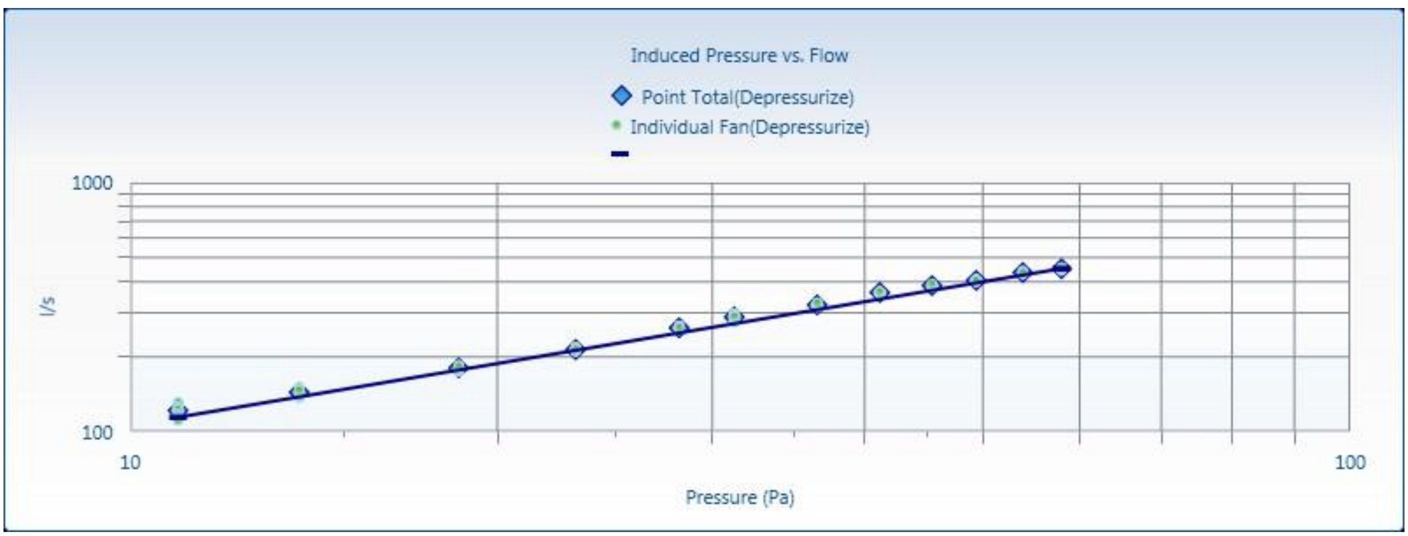
Baseline, initial [Pa]	1.29	2.24	1.48	2.52	0.59	-1.81	-0.09	-1.29	-2.22	-1.19	-1.42	-1.62
Building Test Pressure [Pa]	-10.9	-13.8	-18.6	-23.2	-28.2	-31.3	-36.6	-41.2	-45.4	-49.4	-53.9	-58.0
Baseline, final[Pa]	1.14	1.12	-0.13	0.78	1.33	0.21	2.68	1.93	-0.71	1.29	0.24	1.02
Door Fan Pressure, [Pa]	17.8	24.7	38.4	53.4	78.9	95.8	119.2	148.5	168	184.3	212	226.6
Total flow, V_r[l/sec]	121.8	144.1	180.7	213.9	261.5	288.8	323.2	362.2	386.0	405.0	435.6	450.9
Corrected flow, V_{env}[l/sec]	118.9	140.7	176.4	208.8	255.2	281.9	315.5	353.5	376.8	395.3	425.2	440.1
Error [%]	1.0%	-0.5%	-2.0%	-3.0%	1.2%	2.7%	1.2%	3.0%	1.3%	-0.7%	-0.7%	-3.1%

Baseline pressure Averages: initial [Pa] ΔP_{01} **-0.13**, ΔP_{01-} -1.38, ΔP_{01+} **1.62**
final [Pa] ΔP_{01} **0.91**, ΔP_{01-} **-0.42**, ΔP_{01+} **1.17**

Building Gauge Pressure



Building Gauge Pressure vs. Flow



Depressurize Test Results

	Results		
Correlation, r [%]	**99.89**	95% confidence limits	
Intercept, C_{env} [l/s.Pa^n]	**15.95**	**14.55**	**17.50**
Intercept, C_L [l/s.Pa^n]	**16.01**	**14.60**	**17.60**
Slope, n	**0.8234**	**0.7965**	**0.8503**

	Results	95% confidence		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**401.0**	**393.5**	**409.0**	**+/-0.0190**
Air changes at 50 Pa, n_{50} [/h]	**3.180**	**0.002590**	**6.361**	**+/-0.9992**
Permeability at 50 Pa, q_{50} [l/s.m²]	**1.050**	**0.001**	**2.100**	
Specific Leakage at 50 Pa, w_{50} [l/s.m²]	**2.183**	**0.002**	**4.365**	**+/-0.9992**

Combined Test Data	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**401.0**	**393.5**	**409.0**	**+/-0.0190**
Air changes at 50Pa, n_{50} [/h]	**3.180**	**0.002590**	**6.361**	**+/-0.9992**
Permeability at 50 Pa, q_{50} [l/s.m²]	**1.050**	**0.001**	**2.100**	**+/-1.0000**
Specific leakage at 50 Pa, w_{50} [l/s.m²]	**2.183**	**0.002**	**4.365**	**+/-0.0190**

Test Notes:(add notes here)

