

Report

SolarWall™ monitoring CA Roll Mill

Final Report 50052/A/1
May 2007

Carried out for: CA Group Ltd

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CONTENTS

1	SUMMARY.....	3
2	PROJECT OBJECTIVES.....	4
3	MONITORING EQUIPMENT	5
3.1	Thermocouples on the SolarWall™	5
3.2	Sensors in the ducting from the SolarWall™	7
3.3	Logging equipment and download software.....	8
3.4	Energy, CO ₂ savings and air quality display.....	8
3.5	Data collection and analysis	9
3.5.1	SolarWall™ control system.....	9
3.6	Gas and electricity consumption.....	10
4	RESULTS.....	11
4.1	Fuel Savings	11
4.2	Recommendations for optimising performance.....	11
4.3	Calculating energy saving potential.....	12
4.3.1	Stratification.....	13
4.4	Additional benefits	15
5	CONCLUSIONS	16
	BSRIA PRODUCTS AND SERVICES	23

APPENDICES

APPENDIX: A	ENERGY COLLECTION DATA FOR APRIL	17
APPENDIX: B	ENERGY COLLECTION DATA FOR MAY.....	18
APPENDIX: C	ENERGY COLLECTION DATA FOR DECEMBER	19
APPENDIX: D	TERMS AND CONDITIONS OF BUSINESS.....	20

TABLES

Table 1	Reduction in gas use and SolarWall™ Energy delivered.....	11
Table 2	Temperature gradients during heating periods only	14

FIGURES

Figure 1	Roll Mill monitoring sensor locations	5
Figure 2	SolarWall™ thermocouple locations.....	6
Figure 3	SolarWall™ showing thermocouples before placement of sheeting	6
Figure 4	Duct from SolarWall™ to roof penetration	7
Figure 5	Location of thermocouples in duct within building	8
Figure 6	SolarWall™ output display – proposed layout	9
Figure 7	Seven day temperature profile for all SolarWall™ thermocouples	10
Figure 8	Temperature profiles showing heater operation on a July morning.....	12
Figure 9	Energy collected over a 17½ day period in May-June.....	13
Figure 10	Stratification temperature differences over 10 weeks.....	14
Figure 11	Air stratification reduction from 19 April.....	15

1 SUMMARY

BSRIA monitored a SolarWall™ installation on the CA Group Roll Mill in Evenwood, County Durham for twelve months. Previous BSRIA Reports have reported on initial conditions, airtightness and thermal insulation in the Roll Mill and performance of the SolarWall™ for the first 3 months of operation. This report covers installation of the SolarWall™ and monitoring for the period from April 2006 to March 2007 when the SolarWall™ was operating.

The monitoring comprises 32 thermocouples embedded in the wall, two in the delivery duct, one in the building and one outside below the SolarWall™ plus a pyranometer for measuring solar radiation in the plane of the SolarWall™, all connected to one PC. There are also two external, seven room temperature and humidity sensors and a duct temperature and humidity sensor that communicate by radio with a data logger and telephone with the BSRIA office. In addition a set of sensors on a rack monitors air temperature stratification. A display of system output has been developed and used on collected data, but not installed for live monitoring at the time of writing.

Data has been collected from the SolarWall™ and temperature and humidity around the building. It has shown that the SolarWall™ is providing a significant amount of the heating required by the building.

The energy drawn from SolarWall™ and delivered to the building in each month over the twelve months studied amounts to 21% of the total heating energy used over this period, approximately 79,191kWh out of a total heating usage of 375,104kWh.

The SolarWall™, together with other energy saving features of the system, has reduced the demand for the gas-fired heating so that the gas bill has been reduced by 27,260 cubic metres of gas or 303,543kWh equivalent to 58.9tonnes of CO₂ or 51% of the 2005/6 consumption during the first year of operation.

The year 2006/7 was slightly warmer than 2005/6 (fewer degree-days) but the gas heating requirement per degree-day was reduced by 50%.

This substantial saving is partly attributable to destratification, which is effective in reducing heat demand even when the SolarWall™ is not supplying heat. Stratification has been reduced by the use of the SolarWall™ air distribution technique providing better use of the heat available by eliminating the build-up of warm air at roof level.

A real-time visual display of SolarWall™ temperature and energy supply has been developed and can be installed on any computer-based SolarWall™ monitoring system.

In short the system is producing significant, measurable savings in energy – hence carbon emissions. The SolarWall™ has contributed 21% of the total heat requirement, significantly more than the 10% of heating demand required for the system to be counted as “a renewable energy system” for planning purposes.

