Equalize Air Inspection Report
Canadian Tire
Peterborough Store

Prepared for: Enbridge Gas Distribution

Date: February 9, 2005

Table of Contents:

I. Executive Summary

This report describes the measured temperatures and performance of the de-stratification fans manufactured and installed by Equalize-air in the Canadian Tire store in Peterborough Ontario, during the heating season. The measurements in the store were concentrated on the de-stratification performance of the fans. Results of the measurements were compared to data supplied by Equalize–Air and Canadian Tire on the temperatures in the store prior to installation.

The store is a free standing building above grade with several entrances and an automotive shop as a separate enclosed space.

Temperature data loggers were used to measure the stratification during outside temperatures of -3^{o}C by placing them on a vertical column in the store. The data from the loggers shows that stratification exists in this environment and it measured as floor to ceiling temperature differential of 4^{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 the store environment to a temperature difference of 1^{o}C and thus have a significant impact on comfort and the buildings energy requirements.

Our calculations for the energy savings at the store for the months of December 2004 and January 2005 showed a saving of 30% in the heating gas consumption.

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

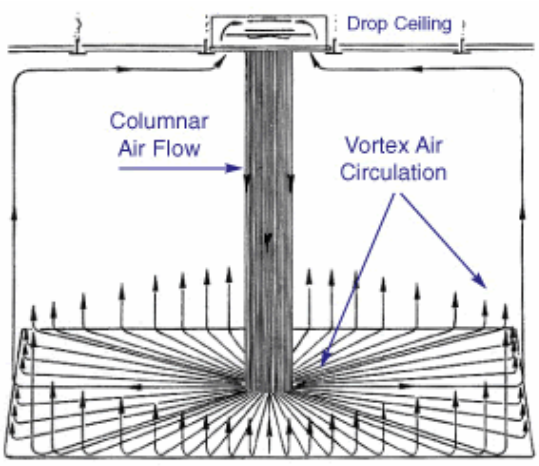
II. Objective

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).



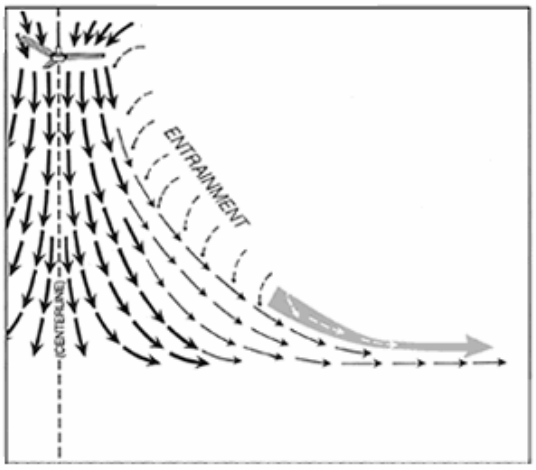


Figure 1 (a) Equalize-Air System unit **Figure 1 (b) conventional ceiling fan unit**
http://www.equalize-air.com/howitworks.html

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:

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

Store design features

The Canadian tire store is a typical warehouse type building with transverse isles affecting the air flow of the de-stratification units.

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 XX fans at the specified capacity 1100 cfm we have 11000 cfm air recirculation.

The system was installed in a store with floor area of XXXXX ft^2

The volume of the shopping area is: XXXXX ft^3

With the volume calculated at XXXXX ft^3 and 10 fans operating we achieve a complete recirculation of the air in the room every XXX minutes if we assume no obstacles and maximum operating speed of the units.

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

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

Month	HDD
Nov-03	402
Dec-03	588.1
Jan-04	817.6
Nov-04	463.6
Dec-04	596
Jan-05	623.1

