Equalize Air Installation and Performance Report

Brassii Restaurant, Toronto

Prepared for: Enbridge Gas Distribution

Date: February 8, 2005

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I. <u>Executive Summary</u>

This report describes the measured temperatures and performance of the de-stratification fans manufactured and installed by Equalize-air in a restaurant environment during the heating season. The measurements in the restaurant were concentrated on the effect of the fans in the main dining room. Results of the measurements were compared to additional measurements and calculations for a Canadian Tire store located in Peterborough ON.

Brassaii is located in a multi dwelling building above grade with the front entrance facing North-West and the service-delivery entrance facing South-West. The restaurant occupies the first floor.

Temperature data loggers were used to measure the stratification during outside temperatures in the range of 0^{o}C to -1^{o}C by placing them on a vertical column in the dinning room. The data from the loggers shows that stratification exists in this restaurant environment and it measured as floor to ceiling temperature differential of 5^{o}C.

With the use of the Equalize-air system this stratification reduced to a temperature differential of less then 1^{o}C.

Infrared pictures were taken to illustrate and measure the stratification with and without the Equalize-air system. These pictures confirmed the results obtained with the data loggers.

Results indicated that the Equalize-air units unit can be an effective tool in reducing the stratification in a restaurant and store environment to a temperature difference of 1^{o}C and thus have a significant impact on comfort and the buildings energy requirements. Energy consumption was reduced from 5% to 28% depending on the outside temperatures.

Our results for the energy savings in Brassaii for the months of December 2004 and January 2005 showed a saving of 28% in the heating gas consumption. Parallel to this measurements and calculations at the Canadian Tire store in Peterborough with the Equalize-air system installed showed an energy saving of 30% over the same time period.

We thus recommend installing these units in all situations where we would like to reduce heating cost and improve comfort.

II. Objective

The objective of this project is to investigate Equalize-air system design through the performance assessment while focusing on the potential to improve the energy efficiency and overall performance of HVAC restaurant system.

III. Introduction

The phenomenon of warm air rising and cold air falling is described as air stratification. Removing the warm air layer near the roof and mixing it with the cold air near the floor can result in significant energy savings. Conventional ceiling fans attempt to re-circulate the warm air from the ceiling down towards the floor, but these fans are not effective since most of the warm air is dispersed before reaching the floor. The solution is a more effective method of bringing the warm air down to the floor.

The Equalize-Air ceiling fans (equalizer units) are composed of a special air-circulating fan with a patented method of collecting warm air beneath the ceiling or roof. The device returns the warm air to the floor through a narrow columnar air path, as seen in "Figure 1" (a).

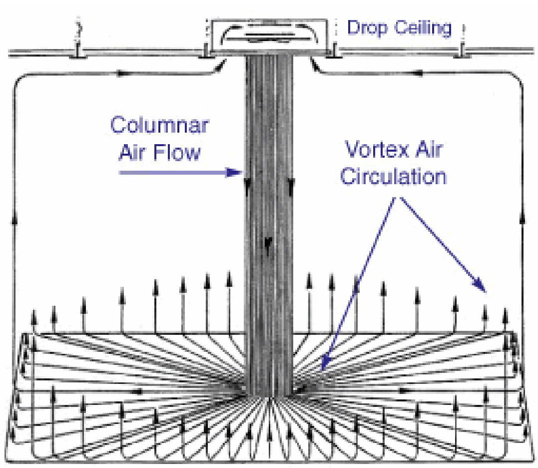


Figure 1 (a) Equalize-Air System unit

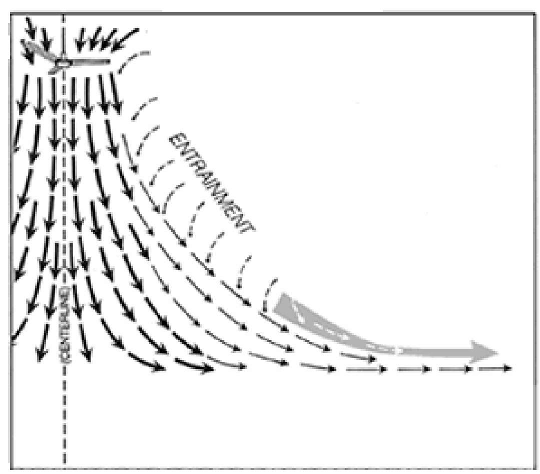


Figure 1 (b) conventional ceiling fan unit

http://www.equalize-air.com/howitworks.html

The fan has a specially designed blade with a ventra ring to collect the warm air and using the grate to channel the air straight down in a column rather than dispersing the air like a conventional industrial ceiling fan, as seen in "Figure 1" (b).

As soon as the air column reaches the floor, it gently spreads out along the floor, up the walls and along the ceiling or roof, where it is collected and returned to the floor. This cycle is then repeated over and over, eventually equalizing the temperature within the space. The same technology can be applied during the summer to reduce air conditioning costs by creating more uniform temperature distributions in the building.

IV. Design Considerations

Care has to be taken to ensure the location of the unit will be functional, non intrusive to the customers underneath it and to operate at comfortable and acceptable output levels.

Critical design considerations for the installation and application of the equalize- air system are:

Restaurant location, layout and age
Building characteristics
Lobbied/no door environment
Horizontal distribution of hot and cold spots

Restaurant design features

Brassaii restaurant is located in a multi dwelling building with occupied floors above and below the restaurant. Walls exposed to outside temperature are the north, west , east and south. Major heat loss is generated by infiltration and by the restaurant exhaust system. Minor heat loss is generated through the walls with substantial window surface. Hot spots are created by the open kitchen concept. Cold spots are created by the large window surfaces and the entry and service doors. Height of the ceiling is 3.2 m. The layout of the restaurant can be seen in "Figure 2".

Brassaii is heated by two Trane YCH240CWHB units. These are Air-Cooled Packaged Gas/Electric Systems units located on the roof of the building with 20 Tons cooling capacity and 400 MBH heating capacity. Additional to the Trane units a 20 KW Electriduct heater is installed in the make up air duct.

Ceiling fan / building volume ratio

Each Equalize-Air Systems unit will deliver 1100 cfm free air at full speed. Floor coverage is approximately 2500 sq. ft. per unit (50 ft. x 50 ft.) at full speed, less coverage for special problems and heavy partitioning.

Using 5 fans at the specified capacity 1100 cfm we have 5500 cfm air recirculation.

The restaurant is split in several areas with a total floor area of: 7700 ft^2

The testing was performed only in the main dining room with floor area of 4900 ft^2

The volume of the dining area is: 64,000 ft^3

With the volume calculated at 64,000 ft^3 and 5 fans operating we achieve a complete recirculation of the air in the room every 12 minutes if we assume no obstacles and maximum operating speed of the units.

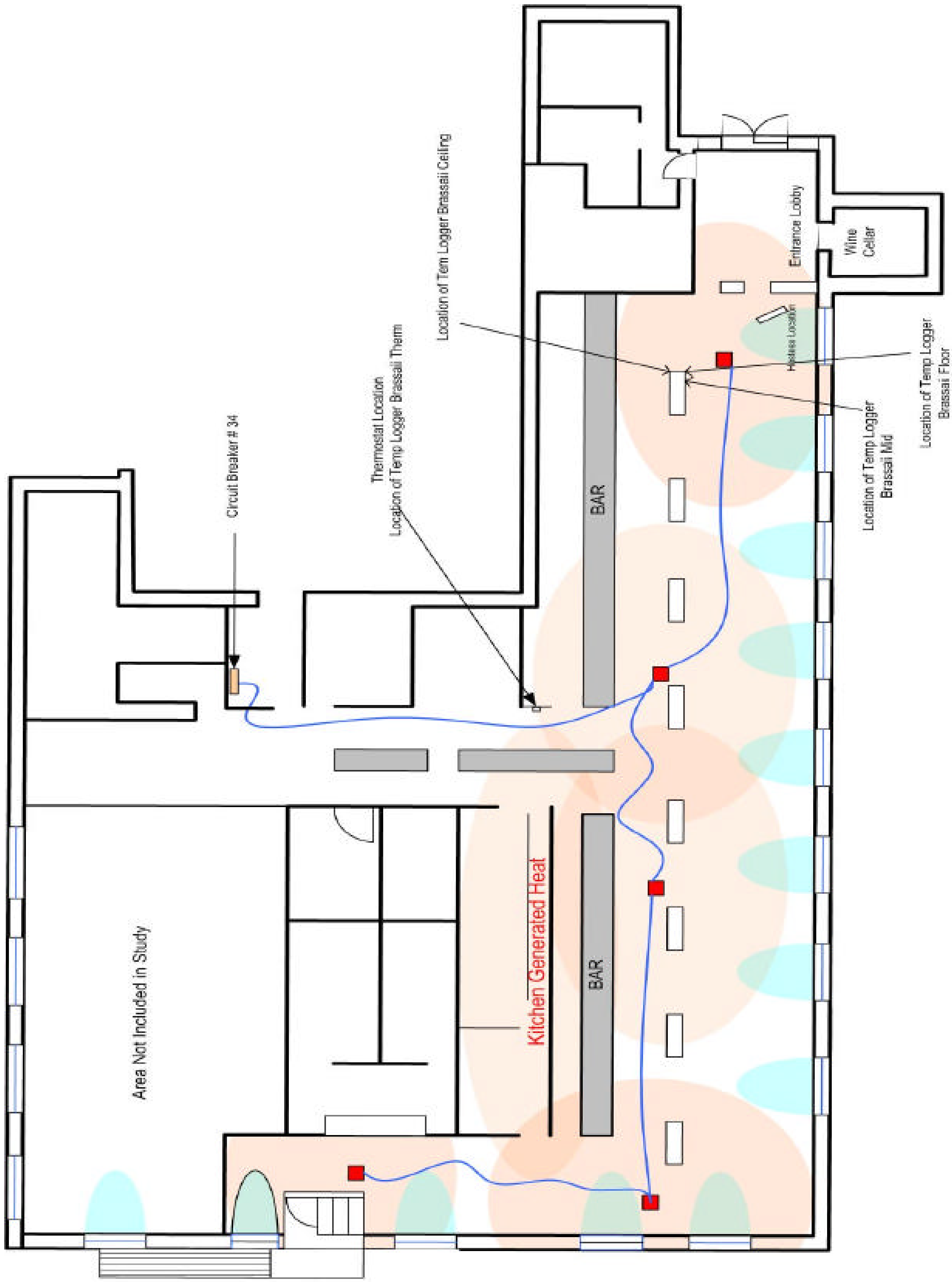

Location of Tem Logger Brassaii Ceiling
Thermostat Location
Location of Temp Logger Brassaii Therm
Circuit Breaker # 34
Entrance Lobby
Wine Cellar
Hostess Location
Location of Temp Logger Brassaii Floor
Location of Temp Logger Brassaii Mid
BAR
BAR
Kitchen Generated Heat
Area Not Included in Study

Figure 2

- **Heating Degree Days (Outdoor temperatures)**

For the purpose of this study the following HDD data from "Figure 3" is used.