Calibration Certificate

Retrotec 2000 .						
Range	N	K	K1	K2	K3	K4
Open(22)	**0.5214**	**486.99**	**-0.07**	**0.8**	**-0.115**	**1.067**
A	**0.503**	**259.038**	**-0.075**	**1**	**0**	**1.023**
B	**0.5**	**174.8824**	**0**	**0.3**	**0**	**1**
C8	**0.5**	**78.5**	**-0.02**	**0.5**	**0.016**	**1**
C6	**0.505**	**61.3**	**0.054**	**0.5**	**0.004**	**1**
C4	**0.514**	**39.3**	**0.08**	**0.5**	**0.0005**	**1**
C2	**0.55**	**20**	**0.139**	**0.5**	**-0.0027**	**1**
C1	**0.541**	**11.9239**	**0.122**	**0.4**	**0**	**1**
L4	**0.48**	**4.0995**	**0.003**	**1**	**0.0004**	**1**
L2	**0.502**	**2.0678**	**0**	**0.5**	**0.0001**	**1**
L1	**0.4925**	**1.1614**	**0.1**	**0.5**	**0.0001**	**1**

2 Pressurization (sealed, “Method B”)

Testing Details

Fan Model: **Retrotec 2000**	Fan SN:	Gauge Model: **DM-2**	Gauge SN: **202276**

Pressurize set

Date: **2011-08-08** Time: **16:40** to **16:57**

Environmental Conditions*:*

Barometric Pressure:**100.9** KPa from **Elevation**.37

Wind speed: **3: Gentle breeze**

Temperature: Initial: indoors **23 °C** outdoors **14 °C**.
Final: indoors **23 °C** outdoors **14 °C**.

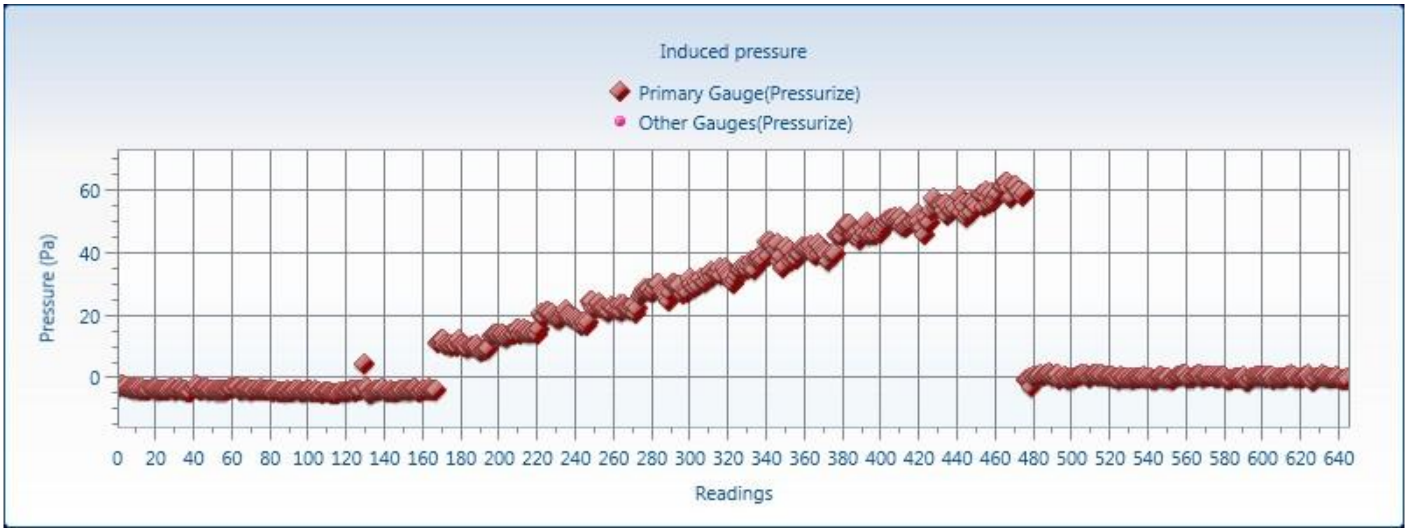
Test Data:

12Baseline pressures taken for **10** sec each.
12 building pressures taken for **20** sec each.