Some other uses of the SolarWall™ system such as warming fresh air for process heating, drying or pre-heating for industrial processes could result in even higher utilisation of the energy available from a SolarWall™ installation.

2 PROJECT OBJECTIVES

The SolarWall™ Metal Solar Cladding System (also known as the Transpired Solar Collector) is a perforated, profiled metal cladding panel, which is installed as an additional skin to a building's elevation. The dark coating on the panel absorbs solar radiation and is subsequently heated. Ambient air is then warmed as it is drawn through the perforations in the panel, to where it is collected within a cavity created between the two building walls. From here the heated air rises up the cavity to a fan unit, which distributes the air through high level fabric ducting. The installation on the SE facing wall of the CA Profile Mill is 70m wide and a total of 410m².

The overall aim of BSRIA's involvement in the SolarWall™ development is to produce, in the form of a supplied product to SolarWall™ users, a publicly visible display of the real time and cumulative savings in energy and "saved CO₂ emissions" achieved by the use of SolarWall™ - installed and demonstrated in an existing building retro-fitted with SolarWall™ (CA's roll shop).

This is to be achieved in the following stages:

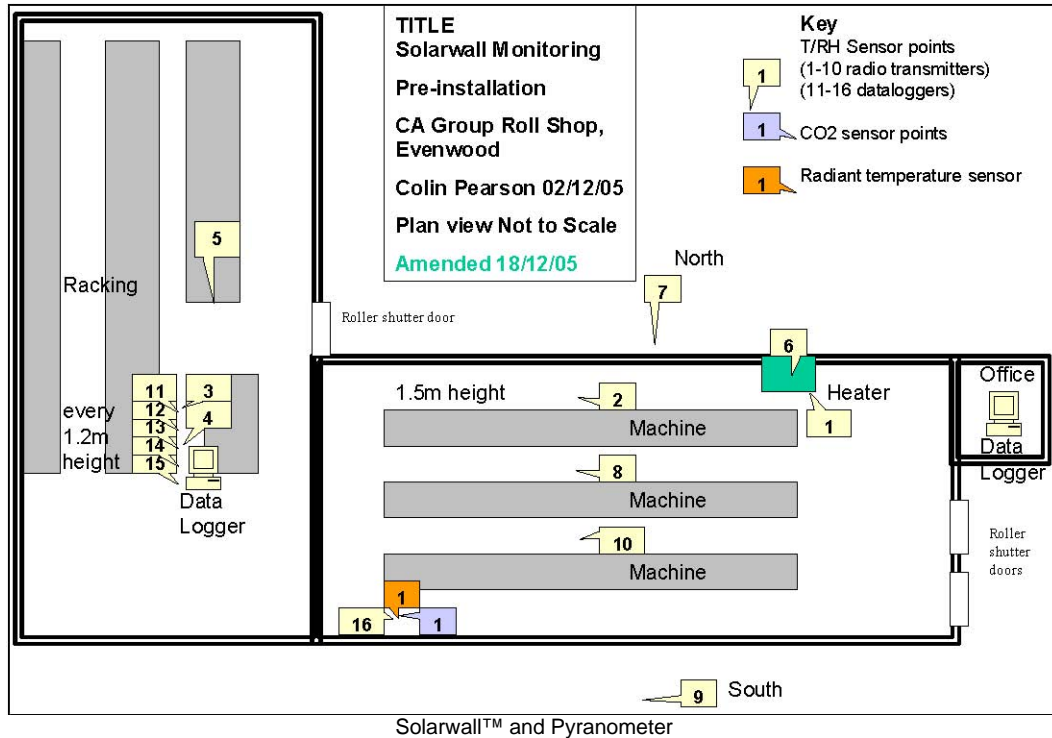
1. Undertake monitoring and produce building and energy performance report on an existing building. *This was reported in BSRIA Report 19681A/1 in February 2006.*
2. Undertake initial monitoring of SolarWall™ installation on the same building and develop a payback period model related to current and future energy costs. *This was reported in BSRIA Report 19681/1 in June and is updated for the whole year by this report.*
3. Develop a standard monitoring package for use in future installations.

The objectives of this report are to monitor the performance of the SolarWall™ retro-fitted to southern elevation and the effect of the associated ventilation system on the energy efficiency of the building over a full year and to complete the real-time visual display of energy collection.

3 MONITORING EQUIPMENT

The temperature and humidity sensors installed in stage one of the project were retained and monitored throughout stage two. The sensor positions are shown in Figure 1.