Month Year	Days	HDD
Oct-03	31	276
Nov-03	30	398.5
Dec-03	31	561.5
Jan-04	31	849.1
Oct-04	31	226.3
Nov-04	30	380.3
Dec-04	31	643.4
Jan-05	31	770

Figure 3

- **Furnace gas consumption metering**

For the purpose of this study the following consumption data from "Figure 4 "obtained from Enbridge is used:

Brassaii - Main Floor (Account 190139377814, Rate 6)

Reading Date (YYYYMMDD)	Consumption (m3)	Total Gas Charge ($)
20030630	0	$22.00
20030730	0	$22.00
20030829	12,175	$5,751.69
20030930	3,505	$1,712.74
20031029	3,273	$1,608.09
20031128	201	$124.29
20031230	**6,975**	$3,506.57
20040130	**495**	$258.87
20040227	6,526	$2,933.43
20040330	283	$156.98
20040428	5,989	$2,585.30
20040531	102	$68.84
20040628	6,130	$2,644.94
20040729	3,496	$1,536.73
20040827	2,433	$1,086.33
20040929	3,256	$1,435.57
20041028	3,892	$1,720.34
20041129	3,442	$1,528.83
20041229	**3,188**	$1,419.75
20050131	**3,909**	$1,724.47

Figure 4

- **Air stratification**

Since Brassaii's ceiling is 3.2 m tall air stratification exists but not to the levels found in warehouses and hangars that have ceilings higher then 30 feet. The stratification is expected to be in the ? T of only 3 ^{o} C but will need to be confirmed with actual temperature measurements and infrared thermographs.

- **Temperature profiling**

Brassaii has several hot spots and many cold spots created by the kitchen generated heat and by infiltrated air from both the front and back entrance. Large window areas create discomfort and draft across the length of the dining room and the outer wall. The isotherms around the kitchen are illustrated in "Figure 5".

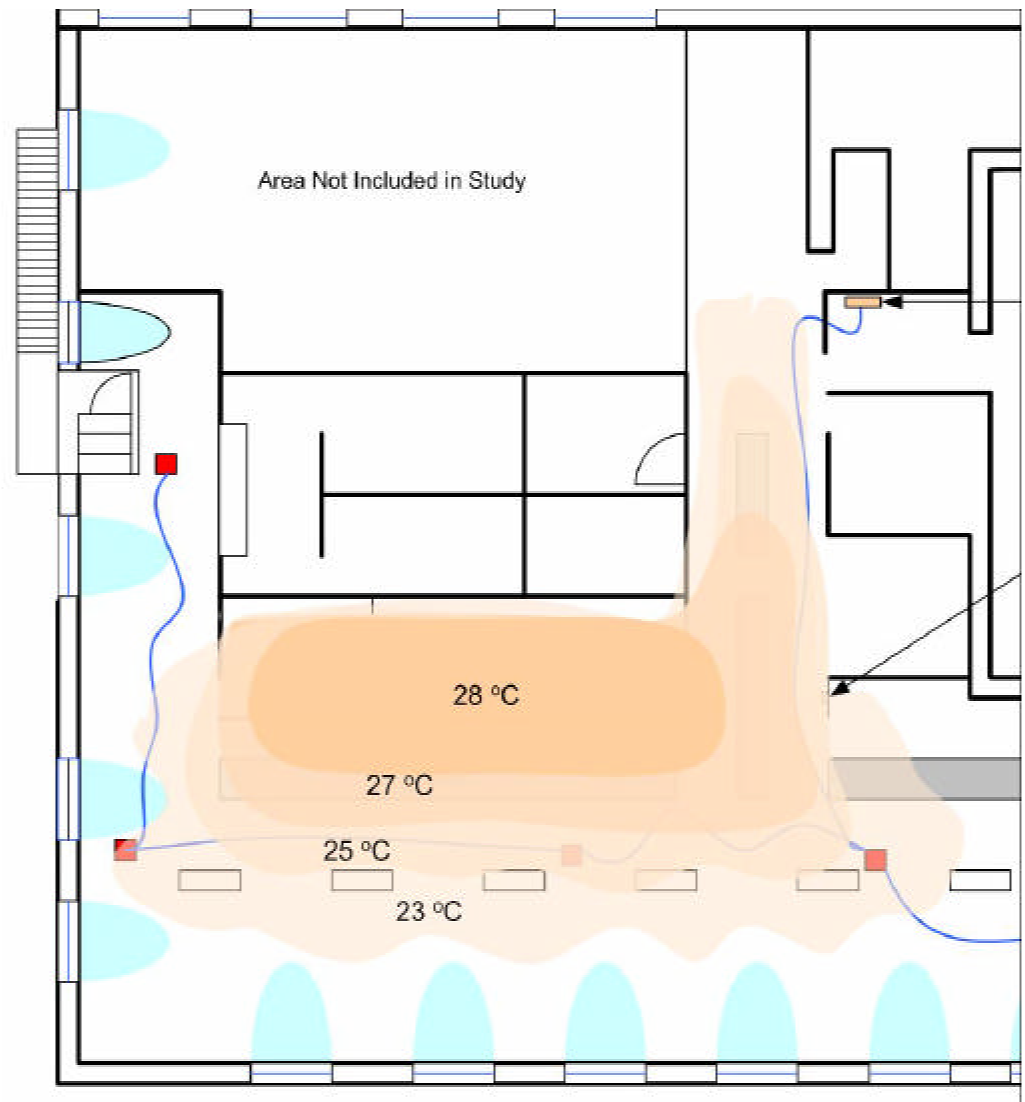


Figure 5

V. **Installation**

The units were installed by Quantum Electric on November 23rd and connected to the electrical panel located in the main electrical room to circuit breaker number 34.

This installation comprised of mounting 5 Equalize-air units across the restaurant at locations illustrated in the attached floor plan in “Figure 2”.

The horizontal positioning of the units had to take into account hot and cold spots in the restaurant and take in account that the vertical air flow does not interfere with the customers seating. The units were mounted as high as possible on the ceiling beams as illustrated in “Figure 6”.

Figure 6 – Location of Equilize Air unit #1 in Brassaii

VI. <u>Measurements</u>

NMTG monitored the selected test site at Brassaii with and without the use of the equalize air units to identify potential benefits and energy savings.

The monitoring consisted of:

- Temperature measurements using temperature data loggers located vertically on one of the columns
- Daily measurements using a digital temperature and humidity meter
- Infrared thermographs using a FLIR E4 infrared camera

a) Indoor temperature measurements with data loggers

For the purpose of measuring the temperature at Brassaii four data loggers were installed along one pillar. These data loggers model EL-USB-1 were set to measure temperature every 1 minute. Specifications of this Unit can be seen in Appendix 6.

The purpose of these units was to measure the stratification and three were found to be sufficient since measurement with infrared thermographs was to follow.

1. The location of the first unit designated "Brassaii floor" was 15 cm above floor level at the first column under the equalize air unit next to the entrance. Chart 1 illustrates the temperature data of this unit.
2. The second unit designated "Brassaii Mid" was located at a height of 1.5 meters on the first indoor column. Chart 2 illustrates the temperature data of this unit.
3. The third unit designated "Brassaii Ceil" was mounted 10 cm below the ceiling above logger Brassaii Mid.
4. The Fourth unit designated "Brassaii Therm" was mounted in the thermostat housing and its function was to measure the

"Figure 2" illustrates the position of the temperature loggers.

Temperature data logger results

The data from the loggers clearly shows in "Figure 7" how the floor temperature rises and supersedes the mid level temperature once the units are turned on. Individual charts of the data loggers can be found in Appendix 1 to 4 to more clearly show the data from the loggers.

From the combined charts in "Figure 7" we can also see the effect of the overall temperature rise in the restaurant as a result of the horizontal equalization of the room. This effect is a result of the movement of the ceiling hot air located in the kitchen area near the thermostat with values above 25oC. (See thermograph of the kitchen area FLIR 4).

Temperature values in the ceiling area of the kitchen are found to range from 25°C to 28°C and are equalized by the two central Equalize-Air units as illustrated in “Figure 2”.