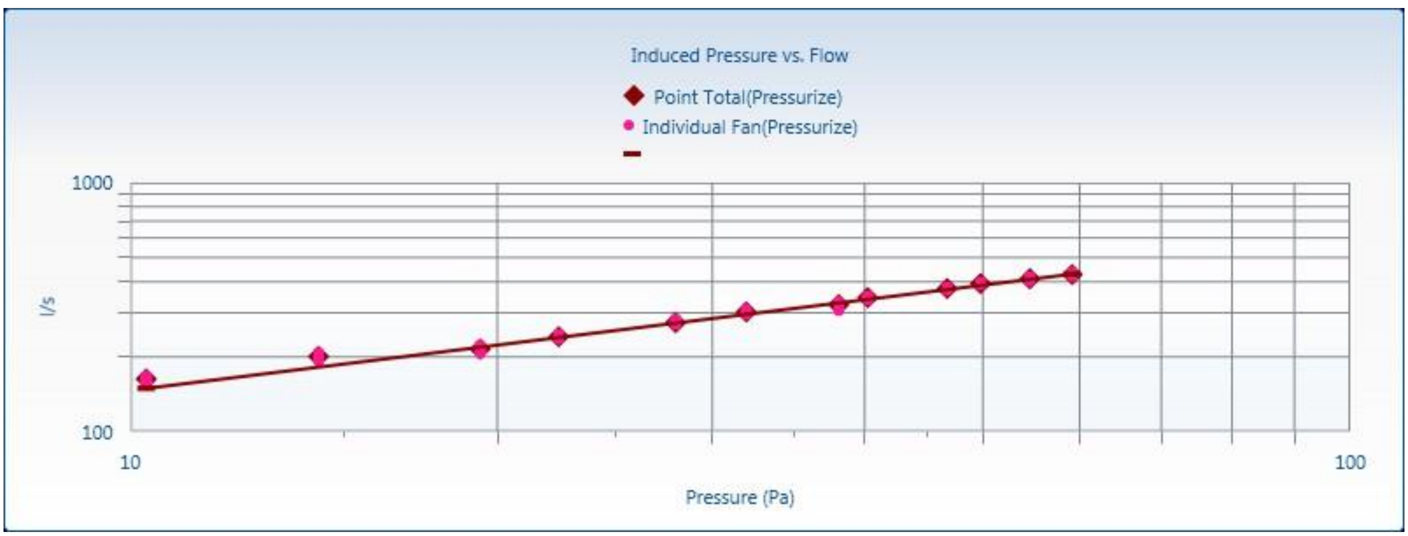
Baseline, initial [Pa]	**-3.11**	**-3.72**	**-3.68**	**-3.74**	**-3.52**	**-3.87**	**-4.24**	**-4.37**	**-4.41**	**-3.38**	**-4.18**	**-3.85**
Building Test Pressure [Pa]	**10.3**	**14.3**	**19.4**	**22.5**	**28.0**	**32.0**	**38.1**	**40.2**	**46.7**	**49.8**	**54.6**	**59.2**
Baseline, final[Pa]	**0.31**	**0.20**	**0.84**	**0.04**	**0.02**	**0.24**	**0.53**	**0.10**	**0.00**	**0.22**	**0.18**	**0.01**
Door Fan Pressure, [Pa]	**41.4**	**61.1**	**73.1**	**89.6**	**114.5**	**136.8**	**157.7**	**176**	**206.5**	**224.3**	**244.8**	**264.4**
Total flow, V_r[l/sec]	**162.9**	**200.7**	**214.9**	**240.8**	**274.2**	**302.7**	**323.7**	**345.7**	**375.9**	**393.6**	**411.3**	**427.9**
Corrected flow, V_{env}[l/sec]	**166.4**	**205.0**	**219.5**	**246.0**	**280.1**	**309.2**	**330.6**	**353.1**	**383.9**	**402.0**	**420.1**	**437.0**
Error [%]	**0.8%**	**4.8%**	**-5.0%**	**-1.9%**	**-1.3%**	**1.0%**	**-2.3%**	**1.1%**	**0.8%**	**1.7%**	**0.7%**	**0.0%**

Baseline pressure Averages: initial [Pa] ΔP_{01} **-3.84**, ΔP_{01-} -3.84, ΔP_{01+} **0.00**
final [Pa] ΔP_{01} **0.22**, ΔP_{01-} **0.00**, ΔP_{01+} **0.25**

Building Gauge Pressure



Building Gauge Pressure vs. Flow



Pressurize Test Results

	Results		
Correlation, r [%]	**99.70**	95% confidence limits	
Intercept, C_{env} [l/s.Pa^n]	**36.55**	**32.50**	**41.05**
Intercept, C_L [l/s.Pa^n]	**36.35**	**32.35**	**40.90**
Slope, n	**0.6038**	**0.5705**	**0.6371**

	Results	95% confidence		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**386.0**	**377.5**	**394.5**	**+/-0.0217**
Air changes at 50 Pa, n_{50} [/h]	**3.061**	**0.002300**	**6.120**	**+/-0.9993**
Permeability at 50 Pa, q_{50} [l/s.m^2]	**1.010**	**0.001**	**2.020**	
Specific Leakage at 50 Pa, w_{50} [l/s.m^2]	**2.100**	**0.002**	**4.198**	**+/-0.9992**

Combined Test Data

	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**386.0**	**377.5**	**394.5**	**+/-0.0217**
Air changes at 50Pa, n_{50} [/h]	**3.061**	**0.002300**	**6.120**	**+/-0.9993**
Permeability at 50 Pa, q_{50} [l/s.m^2]	**1.010**	**0.001**	**2.020**	**+/-1.0000**
Specific leakage at 50 Pa, w_{50} [l/s.m^2]	**2.100**	**0.002**	**4.198**	**+/-0.0220**

Test Notes:(add notes here)

Calibration Certificate

Retrotec 2000 .						
Range	N	K	K1	K2	K3	K4
Open(22)	**0.5214**	**486.99**	**-0.07**	**0.8**	**-0.115**	**1.067**
A	**0.503**	**259.038**	**-0.075**	**1**	**0**	**1.023**
B	**0.5**	**174.8824**	**0**	**0.3**	**0**	**1**
C8	**0.5**	**78.5**	**-0.02**	**0.5**	**0.016**	**1**
C6	**0.505**	**61.3**	**0.054**	**0.5**	**0.004**	**1**
C4	**0.514**	**39.3**	**0.08**	**0.5**	**0.0005**	**1**
C2	**0.55**	**20**	**0.139**	**0.5**	**-0.0027**	**1**
C1	**0.541**	**11.9239**	**0.122**	**0.4**	**0**	**1**
L4	**0.48**	**4.0995**	**0.003**	**1**	**0.0004**	**1**
L2	**0.502**	**2.0678**	**0**	**0.5**	**0.0001**	**1**
L1	**0.4925**	**1.1614**	**0.1**	**0.5**	**0.0001**	**1**