Figure 1 Roll Mill monitoring sensor locations



Temperature and Humidity Sensors 1-10 are connected to the data logger by radio transmitters for ease of downloading. Sensors 7 and 9 outside are screened from solar radiation. Temperature sensors 11-15 are connected to a data logger that was downloaded after 9 weeks. Temperature sensor 16 and associated sensors are included in a 'thermal comfort meter' that also measures radiant temperature and CO₂ concentration. Sensor number 5 shown in Figure 1 was moved, and installed into the steel 'T' section of the SolarWall™ duct (downstream of the fan unit) at the beginning of July.

3.1 THERMOCOUPLES ON THE SOLARWALL™

An array of thermocouples, 8 wide by four high was installed in the SolarWall™ cavity in February. Additional thermocouples were provided for duct and shop-floor temperatures. These were installed on 17 February 2006 and data was collected from that date onward although the SolarWall™ system was not commissioned until 21 March. The thermocouple locations can be seen in Figure 2, viewed from outside the building and the arrangement of the wall in Figure 3. The monitoring comprises 32 thermocouples embedded in the wall, two in the delivery duct and one in the building and one outside below the SolarWall™ plus a pyranometer in the plane of the SolarWall™, all connected to one PC.

Figure 2 SolarWall™ thermocouple locations

Channel numbering							
36	33	28	17	16	27	32	35
34	29	18	8	7	15	26	31
30	19	9	3	2	6	14	25
20	10	4	24	23	1	5	13

Figure 3 SolarWall™ showing thermocouples before placement of sheeting

The horizontal spacing of the thermocouples is 1.7m and the vertical spacing is 1.375m, so that the area covered by the sensor grid is 13.6m wide by 5.5m high, 74.8m², 18.2% of the total area, near the centre of the wall. The thermocouples were fixed to the wall with high strength adhesive tape so that the tip of the thermocouple is 10mm from the original wall surface.

A Pyranometer, solar radiation meter, was installed on the SolarWall™ to measure solar radiation intensity. The pyranometer had been calibrated in a horizontal plane, where it was exposed to diffuse sky radiation from a full hemisphere. Positioning it in the vertical plane of the SolarWall™ introduced some uncertainty to the data because half the hemisphere radiating to the sensor was ground and facing buildings. This uncertainty was estimated by the suppliers to be about $\pm 7\%$, however, the benefit of having the pyranometer in the same plane as the SolarWall™ was thought to outweigh this disadvantage. The pyranometer calibration certificate shows that it produces an output of $77\mu\text{V}$ per W/m^2 .

3.2 SENSORS IN THE DUCTING FROM THE SOLARWALL™

There are three ducts with fans drawing air through the SolarWall™ and delivering it, through high-level perforated ducts, to the building. Each duct carries between 0.85 and 0.94m³/s. The commissioning engineers measured 0.94m³/s in the middle duct monitored here. One of the radio sensors was used to record delivery duct temperature. Additional duct thermocouples were fitted on 6 July 2006 and linked to the main monitoring computer.