Figure 3

- **Furnace gas consumption metering**

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

Markus Weinbrecht (Account #847620849995, Rate 6)
1050 Chemong Rd Peterborough

Reading Date (YYYYMMDD)	Consumption (m3)	Total Gas Charge ($)
19-Feb-03	49,081	$16,095.95
19-Mar-03	26,192	$8,634.84
23-Apr-03	5,997	$2,260.04
21-May-03	1,952	$828.50
15-Jul-03	91	$62.35
13-Aug-03	0	$22.00
17-Sep-03	65	$51.96
22-Oct-03	822	$385.29
31-Oct-03	3,150	$523.84
19-Nov-03	1,493	$259.87
18-Dec-03	11,391	$2,037.99
21-Jan-04	19,473	$2,732.26
18-Feb-04	14,974	$1,829.34
20-Mar-04	14,453	$1,771.29
20-Apr-04	8,668	$937.57
18-May-04	4,453	$523.49
18-Jun-04	1,652	$228.15
20-Jul-04	807	$129.35
20-Aug-04	23	$25.25
17-Sep-04	37	$27.23
18-Oct-04	312	$66.86
22-Nov-04	2,317	$291.14
20-Dec-04	10,708	$1,201.34
16-Jan-05	10,090	$1,131.14

Figure 4

- **Air stratification**

Since the store ceiling is 6 m tall air stratification exists to the levels found in warehouses and hangars. The stratification was expected to be in the ? T of around 10 ^{o} C but will need to be confirmed with actual temperature measurements and infrared thermographs.

- **Temperature profiling**

The store has several cold spots created by the infiltrated air from both the front and automotive entrance. Large window areas create discomfort and draft across the length of the outer wall. The isotherms around the door are illustrated in "Figure 5".