3 Depressurization (unsealed, "Method A")

Testing Details

Fan Model: **Retrotec 2000**	Fan SN:	Gauge Model: **DM-2**	Gauge SN: **202276**

Depressurize set

Date: **2011-08-08** Time: **17:36** to **17:54**

Environmental Conditions*:*
Barometric Pressure:**100.9** KPa from **Elevation**.37

Wind speed: **3: Gentle breeze**

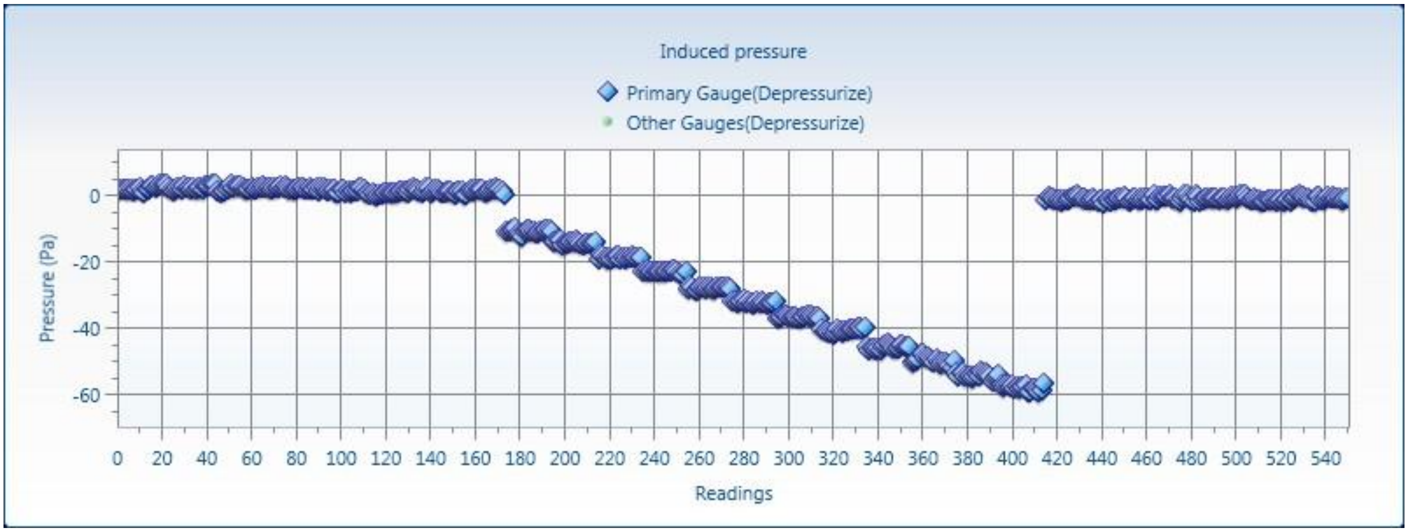
Temperature: Initial: indoors **23 °C** outdoors **14 °C**.
Final: indoors **23 °C** outdoors **14 °C**.

Test Data:
12Baseline pressures taken for **10** sec each.
12 building pressures taken for **20** sec each.

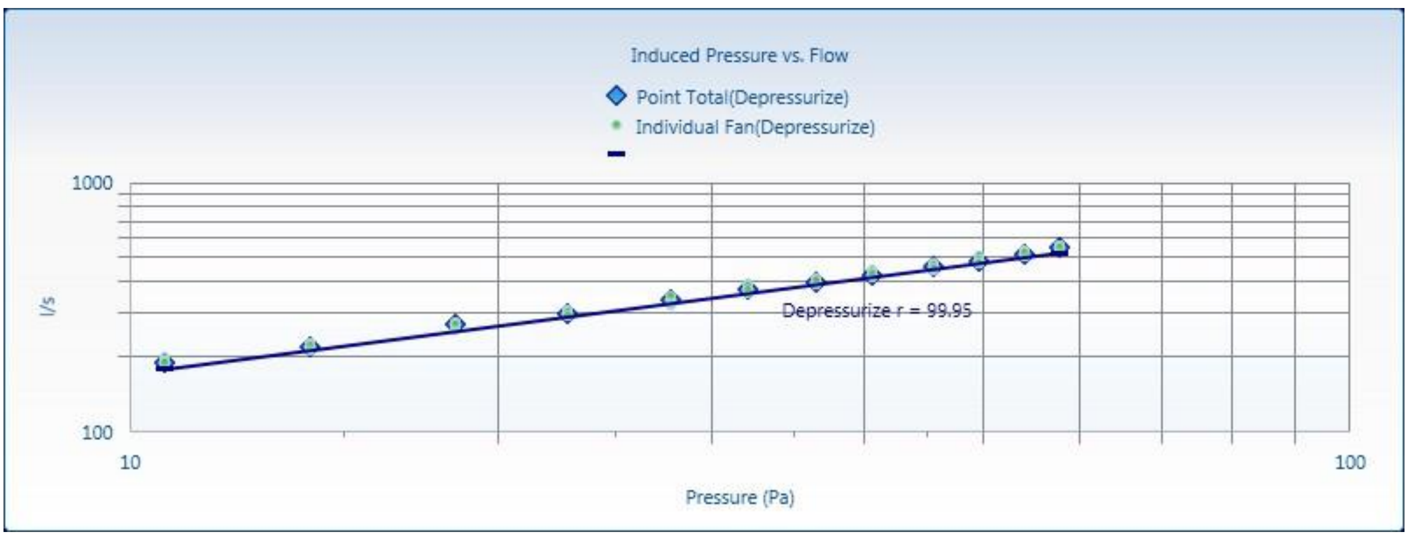
Baseline, initial [Pa]	**1.85**	**2.72**	**2.75**	**2.24**	**2.52**	**2.31**	**1.73**	**1.19**	**1.28**	**1.63**	**1.27**	**1.78**
Building Test Pressure [Pa]	**-10.7**	**-14.0**	**-18.5**	**-22.8**	**-27.7**	**-32.0**	**-36.5**	**-40.5**	**-45.6**	**-49.7**	**-54.1**	**-57.7**
Baseline, final[Pa]	**-0.90**	**-0.68**	**-1.04**	**-0.84**	**-0.33**	**-0.63**	**-0.80**	**-0.33**	**-1.24**	**-0.98**	**-0.74**	**-0.65**
Door Fan Pressure, [Pa]	**26**	**34.5**	**51**	**62.9**	**79.6**	**98.5**	**111.3**	**125.7**	**145.3**	**159.8**	**180.4**	**200.1**
Total flow, V_r[l/sec]	**190.6**	**220.1**	**268.2**	**298.7**	**337.0**	**376.2**	**400.9**	**427.4**	**461.2**	**485.0**	**517.4**	**547.0**
Corrected flow, V_{env}[l/sec]	**186.1**	**214.9**	**261.8**	**291.6**	**329.0**	**367.2**	**391.4**	**417.2**	**450.2**	**473.4**	**505.0**	**533.9**
Error [%]	**0.8%**	**-1.3%**	**1.5%**	**-0.7%**	**-0.8%**	**1.2%**	**-0.5%**	**-0.7%**	**-0.5%**	**-0.9%**	**0.2%**	**1.7%**