Figure 4 Duct from SolarWall™ to roof penetration



Figure 5 Location of thermocouples in duct within building



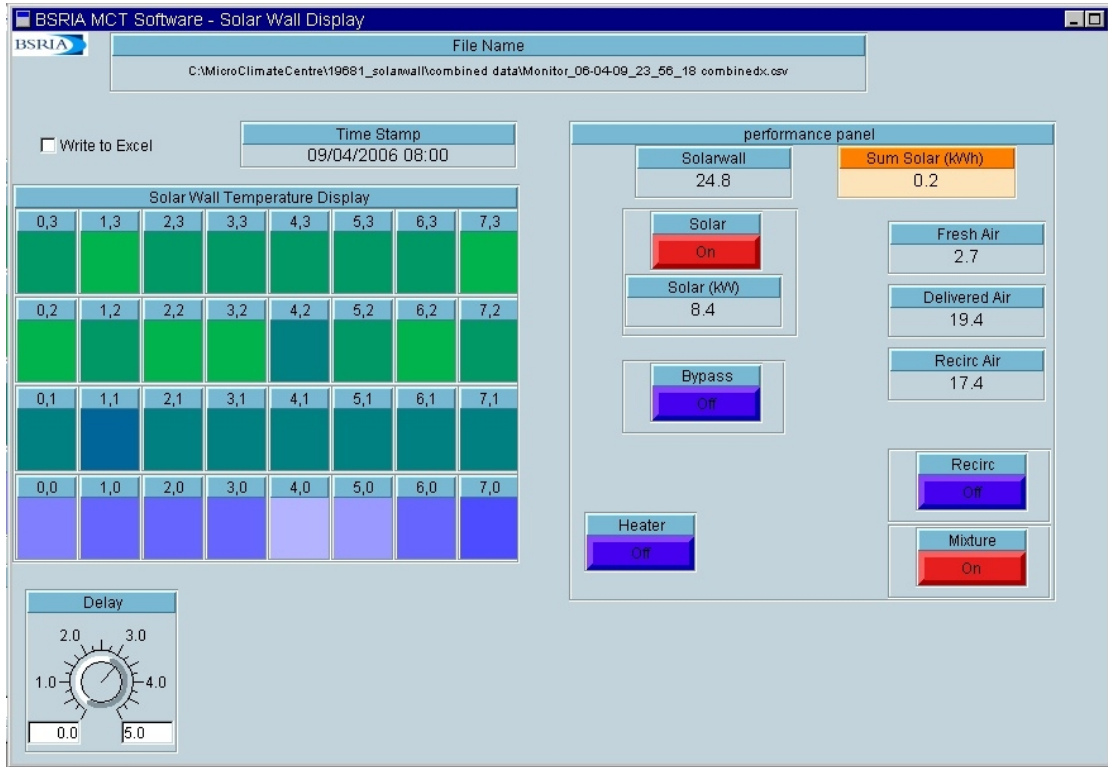
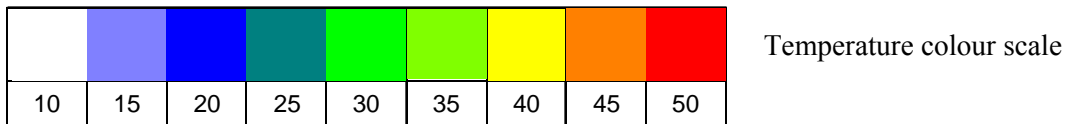
3.3 LOGGING EQUIPMENT AND DOWNLOAD SOFTWARE

The logging system is a Hewlett Packard (Agilent) type 34970A Data Acquisition Switch Unit with two 34901A 20 Channel Multiplexer Modules feeding data to a PC in the building. It was installed on 17 February 2006. Temperatures and solar intensity are recorded every five minutes by the PC and saved to a new file at midnight every day. The saved files were copied from the PC by CA Group staff weekly and sent to BSRIA.

3.4 ENERGY, CO₂ SAVINGS AND AIR QUALITY DISPLAY

A display has been produced that shows temperatures in the SolarWall™ and air supply duct graphically in 40 colours related to temperature from 10 to 50°C. Temperatures outside this range are still recorded but rarely coincide with the most useful energy collection periods. An example can be seen in Figure 6. The CO₂ savings can be calculated from the cumulative energy figure by multiplying by an appropriate factor, often quoted as 0.194kg/kWh, because it is replacing Natural Gas heating.

Figure 6 SolarWall™ output display – proposed layout



3.5 DATA COLLECTION AND ANALYSIS

Data has been monitored since 1 March 2006. However, for the first few weeks there were problems with control of the ventilation system. Data from 1 April 2006 to 31 March 2007 has been used to provide a full year analysis.

3.5.1 SolarWall™ control system

The control system is intended to function as follows: Solar heated air delivered to the building when; outside temperature is below 16°C and time is between 07:00 and 19:00 and building temperature is below 18°C and SolarWall™ temperature is more than 2K above building temperature (at low level wall sensor).

Fresh air, bypassing the SolarWall™ is delivered to the building when: building temperature is 18°C or above and the outside air is 2K lower than the internal temperature

Recirculated air, is delivered to the building when:
 Building temperature is below 18°C and
 SolarWall™ air is less than building temperature

A mixture of SolarWall™ and recirculated air is delivered if SolarWall™ temperature is between building temperature and 2K above. All three dampers (SolarWall™, Fresh Air and Recirc) modulate constantly to ensure a temperature of 18°C within the building during winter operation.