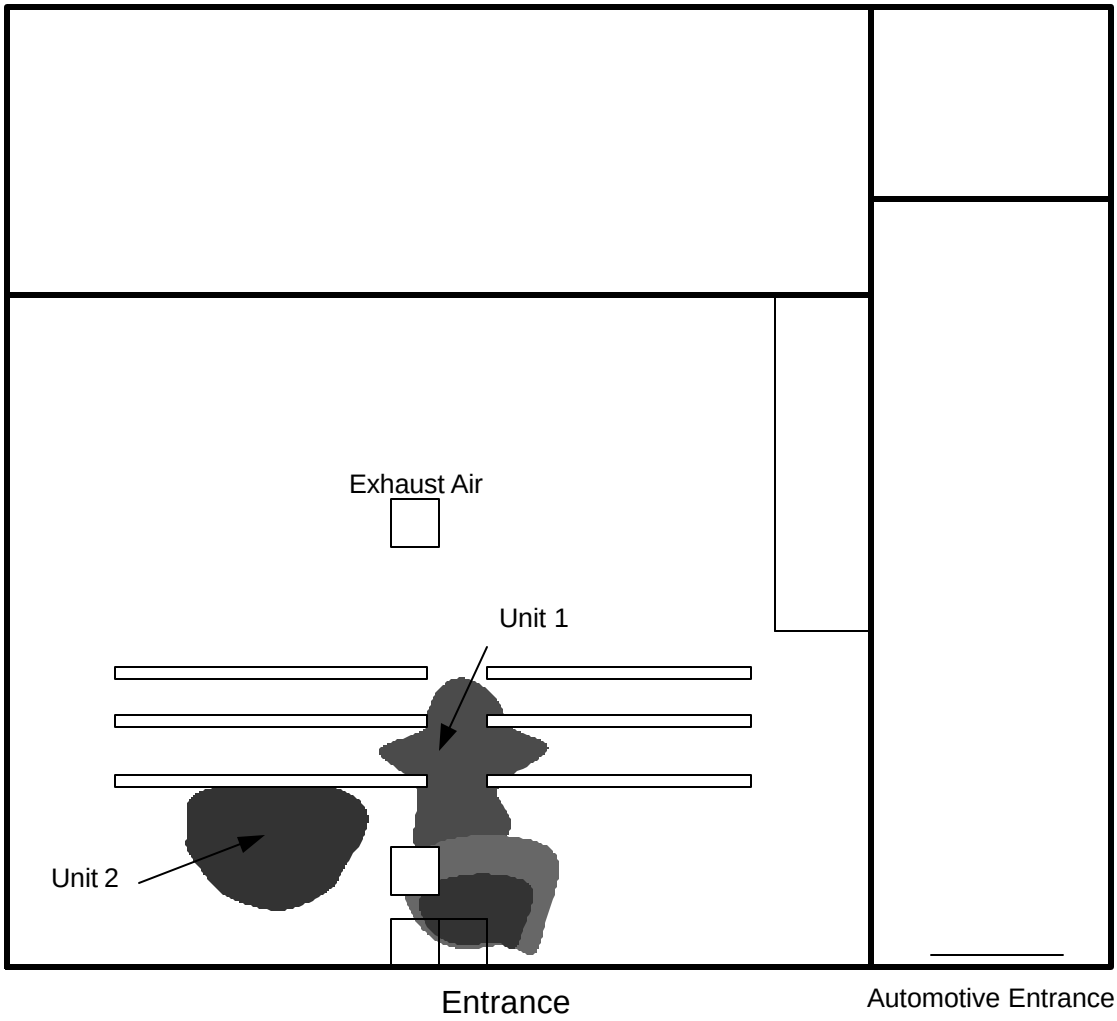


Figure 5

V. Installation

This installation comprised of mounting 10 Equalize-air units across the store at locations illustrated in the attached floor plan in “Figure 2”.

The horizontal positioning of the units had to take into account the location of the isles and the air flow. The units were mounted as high as possible on the ceiling as illustrated in “Figure 6”.

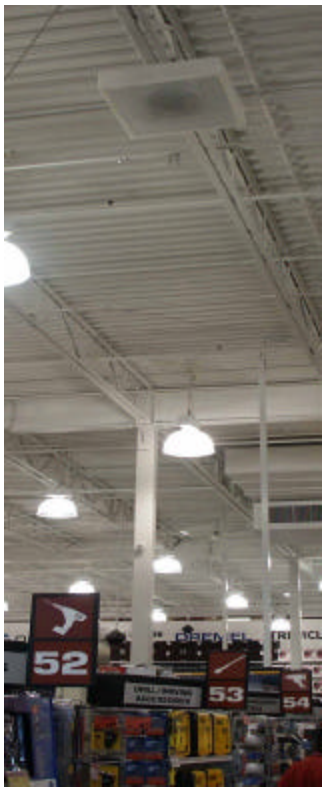


Figure 6 – Location of Equilize Air unit #1 in Canadian Tire Store

VI. Measurements

NMTG measured the selected test site at Canadian Tire 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 isles.
- Measurements using a digital temperature and humidity meter
- Infrared thermographs using a FLIR E4 infrared camera

a) <u>Indoor temperature measurements with data loggers</u>

For the purpose of measuring the temperature at Canadian Tire two data loggers were installed on one isle. These data loggers model EL-USB-1 were set to measure temperature every 1 minute. Specifications of this Unit can be seen in Appendix 3.

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

1. The location of the first unit designated "Can Tir Flor" was 5 cm above floor level at the second isle under the equalize air unit next to the entrance. Chart 1 illustrates the temperature data of this unit.
2. The second unit designated "Can Tir Mid" was located at a height of 2 meters on the same isle. Chart 2 illustrates the temperature data of this unit.

"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 once the units are turned on. Individual charts of the data loggers can be found in Appendix 1 and 2 to more clearly show the data from the loggers.