Baseline pressure Averages: initial [Pa] ΔP_{01} **1.94**, ΔP_{01-} 0.00, ΔP_{01+} **1.94**
final [Pa] ΔP_{01} **-0.76**, ΔP_{01-} **-0.76**, ΔP_{01+} **0.00**

Building Gauge Pressure



Building Gauge Pressure vs. Flow



Depressurize Test Results

	Results		
Correlation, r [%]	**99.95**	95% confidence limits	
Intercept, C_{env} [l/s.Pa^n]	**39.50**	**37.65**	**41.45**
Intercept, C_L [l/s.Pa^n]	**39.75**	**37.90**	**41.70**
Slope, n	**0.6363**	**0.6224**	**0.6502**

	Results	95% confidence		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**479.0**	**474.5**	**484.0**	**+/-0.0097**
Air changes at 50 Pa, n_{50} [/h]	**3.800**	**0.003600**	**7.595**	**+/-0.9990**
Permeability at 50 Pa, q_{50} [l/s.m²]	**1.254**	**0.001**	**2.507**	
Specific Leakage at 50 Pa, w_{50} [l/s.m²]	**2.607**	**0.002**	**5.212**	**+/-0.9990**

Combined Test Data

	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**479.0**	**474.5**	**484.0**	**+/-0.0097**
Air changes at 50Pa, n_{50} [/h]	**3.800**	**0.003600**	**7.595**	**+/-0.9990**
Permeability at 50 Pa, q_{50} [l/s.m²]	**1.254**	**0.001**	**2.507**	**+/-1.0000**
Specific leakage at 50 Pa, w_{50} [l/s.m²]	**2.607**	**0.002**	**5.212**	**+/-0.0100**

Test Notes:(add notes here)

Calibration Certificate

Retrotec 2000 .						
Range	N	K	K1	K2	K3	K4
Open(22)	**0.5214**	**486.99**	**-0.07**	**0.8**	**-0.115**	**1.067**
A	**0.503**	**259.038**	**-0.075**	**1**	**0**	**1.023**
B	**0.5**	**174.8824**	**0**	**0.3**	**0**	**1**
C8	**0.5**	**78.5**	**-0.02**	**0.5**	**0.016**	**1**
C6	**0.505**	**61.3**	**0.054**	**0.5**	**0.004**	**1**
C4	**0.514**	**39.3**	**0.08**	**0.5**	**0.0005**	**1**
C2	**0.55**	**20**	**0.139**	**0.5**	**-0.0027**	**1**
C1	**0.541**	**11.9239**	**0.122**	**0.4**	**0**	**1**
L4	**0.48**	**4.0995**	**0.003**	**1**	**0.0004**	**1**
L2	**0.502**	**2.0678**	**0**	**0.5**	**0.0001**	**1**
L1	**0.4925**	**1.1614**	**0.1**	**0.5**	**0.0001**	**1**

4 Pressurization (unsealed, "Method A")

Testing Details

Fan Model: **Retrotec 2000**	Fan SN:	Gauge Model: **DM-2**	Gauge SN: **202276**

Pressurize set

Date: **2011-08-08** Time: **17:10** to **16:57**

Environmental Conditions*:*
Barometric Pressure:**100.9** KPa from **Elevation**. 37