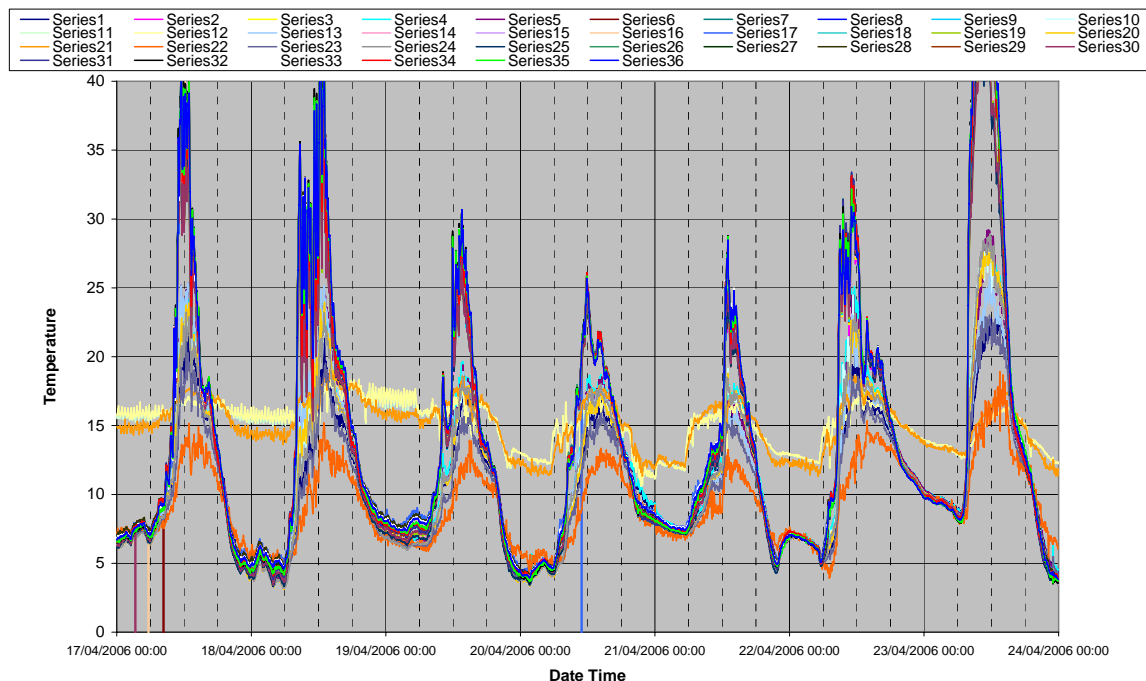
Between hours of 19:00 and 07:00 the room temperature set point is effectively reduced to 14°C

If the outside temperature is 16°C or above, the SolarWall™ damper will be closed and the ventilation system used for fresh air-cooling or recirculation.

If no heat is available from the SolarWall™, it will be provided by the independently controlled gas fired heater.

A sample of the thermocouple data can be seen in Figure 7. Some of the sensors were recording internal building temperature and therefore show a flatter profile than those embedded in the SolarWall™.

Figure 7 Seven-day temperature profile for all SolarWall™ thermocouples



3.6 GAS AND ELECTRICITY CONSUMPTION

Gas bills have been kept by CA Group for the last five years so monthly consumption data is available. Gas and electric meter readings have been taken five times a day by CA Group since 2 December 2005. The consumption in the period from December 2005 to March 2007 are therefore accurate. The meter readings on the bills have sometimes been estimated.

4 RESULTS

4.1 FUEL SAVINGS

Table 1 shows the savings in gas consumption after installation of the SolarWall™. Column 8 in the table is the saving in kWh per degree-day compared with 2005/6. The final column is the estimated total energy collected from all parts of the SolarWall™ installation (only one of three ducts was monitored).

- The total saving has been 27,260 cubic metres of gas or 303,543kWh or 58.9tonnes of CO₂ or 51% of the 2005/6 consumption.
- After taking into account the fact that 2006/7 was a slightly warmer year than 2005/6 (there were fewer degree-days of heating requirement) this is equivalent to a 50% drop in gas heating demand per degree-day.
- This substantial saving is partly attributable to destratification, which is effective in reducing heat demand even when the SolarWall™ is not supplying heat.
- It is also partly due to positive pressurisation of the building, preventing cold air blowing in directly through open doors.
- The total delivered heat energy (gas plus SolarWall™) was 37% less in 2006/7 than in 2005/6
- A significant amount of energy has been collected by the SolarWall™. This 79,191kWh produced by the SolarWall™ is 21% of the total heating demand of the building in the year 2006/7.