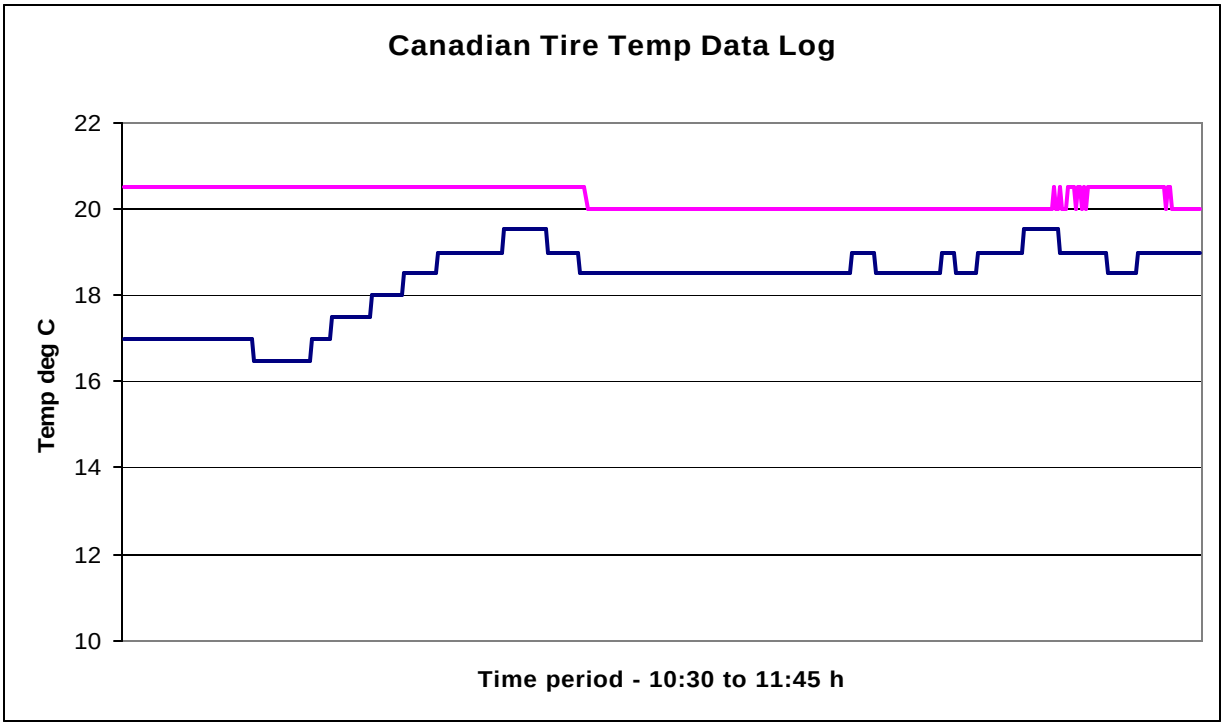


Figure 7

b) Measurements using a digital temperature and humidity meter

The 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 measurements coincided with the data loggers and infrared picture data.

c) Infrared measurements

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 Equalize Air system turned off

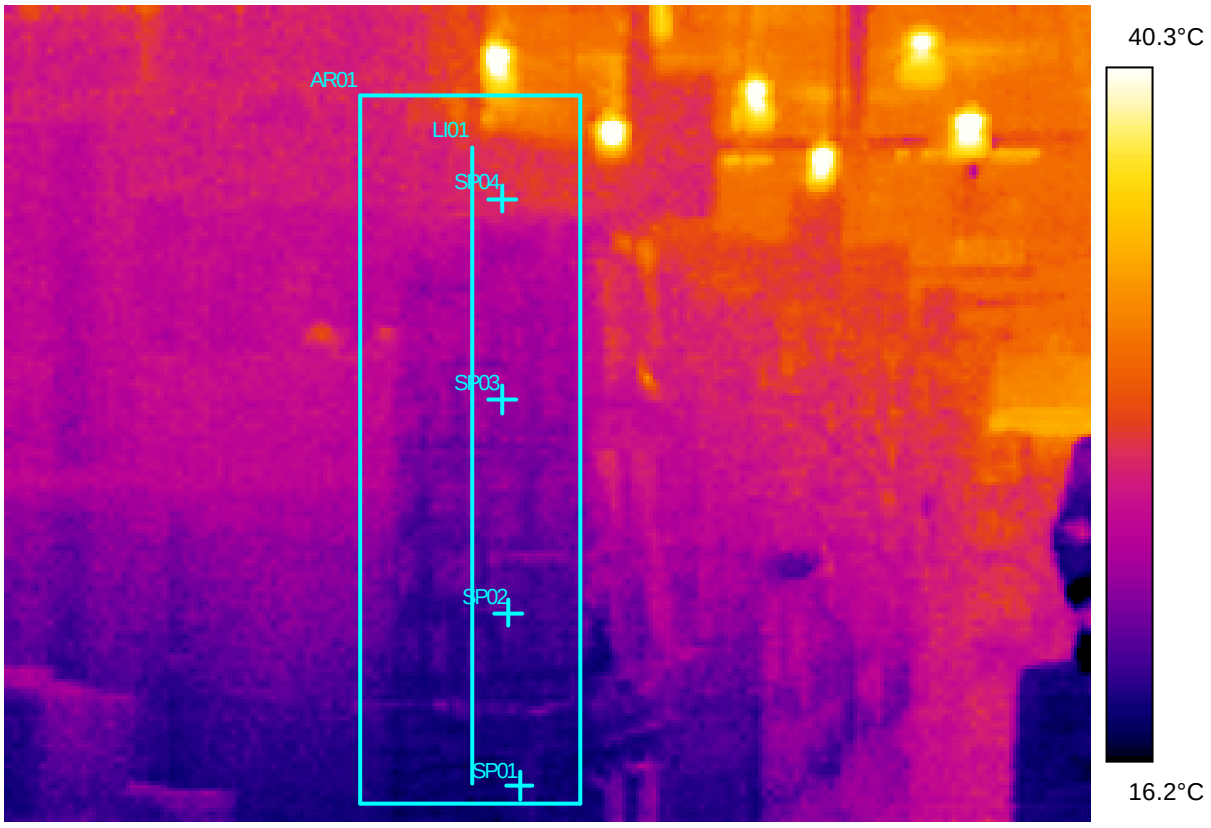
Stratification is noticeable on the isle with measured ? T of 3.6^{o}C at a height of 2m.
Stratification between ceiling temperature of 21.5^{o}C and floor temperature of 16.9^{o}C. was measured at a ? T of 4.6^{o}C.