Wind speed: **3: Gentle breeze**

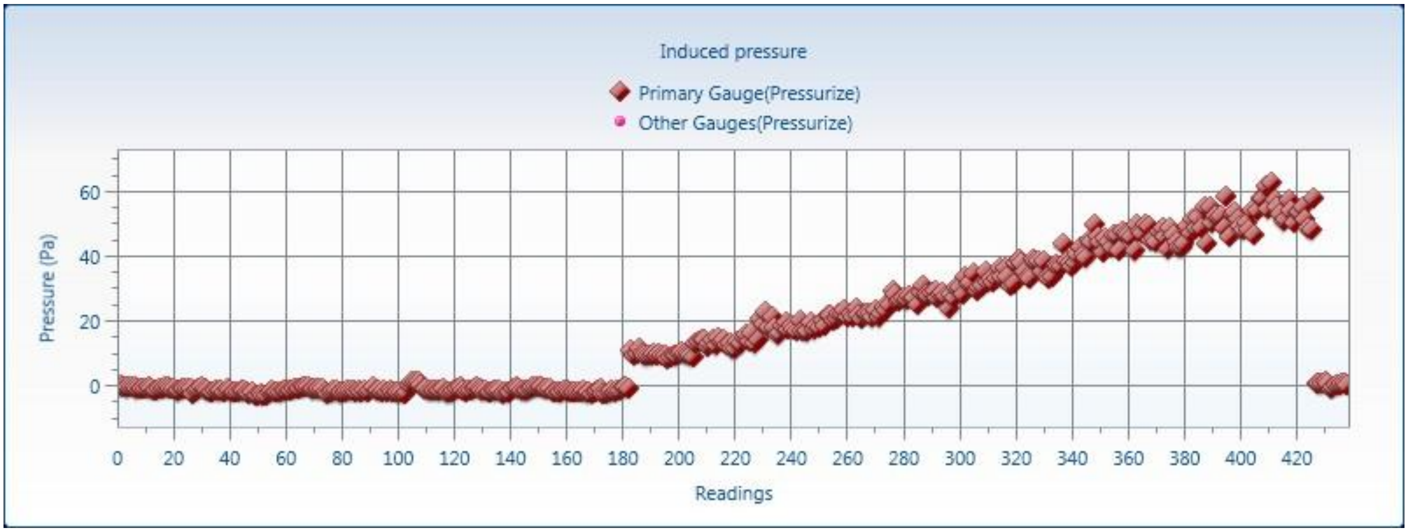
Temperature: Initial: indoors **23 °C** outdoors **14 °C**.
Final: indoors **23 °C** outdoors **14 °C**.

Test Data:
12Baseline pressures taken for **10** sec each.
12 building pressures taken for **20** sec each.

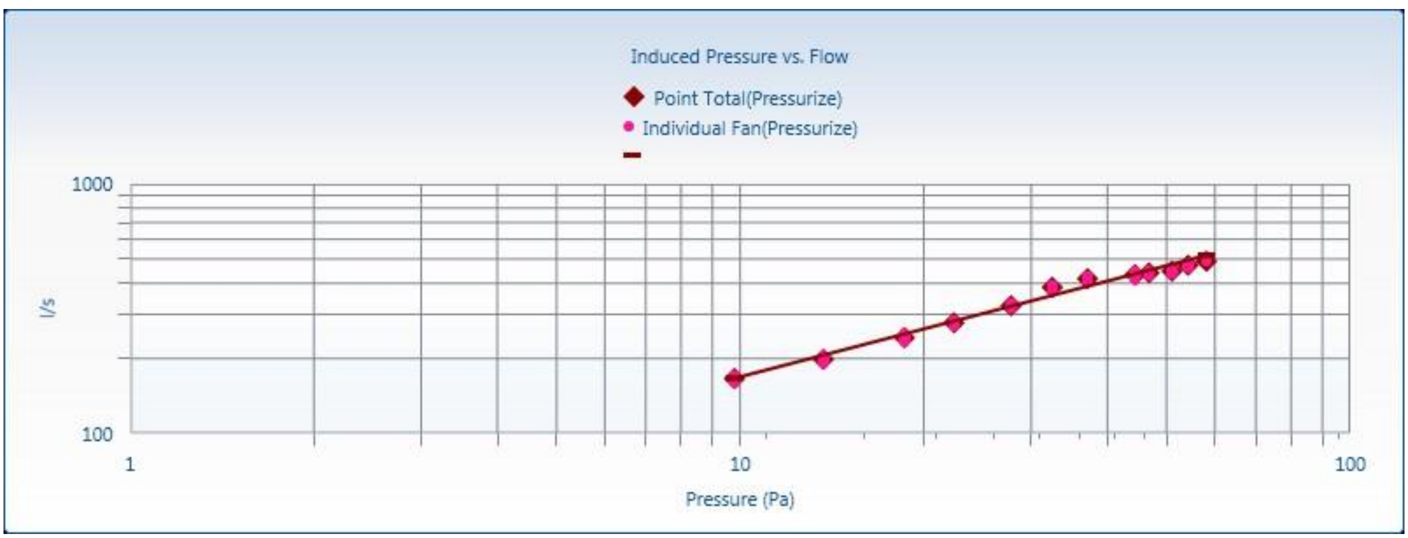
Baseline, initial [Pa]	**-0.56**	**-0.91**	**-1.44**	**-2.01**	**-1.00**	**-1.50**	**-1.00**	**-1.15**	**-1.31**	**-0.96**	**-1.59**	**-1.45**
Building Test Pressure [Pa]	**9.8**	**13.7**	**18.6**	**22.4**	**27.8**	**32.5**	**37.1**	**44.4**	**46.8**	**51.0**	**54.2**	**58.1**
Baseline, final[Pa]	**1.02**	**0.75**	**0.63**	**1.12**	**0.70**	**-0.52**	**-0.38**	**0.12**	**0.37**	**0.59**	**0.96**	**0.49**
Door Fan Pressure, [Pa]	**42.2**	**59.5**	**86.2**	**111**	**148**	**199.2**	**231.6**	**253.7**	**263.4**	**273.9**	**301.6**	**323.3**
Total flow, V_r[l/sec]	**166.4**	**198.4**	**242.2**	**278.1**	**325.3**	**385.4**	**417.3**	**433.1**	**440.9**	**447.4**	**472.5**	**489.9**
Corrected flow, V_{env}[l/sec]	**170.0**	**202.7**	**247.4**	**284.0**	**332.3**	**393.6**	**426.2**	**442.4**	**450.3**	**456.9**	**482.5**	**500.4**
Error [%]	**-0.4%**	**-3.5%**	**-2.6%**	**-0.5%**	**1.7%**	**9.2%**	**8.8%**	**0.8%**	**-0.7%**	**-4.6%**	**-3.1%**	**-3.8%**