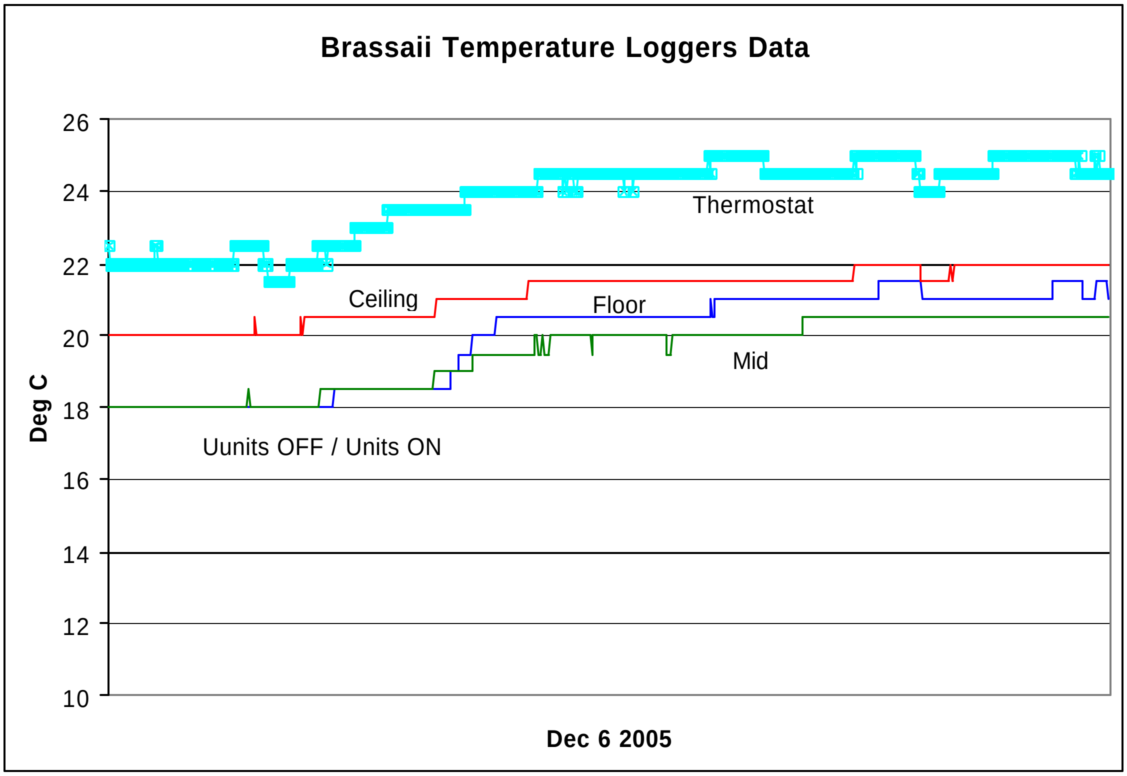


Figure 7

b) <u>Daily measurements using a digital temperature and humidity meter</u>

The daily measurements consisted of recording the temperature and humidity to confirm and check on the accuracy of the data loggers and to have a reference point for calibrating the emissivity of the FLIR infrared camera. All the daily measurements coincided with the data loggers and infrared picture data.

c) <u>Infrared measurements</u>

A series of infrared measurements were performed using a FLIR E4 infrared camera and attached as separate infrared reports within this study.

Using a FLIR camera it is possible to measure an infinite amount of points and eliminate the use of thermocouples and elaborate setups to generate multiple measurements.

The measurements are presented as follows:

1. **FLIR 1**
Infrared measurement of the columns on Jan 5 with Equalize Air system turned off

Stratification is noticeable across the columns with measured ? T on the first column of 5.1^{o}C with ceiling temperature of 22.8^{o}C and floor temperature of 17.7^{o}C. Head level temperature is measured at 19.9^{o}C.

Line LI01 shows the temperature under the ceiling near the kitchen in the middle of the dining room at 24^{o}C showing hot spots created by the kitchen. The main exhaust air leaves from this area and we can assume that at this time the exhaust temperature is over 24^{o}C.

2. **FLIR 2**
Infrared measurement of the columns on Jan 9 with Equalize Air system turned on

With the equalize air fans operating it is immediately noticed that there is almost no stratification. The temperature across the column is a steady 22.2^{o}C. We can thus conclude that the equalize air fans brought the room temperature close to that of the ceiling. In this case the overall room temperature can be reduced with the thermostat setting at 20^{o}C and thus generate substantial energy savings.

3. **FLIR 3**
Infrared measurement of the dining room on Jan 9 with Equalize Air system turned on

The infrared picture of the dining room shows how well the system equalized the temperature across the whole restaurant. Values of 22.4^{o}C were found averaging across the room in both vertical and horizontal distribution.

4. **FLIR 4**
Infrared measurement of the kitchen surroundings on Jan 7 with Equalize Air system turned off

The infrared picture of the bar and kitchen surrounding area that supplies exhaust air shows that the temperatures near the ceiling rise to 28 ^{o} C. This is a major parameter in the heat loss and the picture confirms the isotherms illustrated in "Figure 5".

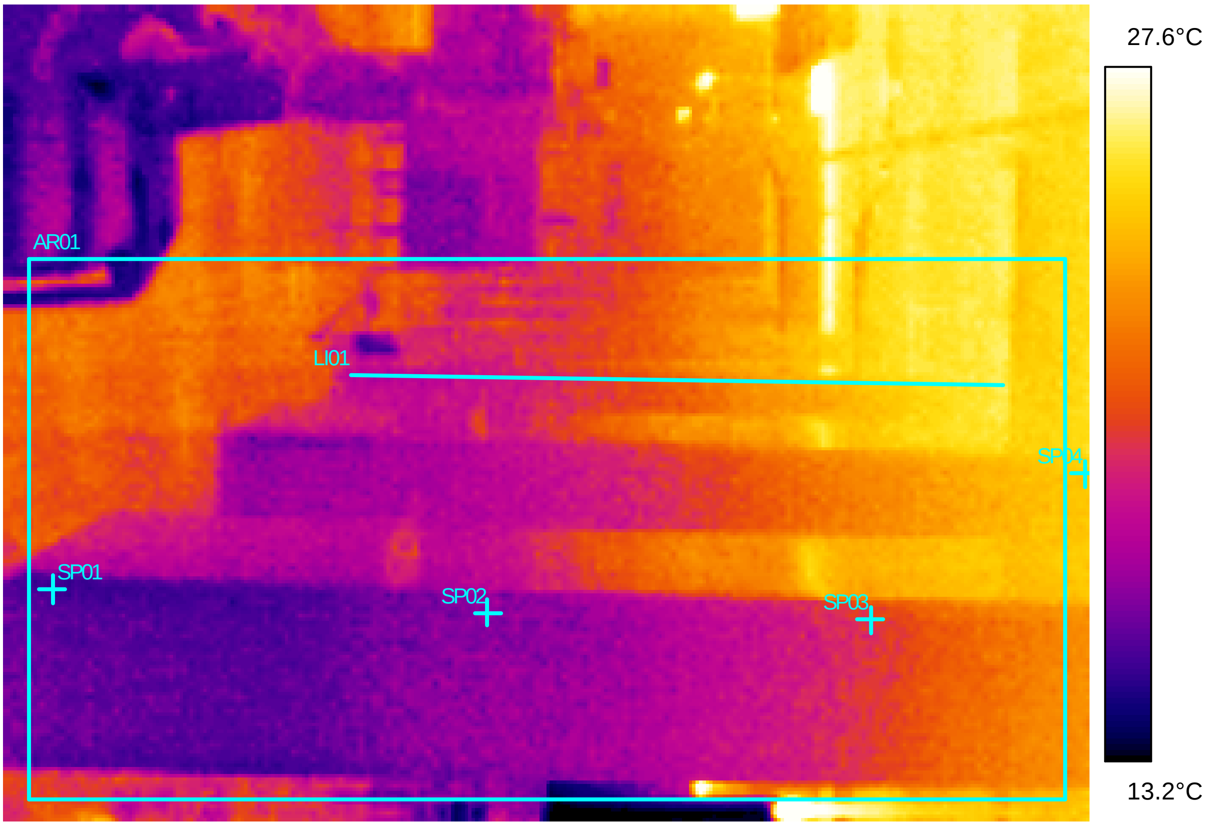
5. **FLIR GRAPH 1**

FLIR GRAPH 1 created by the infrared thermograph FLIR 1 shows the temperature difference and stratification across line LIO in the pictures to be 4.5^{o}C.

6. **FLIR GRAPH 2**

FLIR GRAPH 2 created by the infrared thermograph FLIR 2 shows the temperature difference and stratification across line LIO in the pictures to be 0^{o}C.