2. **FLIR 2**
   Infrared measurement of the Equalize Air system turned on

With the equalize air fans operating it is immediately noticed that there is less stratification. The temperature across the isle equalized to a ? T of 1.8^{o}C and between the ceiling and floor to a ? T of 2.6^{o}C.
The temperature equalization occurred within a one hour period at the entrance of the store. The other locations at the store were equalized to much smaller ? T of 1.2^{o}C to 1.5^{o}C due to the fact that the system was turned off only the previous night and the thermal mass of the concrete floor was to large for it to cool down to the original levels before the units were installed.

FLIR Systems AB

IR-Image File Name	Date
Can Tire Equailize Air Units OFF	4 jan 05

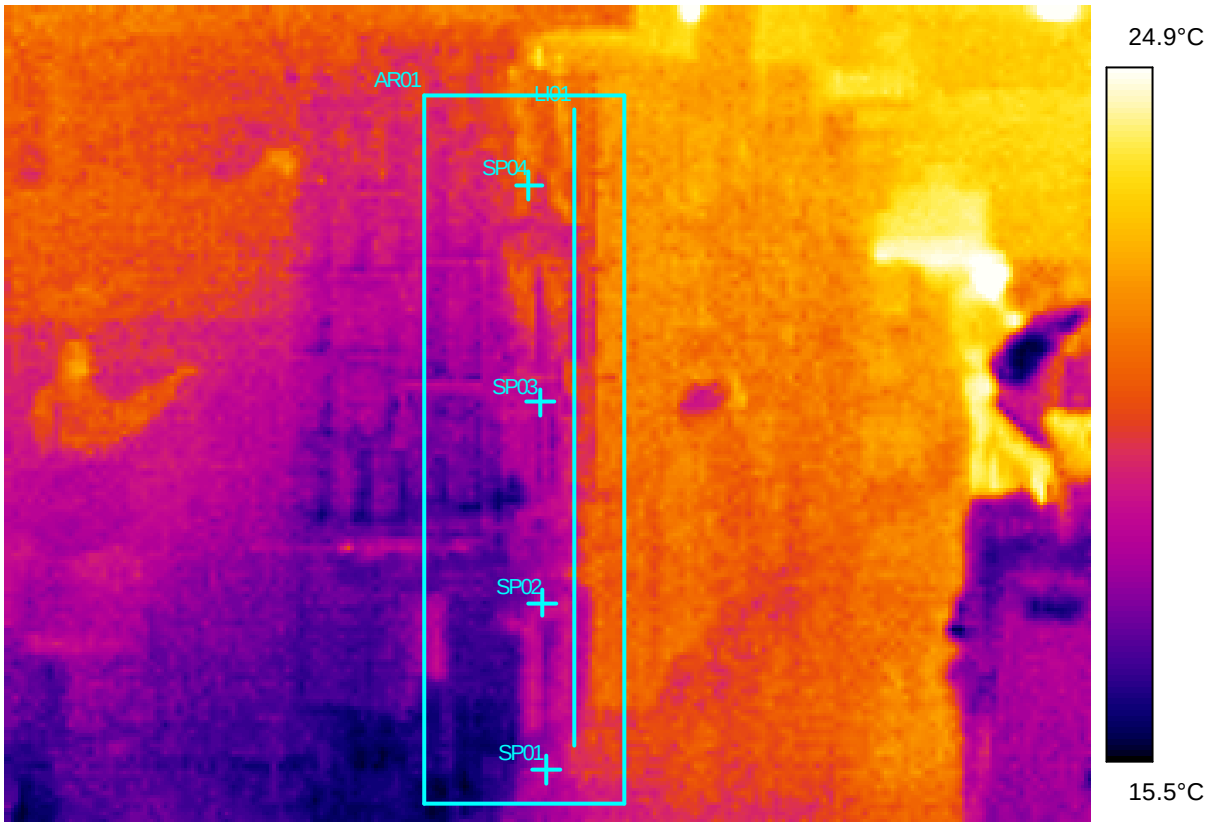


IR information	Value	
Date of creation	1/4/2005	-
Time of creation	10:25:57 AM	-
Object parameter	**Value**	
Emissivity	0.94	-
Object distance	2.0 m	-
Ambient temperature	20.0°C	-
Atmospheric temperature	20.0°C	-
Transmission	0.99	-
Label	**Value**	**Diff**
SP01	17.6°C	-2.4°C
SP02	18.1°C	-1.9°C
SP03	18.9°C	-1.1°C
SP04	20.4°C	0.4°C
LI01 : max	20.5°C	0.5°C
LI01 : min	16.9°C	-3.1°C

Can Tire vertical temperature distribution -Isle 1

The above picture shows the temperature distribution on the first isle in the store. Measurement points SP 1,2,3 and 4 show the temperature at the respective height.

IR-Image File Name	Date
Can Tire Equailize Air Units ON	4 jan 05



IR information	Value	
Date of creation	1/4/2005	-
Time of creation	11:00:53 AM	-
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	18.9°C	-1.1°C
SP02	18.6°C	-1.4°C
SP03	18.5°C	-1.5°C
SP04	20.0°C	-0.0°C
LI01 : max	20.3°C	0.3°C
LI01 : min	18.4°C	-1.6°C

Can Tire vertical temperature distribution -Isle 1

The above picture shows the temperature distribution on the first isle in the store. Measurement points SP 1,2,3 and 4 show the temperature at the respective height.

VI. Results

Gas consumption for heating was calculated at 35507 m3 for 1807.7 HDD and 23115 m3 for 1682.7 HDD respectively. This shows a savings of 30% for the three month period that used the Equalize air units.