Baseline pressure Averages: initial [Pa] ΔP_{01} **-1.24**, ΔP_{01-} -1.24, ΔP_{01+} **0.00**
final [Pa] ΔP_{01} **0.49**, ΔP_{01-} **-0.45**, ΔP_{01+} **0.68**

Building Gauge Pressure



Building Gauge Pressure vs. Flow



Pressurize Test Results

	Results		
Correlation, r [%]	**99.24**	95% confidence limits	
Intercept, C_{env} [l/s.Pa^n]	**38.95**	**32.15**	**47.25**
Intercept, C_L [l/s.Pa^n]	**38.70**	**32.00**	**47.05**
Slope, n	**0.6370**	**0.5815**	**0.6925**

	Results	95% confidence		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**469.0**	**450.5**	**488.0**	**+/-0.0404**
Air changes at 50 Pa, n_{50} [/h]	**3.720**	**0.0007**	**7.435**	**+/-0.9998**
Permeability at 50 Pa, q_{50} [l/s.m^2]	**1.227**	**0.000**	**2.455**	
Specific Leakage at 50 Pa, w_{50} [l/s.m^2]	**2.552**	**0.000**	**5.103**	**+/-0.9998**

Combined Test Data

	Results	95% Confidence Interval		Uncertainty
Air flow at 50 Pa, V_{50} [l/s]	**469.0**	**450.5**	**488.0**	**+/-0.0404**
Air changes at 50Pa, n_{50} [/h]	**3.720**	**0.0007**	**7.435**	**+/-0.9998**
Permeability at 50 Pa, q_{50} [l/s.m^2]	**1.227**	**0.000**	**2.455**	**+/-1.0000**
Specific leakage at 50 Pa, w_{50} [l/s.m^2]	**2.552**	**0.000**	**5.103**	**+/-0.0400**

Test Notes:(add notes here)

Calibration Certificate

Retrotec 2000 .						
Range	N	K	K1	K2	K3	K4
Open(22)	**0.5214**	**486.99**	**-0.07**	**0.8**	**-0.115**	**1.067**
A	**0.503**	**259.038**	**-0.075**	**1**	**0**	**1.023**
B	**0.5**	**174.8824**	**0**	**0.3**	**0**	**1**
C8	**0.5**	**78.5**	**-0.02**	**0.5**	**0.016**	**1**
C6	**0.505**	**61.3**	**0.054**	**0.5**	**0.004**	**1**
C4	**0.514**	**39.3**	**0.08**	**0.5**	**0.0005**	**1**
C2	**0.55**	**20**	**0.139**	**0.5**	**-0.0027**	**1**
C1	**0.541**	**11.9239**	**0.122**	**0.4**	**0**	**1**
L4	**0.48**	**4.0995**	**0.003**	**1**	**0.0004**	**1**
L2	**0.502**	**2.0678**	**0**	**0.5**	**0.0001**	**1**
L1	**0.4925**	**1.1614**	**0.1**	**0.5**	**0.0001**	**1**

...boks 9
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Kontoret har åbent:
hverdage kl. 8:00 - 16:00
lørdag og søndag lukket
E-mail .: Sisolie@greennet.gl

AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Faktura 811973

Kundenr. ....: 014146
Dato ....: 16/03-11
Forfaldsdato ......: 24/03-11
Side ....: 2

Varenr	Varebetegnelse	Antal	Enh	Pris	Beløb
2009	Solar - Arctic Grade	695	Ltr	4,47	3.106,65
1200	Kørsel fast pris	1	Ltr	140,00	140,00
	1200 L				

Aqq/Rb

39395

BETALT
19 MAJ 2011
SISIMIUT OLIE APS

Val	Totalbeløb
DKK	3.246,65

4,5BT

Axel
axol@geggata.gl
mobil:+ 522507

..ie ApS
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E-mail .: Sisolie@greennet.gl

AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Faktura 810512

Kundenr. ....: 014146
Dato ....: 27/01-11
Forfaldsdato ......: 04/02-11
Side ....: 2

Varenr	Varebetegnelse	Antal	Enh	Pris	Beløb
2009	Solar - Arctic Grade	668	Ltr	4,47	2.985,96
1200	Kørsel fast pris 1200 L	1	Ltr	140,00	140,00

As/Gs

38839

BETALT
9 FEB. 2011
SISIMIUT OLIE APS

Val	Totalbeløb
DKK	3.125,96

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AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Faktura 803737

Kundenr. ....: 014146
Dato ....: 30/11-10
Forfaldsdato ......: 08/12-10
Side ....: 2

Varenr	Varebetegnelse	Antal	Enh	Pris	Beløb
2009	Solar - Arctic Grade	601	Ltr	4,27	2.566,27
1200	Kørsel fast pris	1	Ltr	140,00	140,00
	1200 L				

gs/jk

38158

BETALT

Val	Totalbeløb
DKK	2.706,27

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E-mail .: Sisolie@greennet.gl

AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Fakturakopi 802183

Kundenr. ....: 014146
Dato ....: 28/09-10
Forfaldsdato ......: 06/10-10
Side ....: 2