IR-Image File Name	Date
Brassaii Equailize Air Units OFF - Columns	5 jan 05

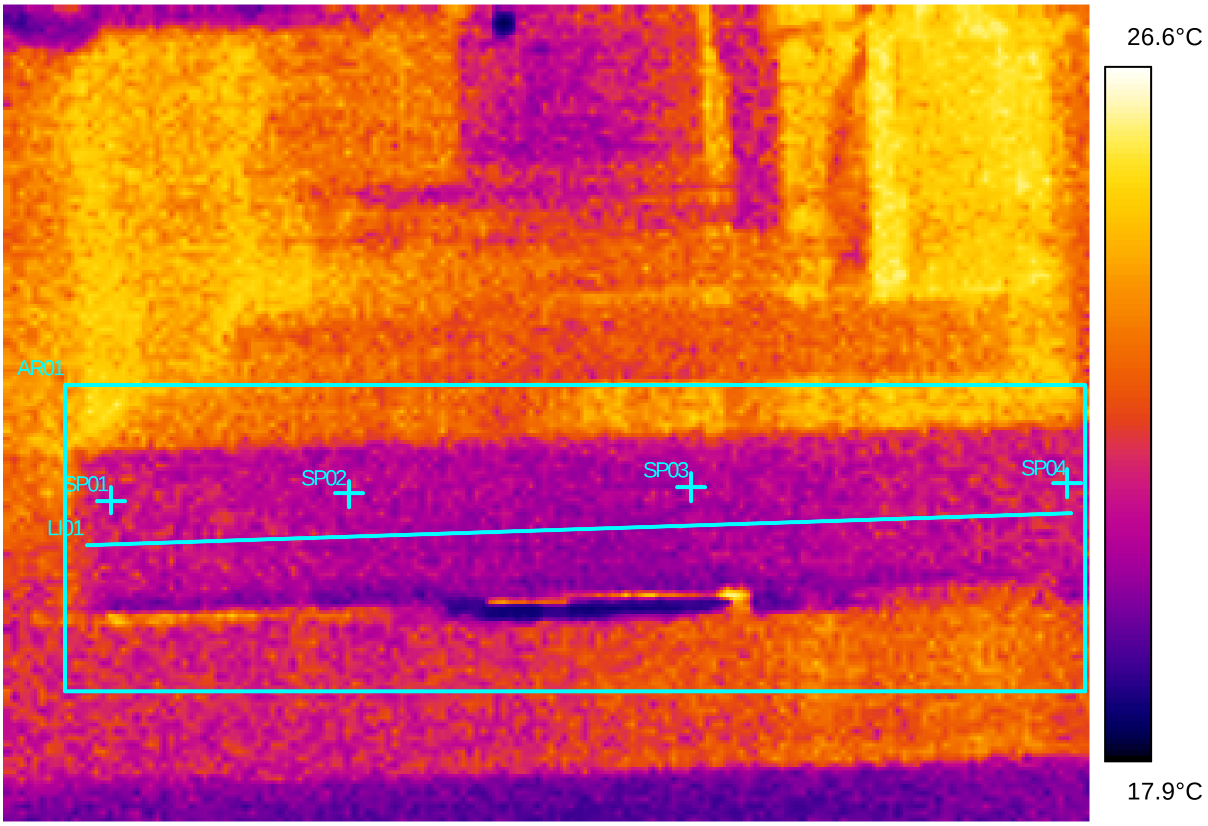


IR information	Value	
Date of creation	1/5/2005	-
Time of creation	2:51:09 PM	-
Object parameter	**Value**	
Emissivity	0.94	-
Object distance	6.0 m	-
Ambient temperature	20.0°C	-
Atmospheric temperature	20.0°C	-
Transmission	0.99	-
Label	**Value**	**Diff**
SP01	17.7°C	-2.3°C
SP02	18.7°C	-1.3°C
SP03	19.9°C	-0.1°C
SP04	22.8°C	2.8°C
LI01 : max	24.0°C	4.0°C
LI01 : min	19.0°C	-1.0°C

Brassaii vertical temperature distribution - Columns

The above picture shows the temperature distribution without the equualize air units operating.
A temperature difference of 5.1 degrees C is measured across the first column.
Measurement points SP 1,2,3 and 4 show the temperature of the columns at the respective height.

IR-Image File Name	Date
Brassaii Equailize Air Units ON - Columns	9 jan 05

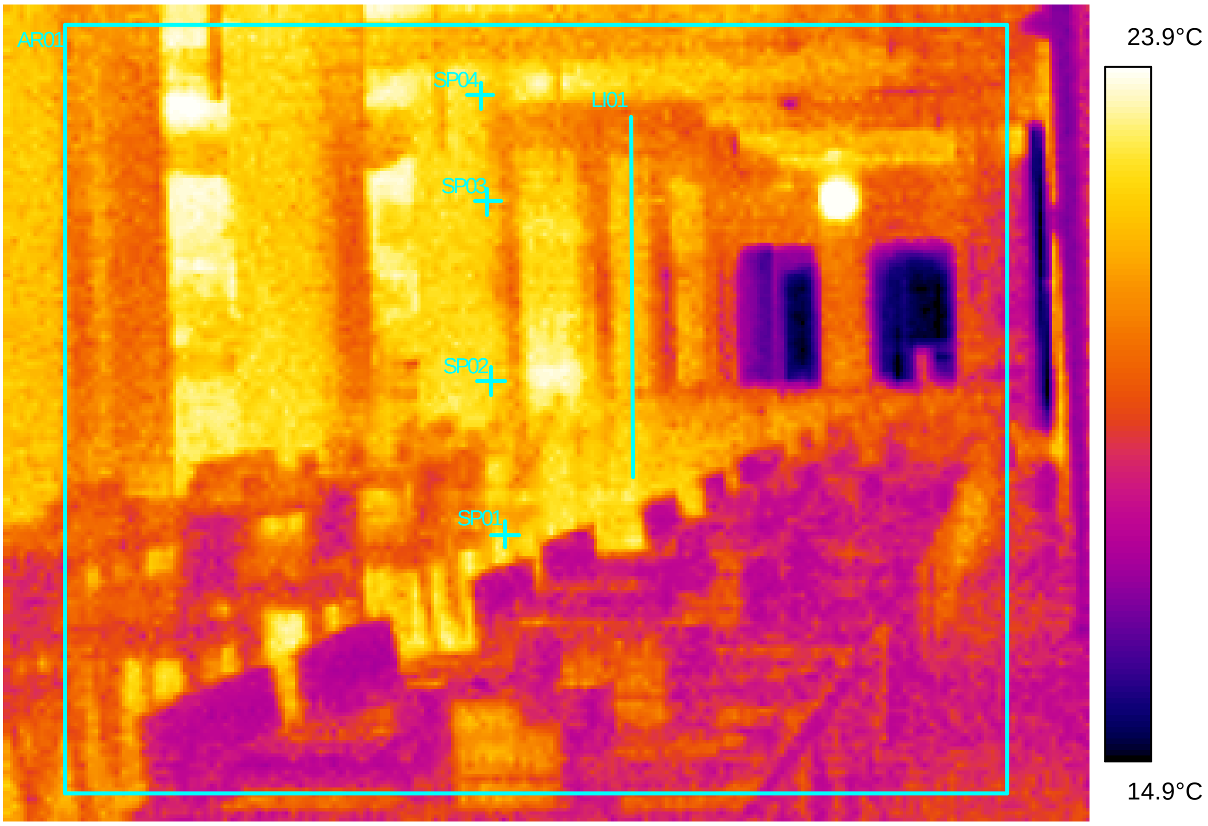


IR information	Value	
Date of creation	1/9/2005	-
Time of creation	2:55:24 PM	-
Object parameter	**Value**	
Emissivity	0.94	-
Object distance	2.0 m	-
Ambient temperature	22.0°C	-
Atmospheric temperature	22.0°C	-
Transmission	0.99	-
Label	**Value**	**Diff**
SP01	22.3°C	-0.1°C
SP02	22.3°C	-0.1°C
SP03	22.2°C	-0.2°C
SP04	22.3°C	-0.1°C
LI01 : max	22.5°C	0.1°C
LI01 : min	21.8°C	-0.6°C

Brassaii vertical temperature distribution - Columns

The above picture shows the temperature distribution in the main dining room of the restaurant. Measurement points SP 1,2,3 and 4 show the temperature of the columns at the respective height.

IR-Image File Name	Date
Brassaii Equailize Air Units ON - Room	9 jan 05

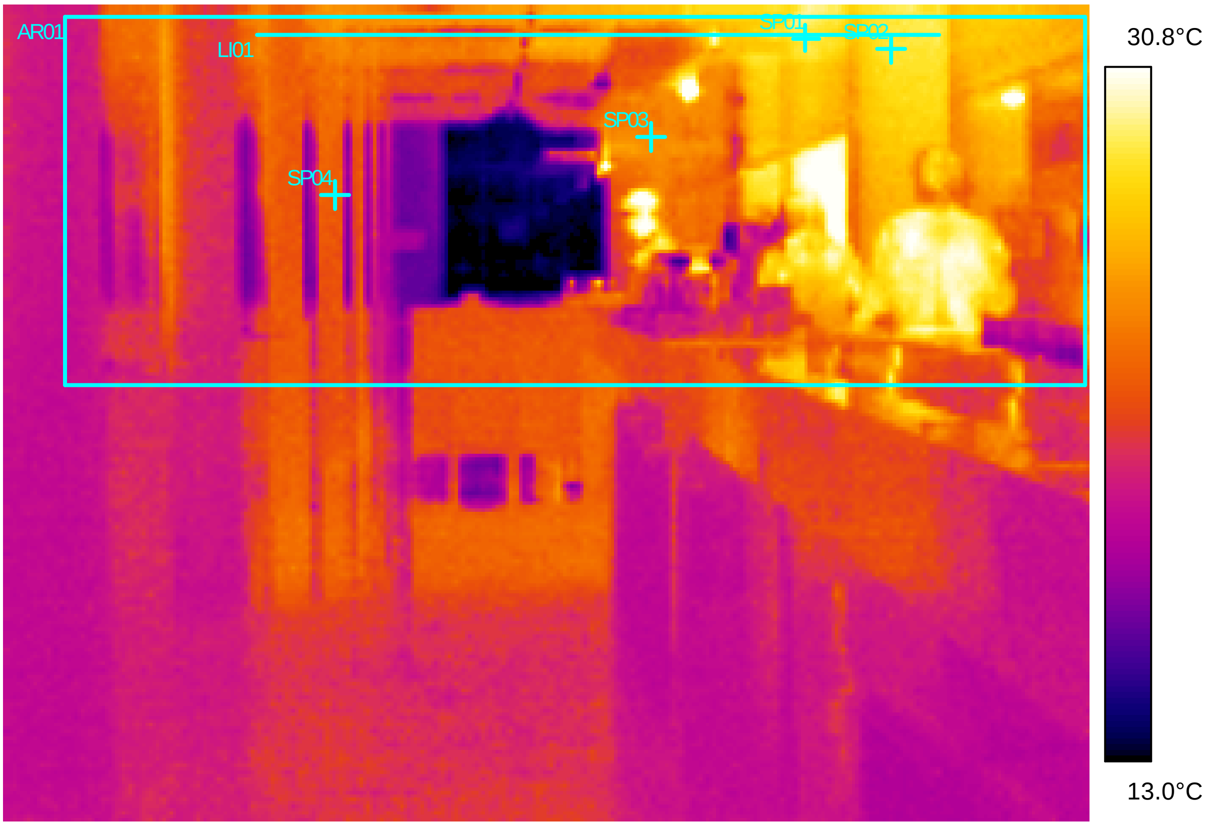


IR information	Value	
Date of creation	1/9/2005	-
Time of creation	2:54:37 PM	-
Object parameter	**Value**	
Emissivity	0.94	-
Object distance	6.0 m	-
Ambient temperature	22.0°C	-
Atmospheric temperature	22.0°C	-
Transmission	0.99	-
Label	**Value**	**Diff**
SP01	22.5°C	0.1°C
SP02	22.4°C	0.0°C
SP03	22.2°C	-0.2°C
SP04	22.3°C	-0.1°C
LI01 : max	22.6°C	0.2°C
LI01 : min	21.5°C	-0.9°C

Brassaii vertical temperature distribution - Dining Room

The above picture shows the temperature distribution in the main dining room of the restaurant. Measurement points SP 1,2,3 and 4 show the temperature of the columns at the respective height.