The above savings can only be a result of the reduction of the ceiling temperature by over 5 ^{o} C from the temperature measured. No measurements were made before the installation of the units by NMTG.

Information from the supplier stated a ?T of 11^{o}C and the resetting of the thermostat to a lower value.

NB.
The following quote is from Equalize-Air regarding the conditions before the units were installed:

In response to our previous conversation, for your information:
The ceiling temperature at Can. Tire in Peterborough was
28 deg. C before Equalize-Air destratifiers were installed.
It is presently 20 deg. C on the ceiling.
The previous floor temp was 17 deg. C and is now 19 deg. C
The thermostats were previously set at 22 deg. C and are now set at 18 deg. C and the store remains comfortable

VII. Summary and recommendations

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 Canadian Tire all elements contributing to stratification can be found as a textbook example. The major heat loss is generated by the roof exposed to the environment, combined with heat losses of make up and infiltrated air.

It is clear that the reduction of the ceiling temperature produces substantial gas savings. We must note that heat generated from the ceiling lights was now used as the main heat source and thus assisted in reducing the gas consumption.

Measurements without the Equalize-air showed stratification of 3.6^{o}C to 4.6^{o}C depending on the location. With the equalize air units stratification was reduced to 1.8^{o}C and 2.6^{o}C as shown with the infrared thermograph (FLIR 2).

The installed units provided a marked improvement in thermal conditions in the store compared to the situation without the units with actual gas savings calculated at an impressive **30%.**

We can thus summarize that:

a) The Equalize-Air units reduced the energy consumption in the Canadian Tire by 30%.
b) 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.