Table 1 Reduction in gas use and SolarWall™ Energy delivered

Month	2005/06 consumed (kWh)	2006/07 consumed (kWh)	2005/06 degree days	2006/07 degree days	kWh/degree day 2005/6 - 2006/7		Saving in kWh/dd compared to 2005/6	SolarWall™ Energy delivered, kWh
Apr	64754	40,000	223	221	290	181	38%	9396
May	41357	6,709	152	147	272	46	83%	4776
Jun	6700	1,023	66	58	102	18	83%	1626
Jul	0	62	38	26	0	2	0%	902
Aug	1729	85	45	37	38	2	94%	1438
Sep	9948	52	69	34	144	2	99%	2892
Oct	37541	13,980	102	102	368	137	63%	7661
Nov	74563	45,446	288	225	259	202	22%	9072
Dec	75316	36,855	345	306	218	120	45%	25075
Jan	90721	56,930	358	274	253	208	18%	4428
Feb	96076	44,976	306	281	314	160	49%	2310
Mar	100751	49,796	353	264	285	189	34%	9616
Total	599,456	295,913	2345	1975	2545	1266	50%	79,191

4.2 RECOMMENDATIONS FOR OPTIMISING PERFORMANCE

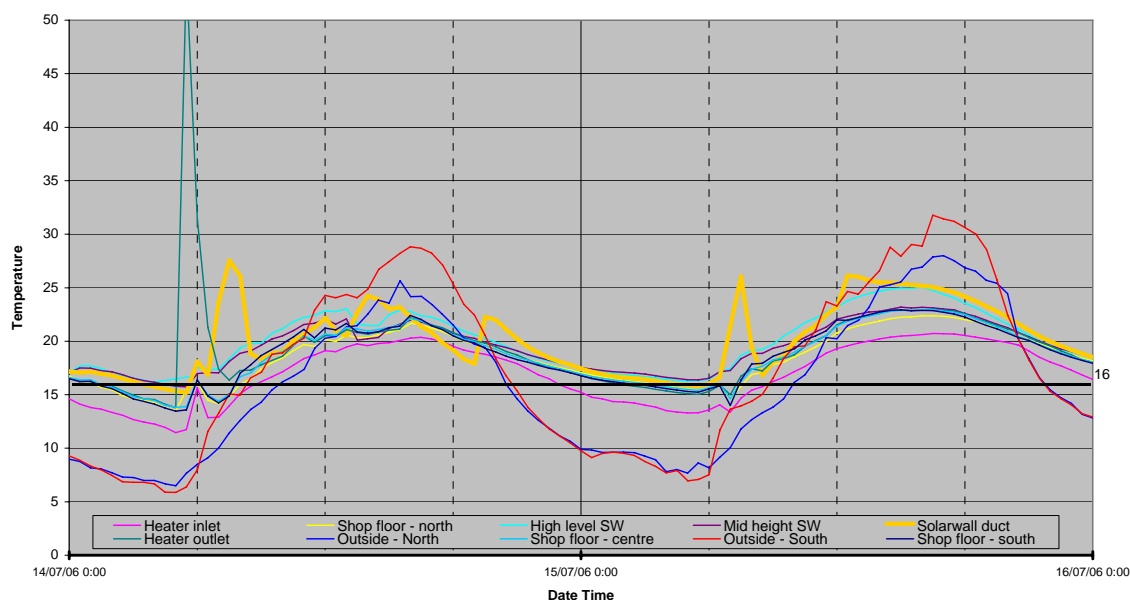
We believe that even greater savings can be made by making better use of the energy collected by the SolarWall™. The following points should be considered:

1. Savings could be made by linking the control of the gas-fired heater to the SolarWall™. There have been several occasions when the gas-fired heater has fired up unnecessarily, shortly followed by the SolarWall™.
2. The heating demand of some buildings may match the SolarWall™ better than the profile mill. It has a demand from 05:30 in the morning, before much solar gain is

available and the low internal temperature set-point does not allow use of the SolarWall™ later in the morning. The gas fired heater was used early on some mornings even in July as shown in Figure 8.