IR-Image File Name	Date
Brassaii Equailize Air Units OFF -Kitchen	7 jan 05

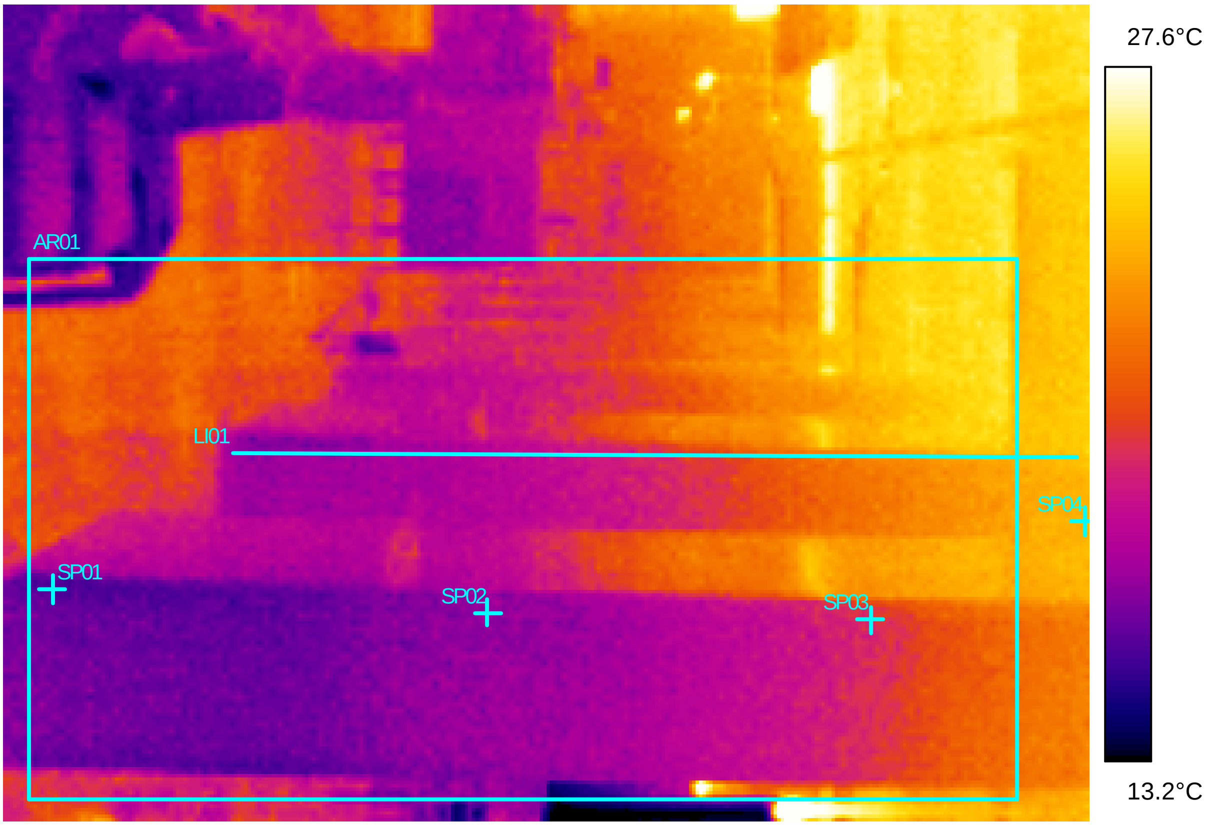


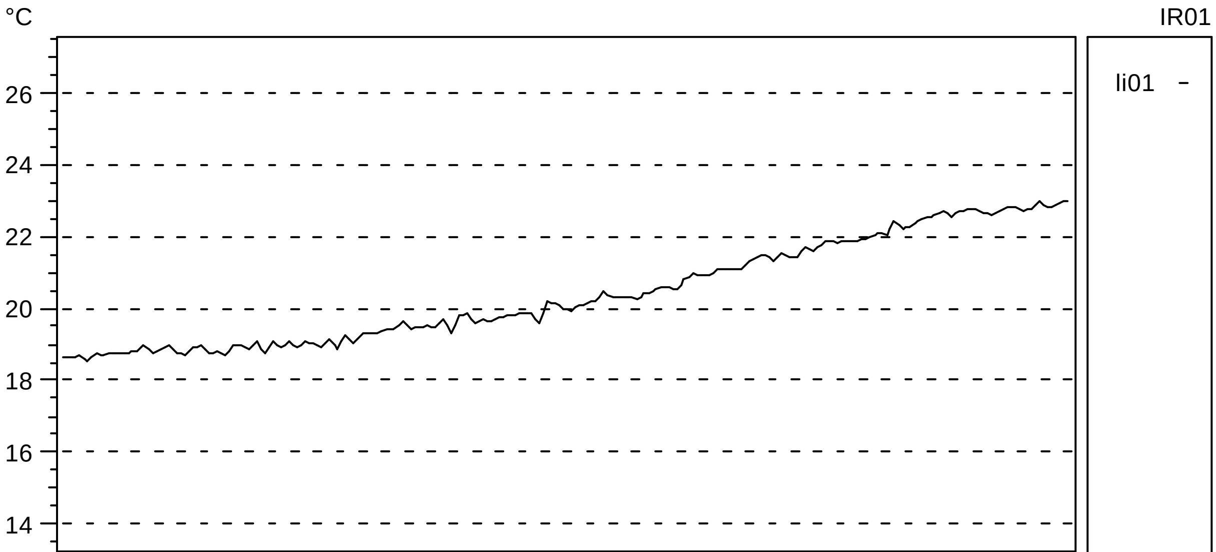
IR information	Value	
Date of creation	1/7/2005	-
Time of creation	2:50:27 PM	-
Object parameter	**Value**	
Emissivity	0.94	-
Object distance	2.0 m	-
Ambient temperature	20.0°C	-
Atmospheric temperature	20.0°C	-
Transmission	0.99	-
Label	**Value**	**Diff**
SP01	28.4°C	8.4°C
SP02	28.0°C	8.0°C
SP03	25.2°C	5.2°C
SP04	24.3°C	4.3°C
LI01 : max	28.9°C	8.9°C
LI01 : min	23.5°C	3.5°C

Brassaii kitchen area temeperature distribution

The above picture shows the temperature distribution in the area surounding the kitchen. Measurement points SP 1,2,3 and 4 show the temperature at the respective locations while line 01 shows the minimum and maximum across the line distance..

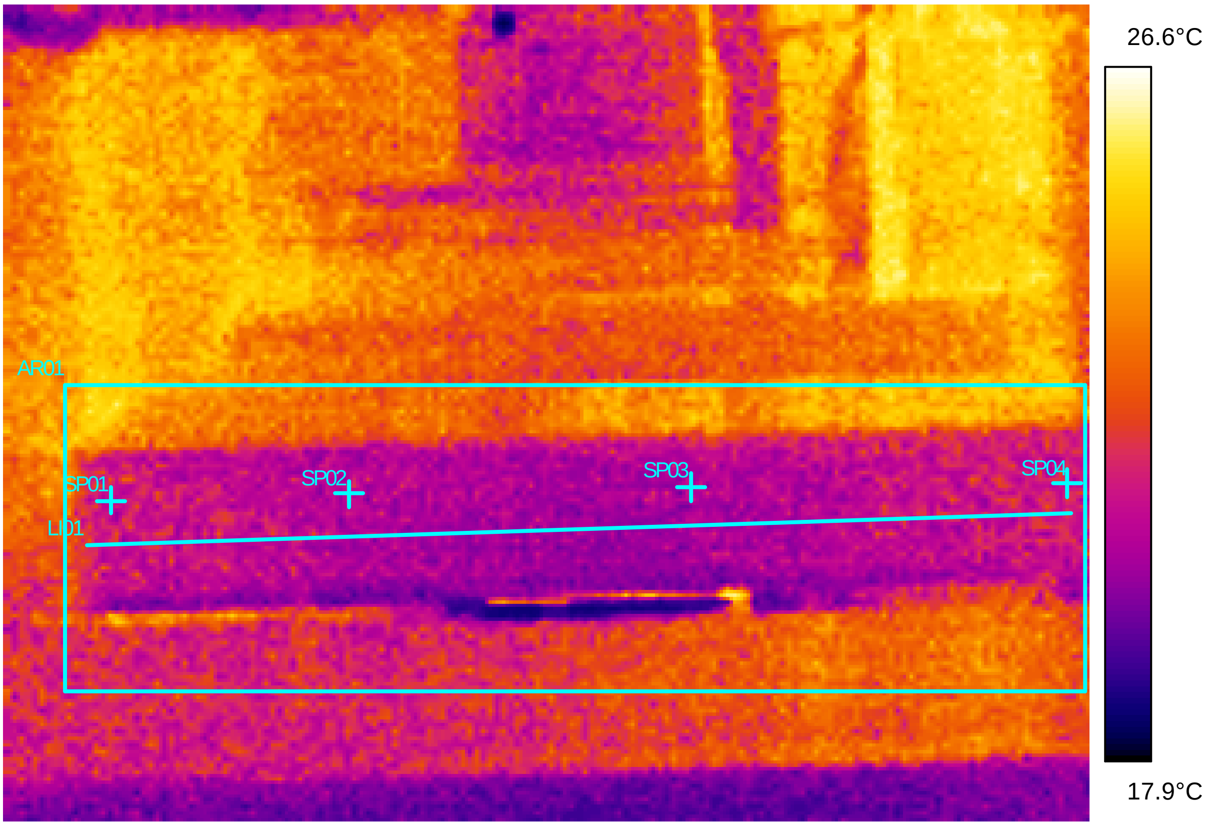
IR-Image File Name	Date
Equailize Air Units OFF - Column Temperature Graph	5 jan 05