Varenr	Varebetegnelse	Antal	Enh	Pris	Beløb
2009	Solar - Arctic Grade	518	Ltr	4,27	2.211,86
1200	Kørsel fast pris	1	Ltr	140,00	140,00
	1200 L				

Aqq/Jk

37499

BETALT
25 OKT. 2010
Sisimiut Olie ApS

Val	Totalbeløb
DKK	2.351,86

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E-mail .: Sisolie@greennet.gl

AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Faktura 2956

Kundenr. ....: 014146
Dato ....: 27/05-10
Forfaldsdato ......: 04/06-10
Side ....: 2

Varenr	Varebetegnelse	Antal	Enh	Pris	Beløb
2009	Solar - Arctic Grade	423	Ltr	4,27	1.806,21
1200	Kørsel fast pris 1200 L	1	Ltr	140,00	140,00

aqq/jk

BETALT
30 JUNI 2010
SISIMIUT OLIE APS

Val	Totalbeløb
DKK	1.946,21

Sisimiut Olie ApS
Kaassassuup aqq. 1
Postboks 9
3911 Sisimiut
Tlf .: (00 299) 864020
Fax .: (00 299) 864775

Kontoret har åbent:
hverdage kl. 8:00 - 16:00
lørdag og søndag lukket
E-mail .: Sisolie@greennet.gl

AXEL LUND OLSEN

QAJAASAT 19 B-1158
3911 SISIMIUT

Faktura 1379

Kundenr. ....: 014146
Dato ....: 26/03-10
Forfaldsdato ......: 03/04-10
Side ....: 1

Varenr	**Varebetegnelse**	**Antal**	**Enh**	**Pris**	**Beløb**
2009	Solar - Arctic Grade	798	Ltr	4,27	3.407,46
1200	Kørsel fast pris 1200 L	1	Ltr	140,00	140,00

aqq/jk

BETALT
29 APR. 2010
SISIMIUT OLIE APS

Val	**Totalbeløb**
DKK	3.547,46

Sisimiut Olie ApS
Kaassassuup aqq. 1
Postboks 9
Tlf: +299 86 40 20
Fax: +299 86 47 75
e-mail: sisolie@greennet.gl

Kontoret har å
hverdage kl.8:
lørdag og søn(

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Sisimiut Olie APS
Postboks 9
3911 Sisimiut
TLF. 299866136
CVR.NR. 21366633

2010-02-26              15:49

KØB          DKK      3000,90
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VisaDankort           PSN: 00
XXXX XXXX XXXX 0406
TERM:       05244081-003893
IA1        PBS NR:0003332179

ATC:01013        AED:000000
AID:         A0000000031010
PSAM:      5374978-0000156600
ARC:00          STATUS:0000
AUT KODE:            154943
REF:003893       AUTORISERET
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URA
65
014146
20-01-2010
8-01-2010
1

AXEL LUND OLSEN

QAJAASAT 19 B-1158

3911 SISIMIUT

Varenr.	**Betegnelse**				**Ialt**
	Følgeseddelsnr. 34369 AS/GS				
2009	Solar - Arctic Grade	Ltr.	670,00	4,27	2.860,90
1200	Kørsel fast pris under 800 L	Ltr.	1,00	140,00	140,00
	Automatisk opfyldning				
	Næste opfyldning : 26-03-10				

BETALT
26 FEB 2010
SISIMIUT OLIE APS

<u>3.000,90</u> Kr.

AKILIGASSAT SIULLIIT NASSIUNNEQARSIMASUT AKILERNEQARSIMANNGIPPATA
- ORSUSSAMIK PAJUNNEQASSANNGILASI!
SÅFREMT TIDLIGERE FREMSENDTE FAKTURAER IKKE ER BETALT,
-VIL DER IKKE BLIVE TILKØRT MERE OLIE!

Sisimiut Olie ApS
Kaassassuup aqq. 1
Postboks 9
Tlf. +299 86 40 20
Fax: +299 86 47 75
e-mail: sisolie@greennet.gl

Kontoret har åbent:
hverdage kl.8:00 - 16:00
lørdag og søndag lukket

FAKTURA
71514

AXEL LUND OLSEN

QAJAASAT 19 B-1158

3911 SISIMIUT

Kundenr.	**014146**
Dato	30-09-2009
Forfaldsdato	**08-10-2009**
Side	1

Varenr.	**Betegnelse**		**Antal**	**Pris**	**Ialt**
	Følgeseddelsnr. 32354 GS				
2009	Solar - Arctic Grade	Ltr.	428,00	4,27	1.827,56
1200	Kørsel fast pris	Ltr.	1,00	110,00	110,00
	Automatisk opfyldning				

1.937,56 Kr.

AKILIGASSAT SIULLIIT NASSIUNNEQARSIMASUT AKILERNEQARSIMANNGIPPATA
- ORSUSSAMIK PAJUNNEQASSANNGILASI!
SÅFREMT TIDLIGERE FREMSENDTE FAKTURAER IKKE ER BETALT.
-VIL DER IKKE BLIVE TILKØRT MERE OLIE!

Betalingsbetingelse : NETTO KONTANT 8 DAGE DEREFTER 2%

Kan indsættes /Akiliiffigineqarsinnaavoq; GrønlandsBANKEN A/S på Reg: 6471 Konto: 2009320

AXEL LUND OLSEN
QAJAASAT 19 B-1158
3911 SISIMIUT

1.937,56 **Kr.**

Betalings ID:

+71< 014146000715149+84092509<