3. In new installations the orientation of the SolarWall™ should be optimised to fit the heating requirements.

Figure 8 Temperature profiles showing heater operation on a July morning



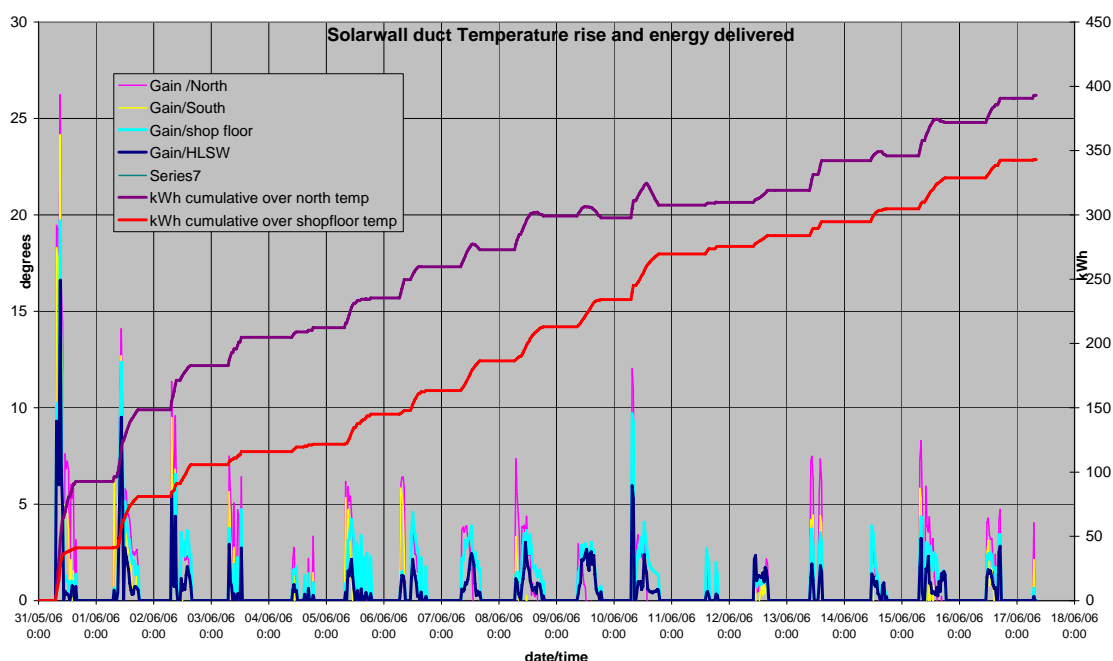
4.3 CALCULATING ENERGY SAVING POTENTIAL

The energy delivered by the SolarWall™ can be calculated from the well-known H&V equation $Q = MC_p\Delta T$ where M = mass flow rate, C_p = specific heat capacity and ΔT is the temperature difference between occupied space temperature and solar duct temperature. This definition assumes that the SolarWall™ is replacing a system that recirculates air. If the full ventilation rate is required to be fresh air, the larger temperature difference between outside air and SolarWall™ air can be used and a greater heat delivery seen in the upper cumulative energy line in Figure 9, can be shown. The volume flow rate of the fan during commissioning was $0.94\text{m}^3/\text{s}$. The other two fans had flow rates of 0.89 and $0.92\text{m}^3/\text{s}$. The total air delivery is therefore $2.75\text{m}^3/\text{s}$, which is 2.93 times the flow through the part of the system that was monitored.

The monitoring system measures duct temperature continuously, but to calculate energy saved it is necessary to distinguish the times when SolarWall™ air is being used. This has been done using the control system parameters:

- Time is between 07:00 and 19:00 and
- Building temperature is below 18°C
- And, to differentiate SolarWall™ from recirculated air, the supply duct temperature is more than 0.2°C above the high-level building air temperature.

For every measurement where all the above are true, the energy collected was calculated. Results are presented as a cumulative kWh collected curve for each month as shown in Figure 9 and the Appendix A, B and C.

Figure 9 Energy collected over a 17½ day period in May-June

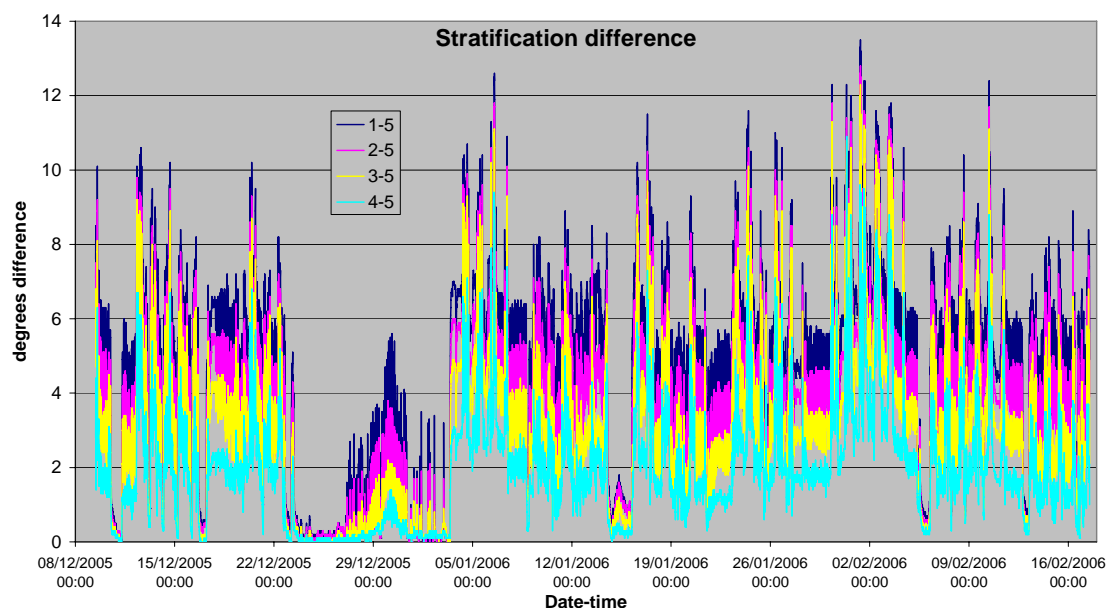
It can be seen that 343kWh of energy was collected in this period, and average of 19.6kWh per day for this duct. The total for the three ducts would therefore be approximately 60kWh per day. It can also be seen that if the energy is calculated relative to the outside temperature the value is 22.5kWh for one duct or 67.5kWh per day for all three ducts. Charts like this for April, May and December can be seen in the Appendix.