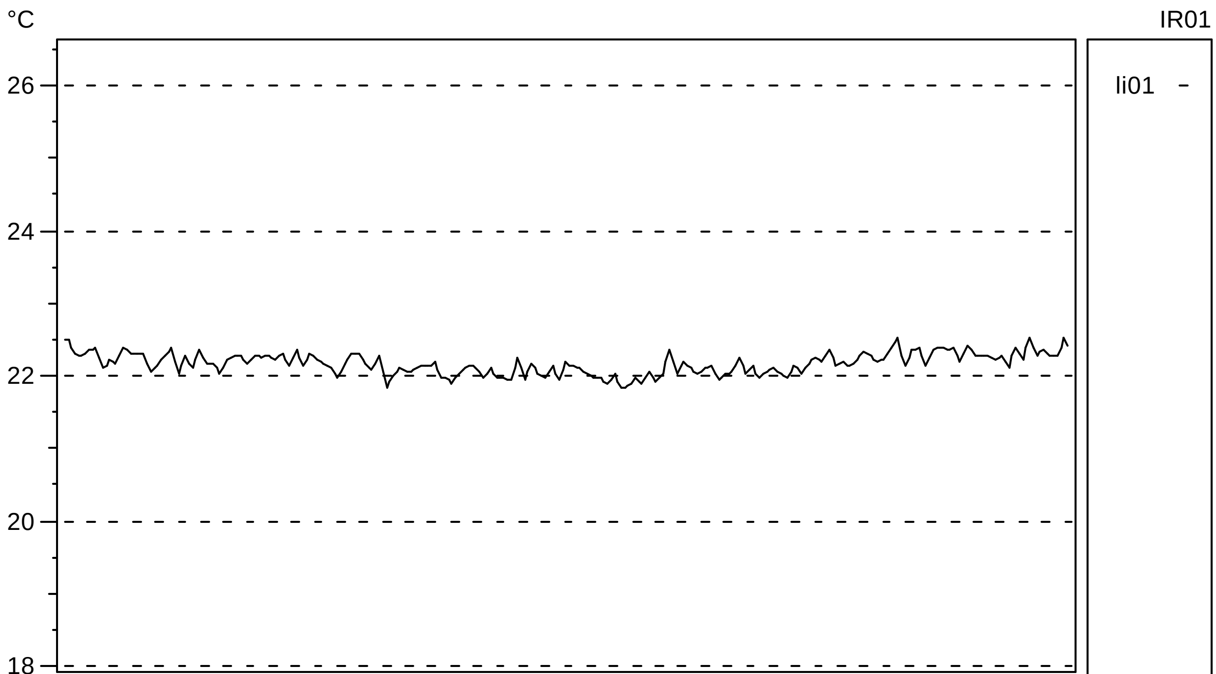




Line	Min	Max	Cursor
li01	18.5°C	23.0°C	-

IR-Image File Name	Date
Brassaii Equailize Air Units ON - Column Graph	9 jan 05





Line	Min	Max	Cursor
li01	21.8°C	22.5°C	-

VI. <u>Results</u>

Since Brassaii is located in between floors in a multi dwelling building there is no heat loss generated through the floor and ceiling. The main heat loss in the restaurant is a result of the infiltration and exhaust air. From the enclosed calculations in "Figure 8" by Terrelonge (1) the heat loss for the restaurant comprised of the following:

Design T - F	0			
	TIN ^{o}F	TO ^{o}F	DT ^{o}F	
	72	0	72	
U Values				
Wall	0.1			
Glass	0.58			
Roof	NA			
Infiltration	800	cfm		
FA	6000	cfm		
CFM Door	0			
Wall	2470	0.1	72	17,784
Glass	1010	0.58	72	42,178
Roof				
Infiltration	800	1.08	72	62,208
FA	6000	1.08	72	466,560
TOTAL Btu/h				588,730
TOTAL kW				173.16

:Figure 8" Terrelonge Heat Loss Calculation

(1) Terrelonge, 477 Richmond St. W #306 Toronto ON Canada M5V #E7

Considering that the exhaust removes the hottest air in the restaurant located below the ceiling it is obvious that de-stratification and reducing the temperature of the room will result in the maximum energy saving that can be achieved in this scenario. Temperature reductions in the kitchen area near the exhaust of 2oC to 4oC are possible without sacrificing comfort.

During December the total HDD for Toronto were 643.4 ^{o} C or an average HDD per day of 20.75 o C or 37.35 o F.

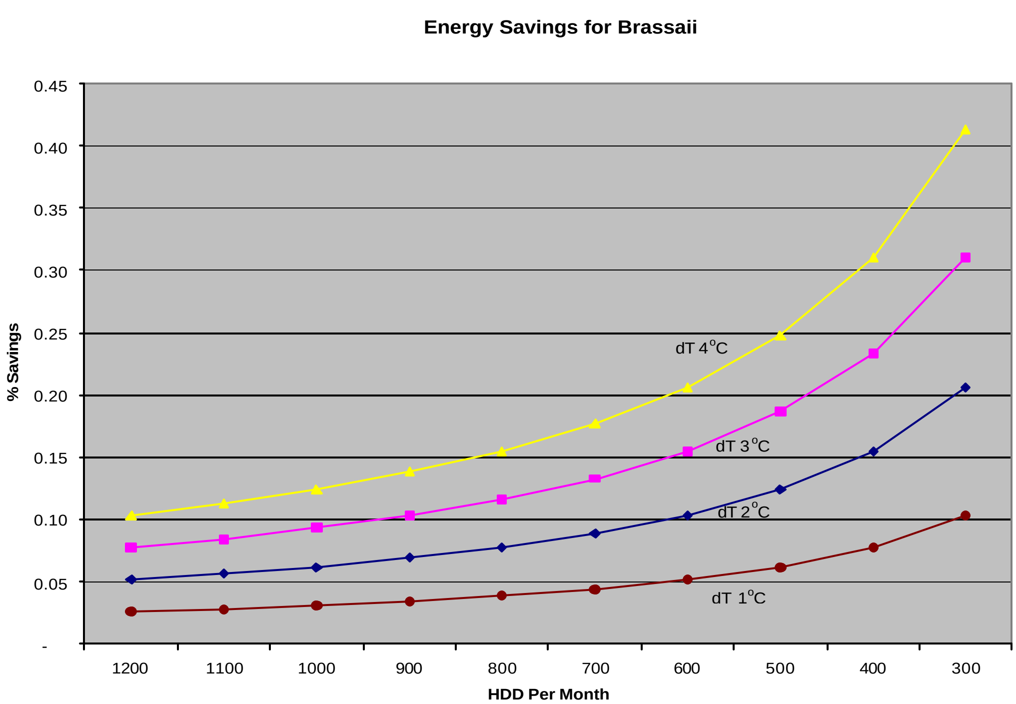
By reducing the temperature of the ambient and exhaust air in the restaurant by 2 ^{o} C or 3.6oF we can achieve a 9.6% saving. Further in the report the infrared pictures show how de-stratification allows for this reduction without sacrificing comfort level in the restaurant.

During January 2005 the total HDD for Toronto was 770 ^{o} C. This creates a different saving scenario resulting in 8% saving in the energy consumption for a 2^{o}C drop.

We can thus conclude that the energy saving will be a function of the total HDD for the month in question and the reduction in temperature that can be achieved by de-stratification. In colder months with HDD of 1000 ^{o} C the energy saving will be lower but still up to 6% while in warmer months like October with HDD of 226 ^{o} C the energy saving can reach values above 25%.

In order to analyze the savings we calculated the total gas consumption for the period Nov 28, 2003 to Jan 30 2004 and Nov 29, 2004 to Jan 31 2005 and compared it to the HDD for the respective periods excluding the average gas consumption during the summer periods for cooking calculated at 3062 m3. ("Figure 4" – Months: July, August and September of 2004).

Gas consumption for heating was calculated at 1347 m3 for 1410 HDD and 974 m3 for 1413 HDD respectively. This shows a savings of 28% for the period that used the Equalize air units. Since most of the gas was consumed in the kitchen for cooking, its effect in the total gas consumption can not be easily separated without additional monitoring. Brassaii also intermittently operated gas patio heaters during the month of November and this consumption needs to be taken into account. Nevertheless the number of 28% gas consumption for heating warrants additional testing and measurements.



"Figure 6"

The above calculations and savings were based on the fact that we can reduce the ambient temperature in the kitchen area where the main exhaust originates by 2 ^{o} C and thus achieve savings of 9% and 16 % for October and November 2004 respectively.

Since the isotherms around the kitchen at height of 1.8 m. show temperatures ranging from 25 ^{o} C to 28 ^{o} C (FLIR 4), we can assume a possible average reduction of 4 ^{o} C when the kitchen operates. Unfortunately the kitchen does not operate full time so during idle hours the ?T drops to 2 ^{o}C. “Figure 4” illustrates the isotherms around the kitchen area. A better representation of the temperatures is visible on the thermograph showing the kitchen and surrounding area in the infrared study (FLIR 4).