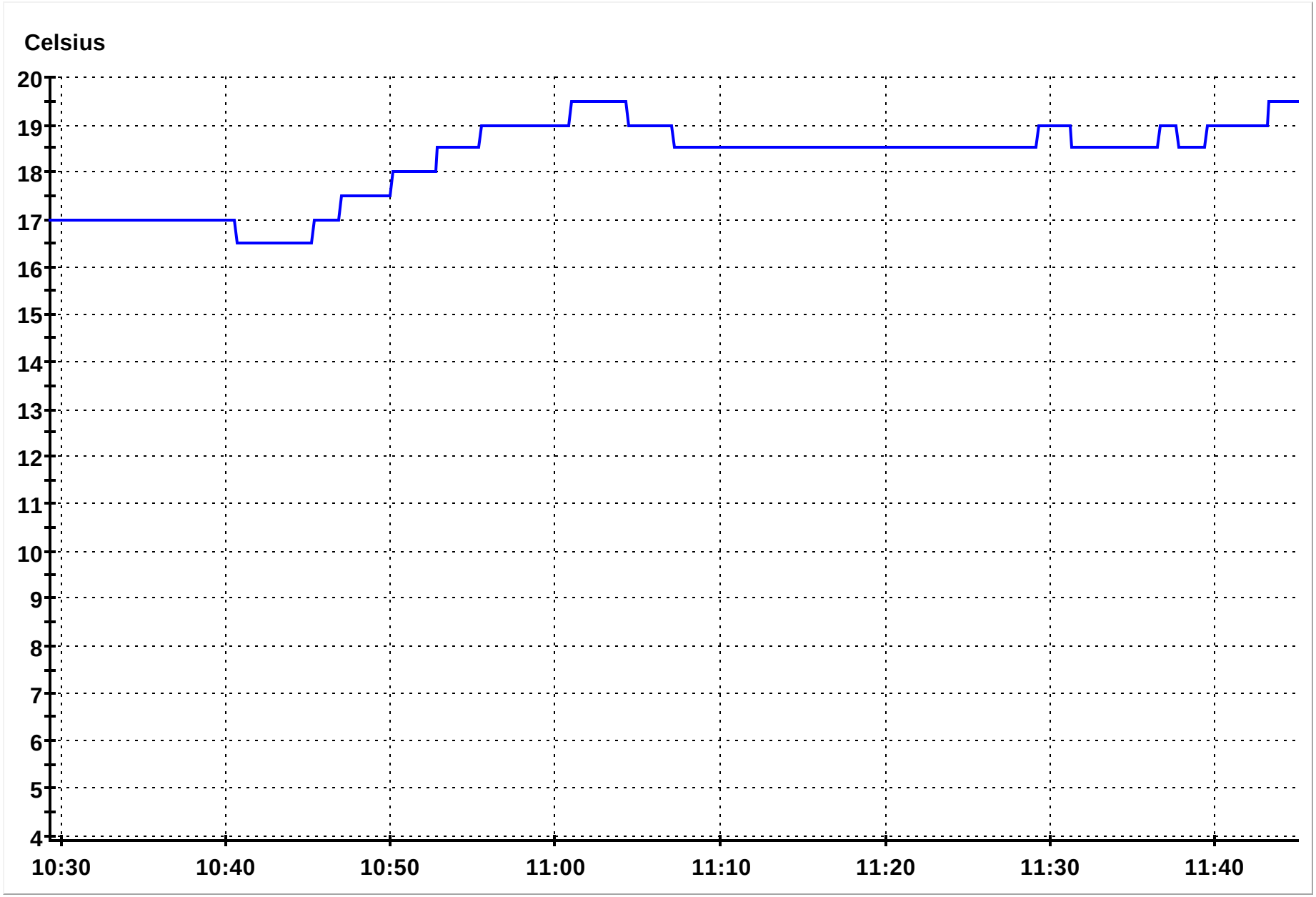
c) The system created a more evenly distributed temperature on a horizontal level eliminating cold spots.
d) Installing the units lowered overall energy usage by reducing the temperature of the exhaust air and roof generated losses.

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.