Thus the calculated savings of **28%** in gas consumption for heating Brassaii are a result of an average exhaust temperature difference of over 4^{o}C over the 2 month period.

VII. Summary and recomendations

Stratification tends to affect heat loss in buildings that have roofs exposed to the environment with high ceilings and a large vertical ?T. In the case of Brassaii there is an additional floor above and the heat loss from the ceiling is nullified.

In the case of the Canadian Tire store in Peterborough the roof is exposed to the environment and it generates the major heat loss.

It is clear that in Brassaii if there are to be substantial energy savings main emphasis has to be toward reducing the temperature of the exhaust air. The temperature in the surrounding area near the kitchen was 4^{o}C higher that that in the main dining room rising up to 24^{o}C at 1.5 m height and 29^{o}C at the ceiling during lunch hour (FLIR 4). Since the main exhaust system draws air from this area equalizing the temperature in this part produces the main energy savings.

The equalized air units performed well in equalizing not only the vertical distribution in the restaurant but also more importantly the horizontal distribution and hot pockets created by the kitchen generated heat.

Measurements without the Equalize-air showed stratification of 4.5^{o}C to 6^{o}C depending on the room location. With the equalize air units stratification was reduced and almost negligible as shown with the infrared thermographs (FLIR 2 and FLIR 3).

The installed units provided a marked improvement in thermal conditions within the restaurant compared to the situation without the units. Savings of 6% to 25% were expected depending on the HDD for the month.

Measured gas savings for December and January were actually **28%**.

In the case of the Canadian Tire store the actual gas savings calculated for December 2004 and January 2005 showed an impressive **30%.**

We can thus summarize that:

a) The Equalize-Air units reduced the energy consumption in Brassaii by 28%.
b) At the Canadian Tire store the savings were 30%.
c) Free standing building with exposed roofs to the environment will have additional savings to multi dwelling locations.
d) The equalized air fans caused the air to mix and reduced stratification significantly allowing for a lower overall room temperature with the same or increased comfort level.

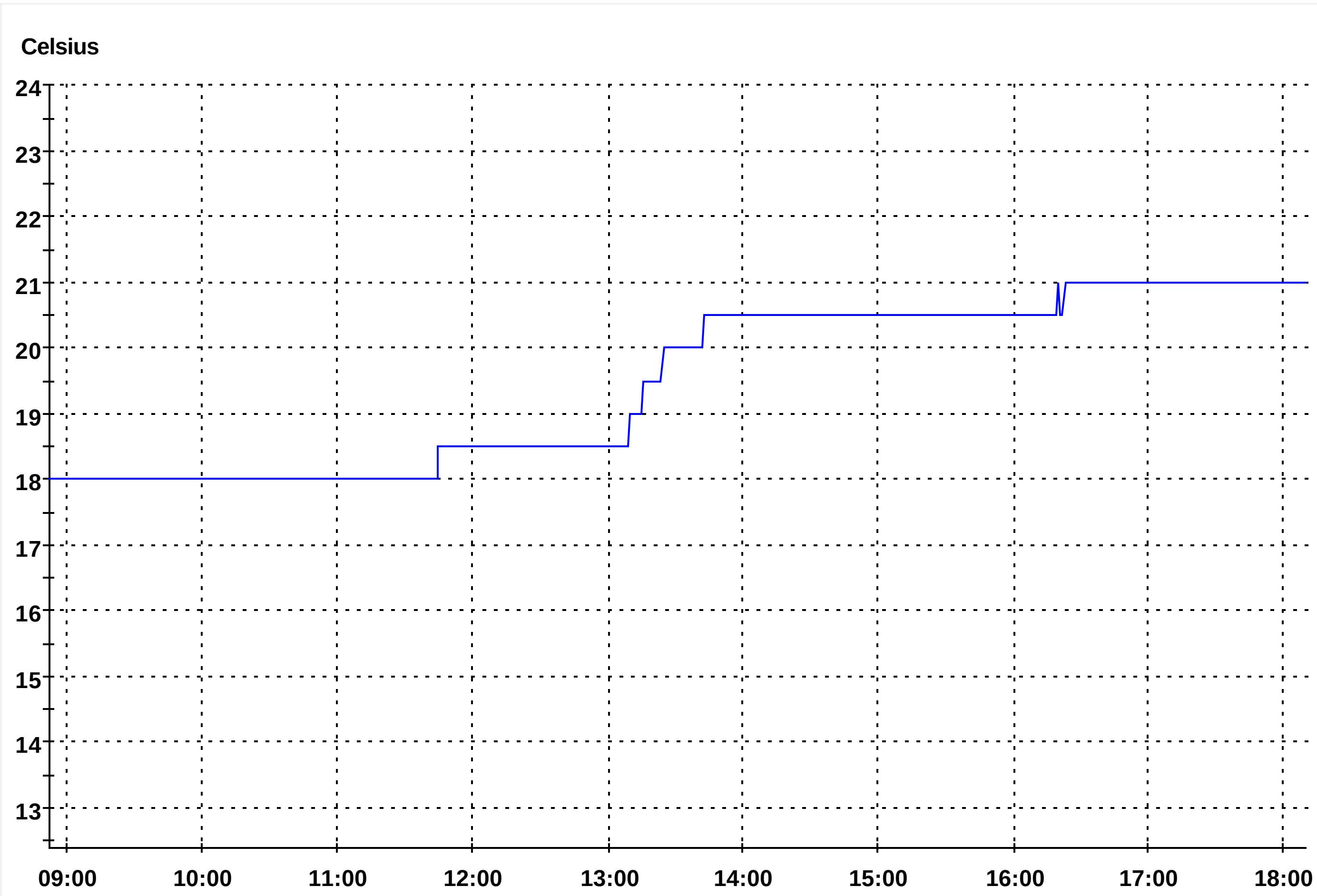
e) The system created a more evenly distributed temperature on a horizontal level eliminating hot and cold spots.
f) Installing the units lowered overall energy usage by reducing the temperature of the exhaust air and roof generated losses.

While we have a good indication of how the equalize air fans works in this system, testing different conditions of exhaust air, infiltration and external temperatures, will result in different temperature profiles and different energy savings.

This report must be read and interpreted within the context in which it was compiled.

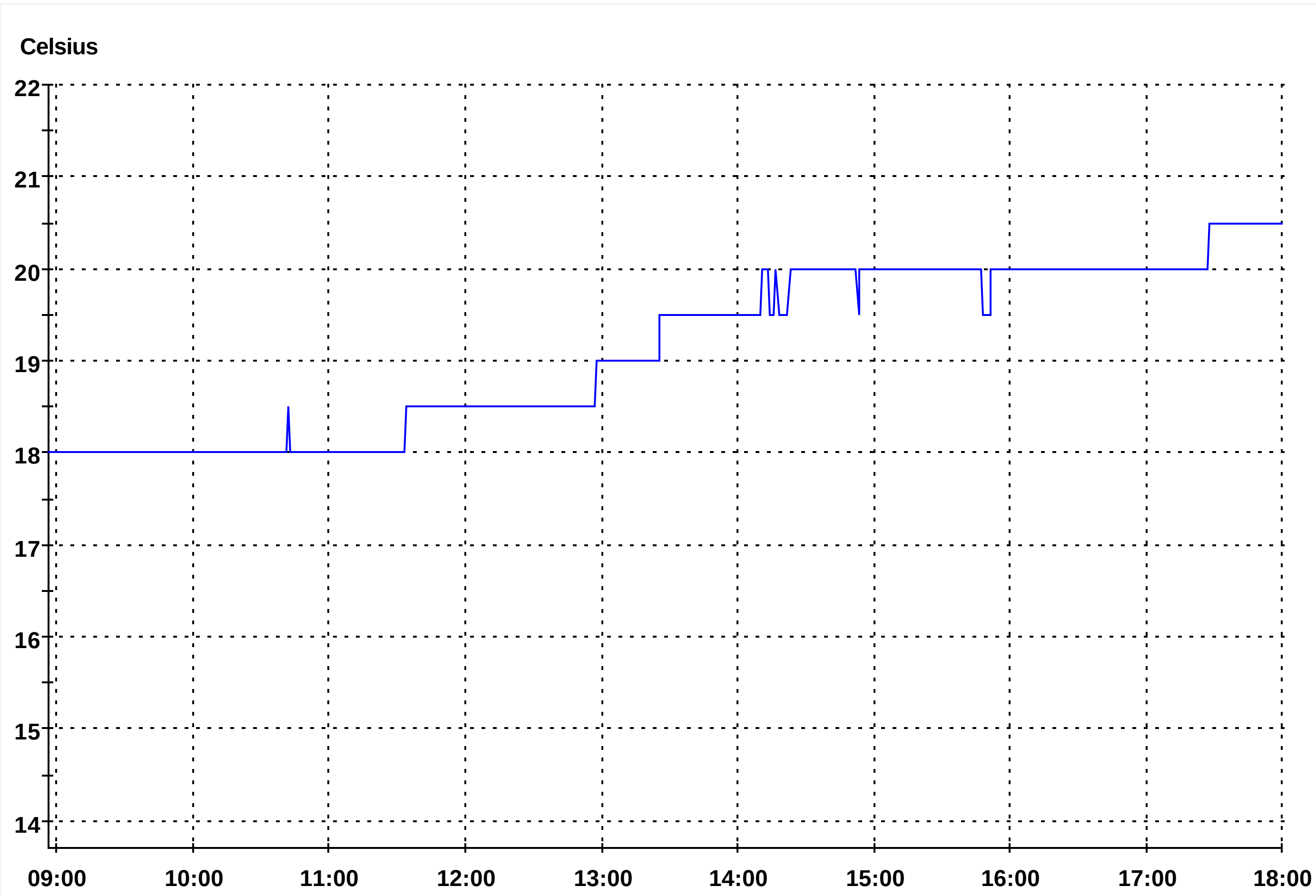
The results presented here are valid only for the installation assessed. They are dependent on the boundary conditions and units used.

Brassaii Floor



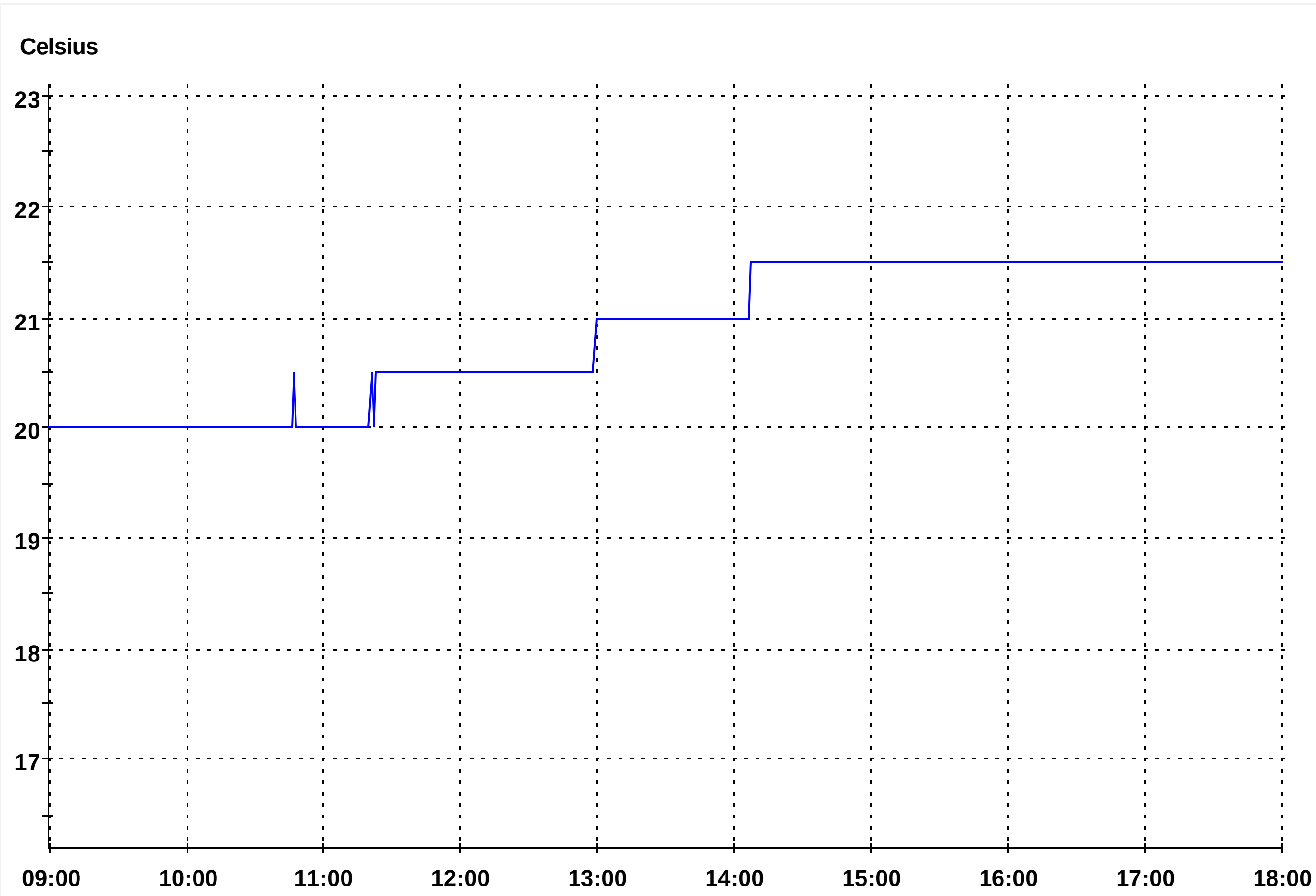
From:- 06 January 2005 08:52:00 To:- 06 January 2005 18:10:00

Brasai Mid



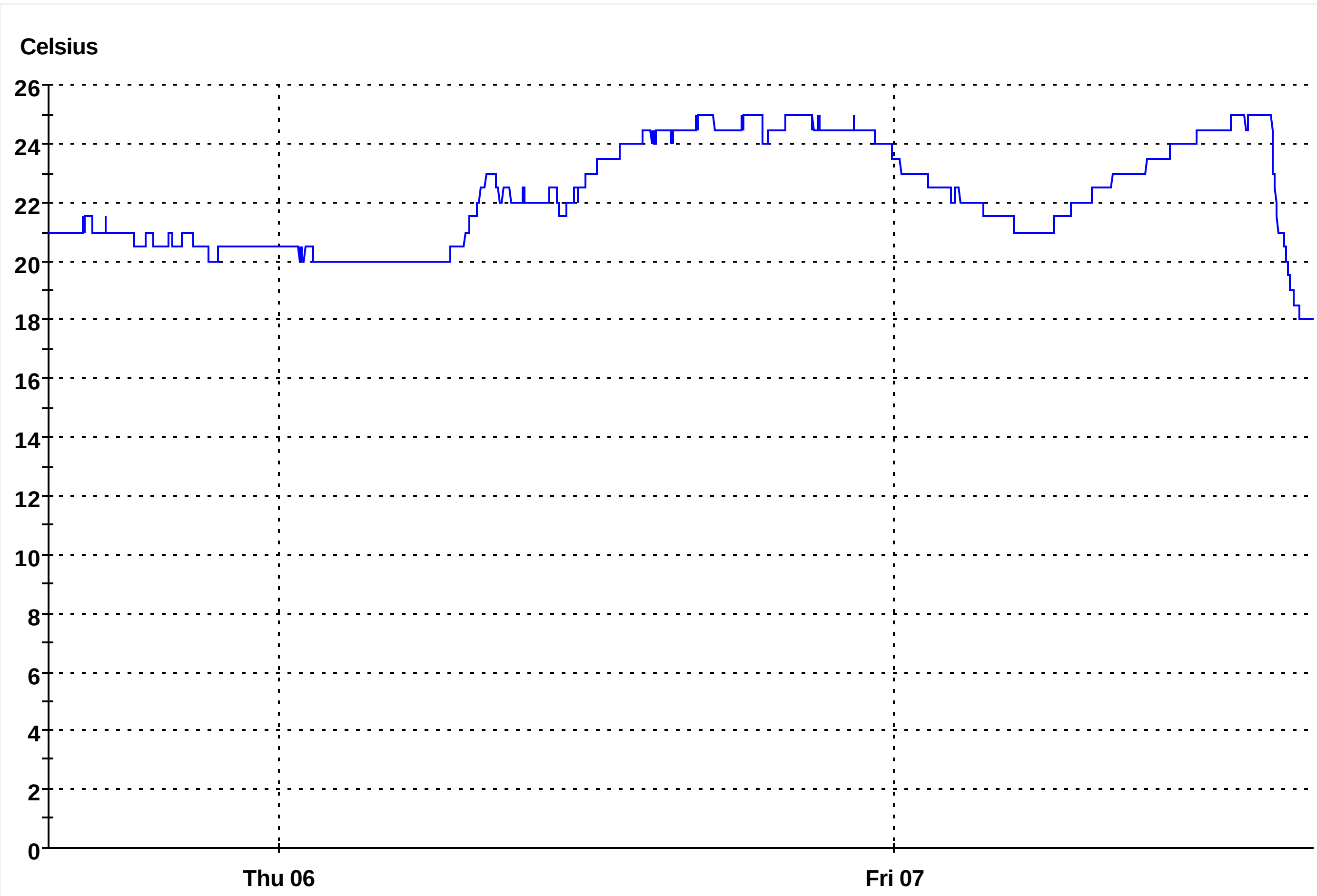
From:- 06 January 2005 08:56:00 To:- 06 January 2005 18:00:00

Brasai Ceil



From:- 06 January 2005 08:59:00 To:- 06 January 2005 18:00:00

Brasai Therm



From:- 05 January 2005 15:00:00 To:- 07 January 2005 16:20:00

EL-USB-1

Temperature Data Logger with USB Interface

This data logger measures and stores up to 16,382 temperature readings over a -25 to +80°C (-13 to +176°F) range. The user can easily set up the logging rate and start-time, and download the stored data by plugging the module straight into a PC's USB port and running the purpose designed software under Windows 98, 2000 or XP. Data can then be graphed, printed and exported to other applications. The data logger is supplied complete with a long-life lithium battery, which will last for at least 1 year. Correct functioning of the unit is indicated by a flashing red, green and orange LEDs. The data logger is protected against moisture to IP 67 standard when the protective cap is fitted.

- -25 to +80°C (-13 to +176°F) Measurement Range
- USB Interface for Set-up and Data Download
- 2 User-Programmable Alarm Thresholds
- Bright Red, Green and Orange LED Indication
- Replaceable Internal Lithium Battery
- IP 67 Protection

WINDOWS CONTROL SOFTWARE

Easy to install and use, the control software runs under Windows 98, 2000 and XP (Home and Professional Editions)*. It allows the user to set up and download any EL-USB-1. The latest version of the control software may be downloaded from *www.lascarelectronics.com*.

DATA LOGGER SET-UPS

- Logger Name
- °C, °F
- Logging Rate (10s, 1m, 5m, 30m, 1hr, 6hr, 12hr)
- High and Low Alarms
- Start Date and Start Time

SPECIFICATIONS

Specification	Min.	Typ.	Max.	Unit
Measurement range	-25 (-13)		+80 (176)	°C (°F)
Internal resolution		0.5 (1)		°C (°F)
Accuracy (overall error)		±1 (±2)		°C (°F)
Logging rate	every 10s		every 12hr	-
Operating temperature range	-25 (-13)		+80 (176)	°C (°F)
1/2AA 3.6V Lithium Battery Life	1*			Year

* @ 25°C and 1m logging rate