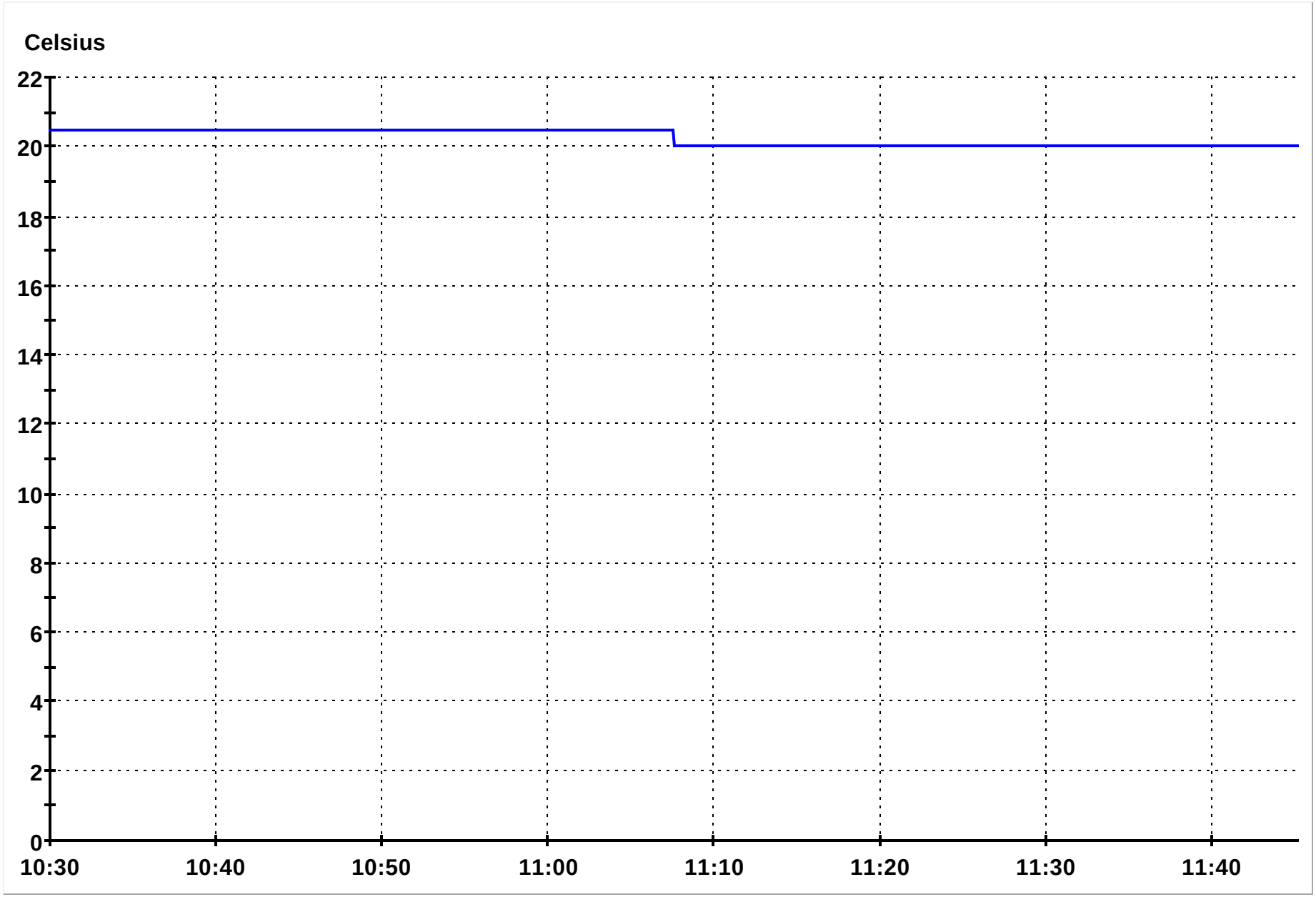
The results presented here are valid only for the installation assessed. They are dependent on the boundary conditions and units used.

CanTir flor



From:- 04 January 2005 10:29:20 To:- 04 January 2005 11:45:00

Can Tir Mid



From:- 04 January 2005 10:30:00 To:- 04 January 2005 11:45:10

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