Data like this has been processed for the 12 months of April 2006 to March 2007 with the SolarWall™ working correctly. Where missing data prevented the calculation of the SolarWall™ output the monthly total was adjusted pro-rata for the missing days. A total of 265 days of complete data was collected and the lowest number of days in a month was nine in August when radio logger data was lost due to staff holidays and there was a crash of the main logging computer. The months of July to August had relatively low utilisation of energy from SolarWall™ because little heating was required.

As well as providing heated ventilation air during the heating season, further energy savings could also be gained during the warmer periods by utilising the heat generated from the SolarWall™ in process applications. In other buildings this could include applications such as crop drying, or using the heated air as pre-heated air for industrial furnaces and ovens.

4.3.1 Stratification

Stratification of air in the 6m height of the building was suspected and this was monitored by both the radio sensors and more accurately by the 5 temperature sensors with their local data logger. There was significant stratification with the temperature near the roof always warmer than that at low level (except for a brief period in the winter shut-down when very cold external temperatures caused the temperature just below the roof to drop to 0.1°C below that in the occupied zone).

Figure 10 Stratification temperature differences over 10 weeks

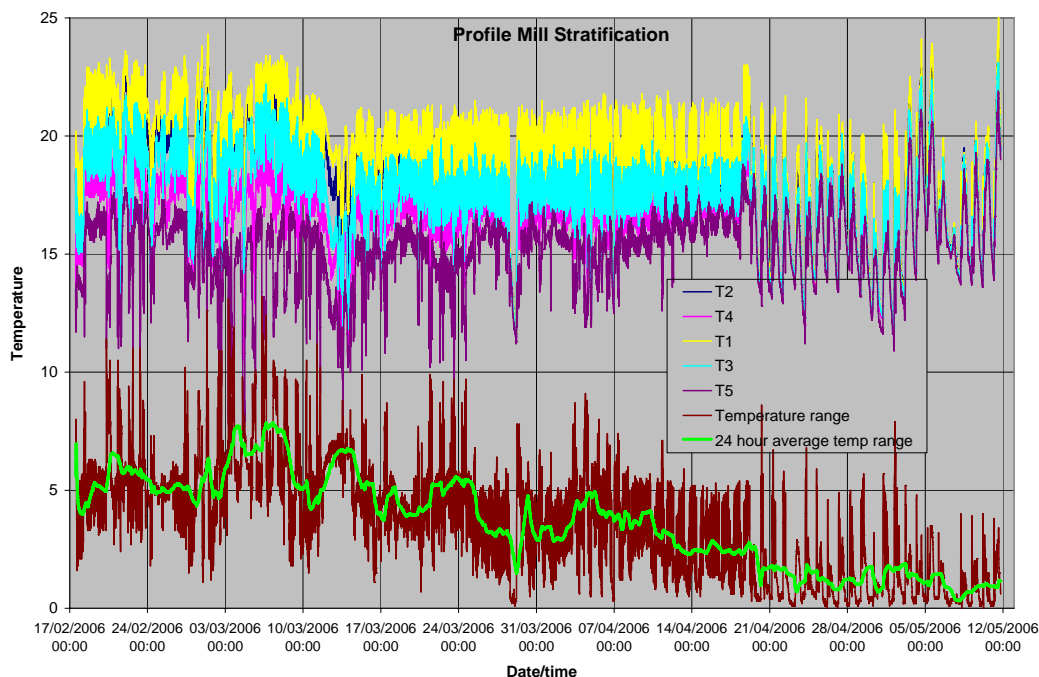
The occupied zone sensor was 1.5m above floor level and the other sensors were placed every 1.2m above that, up to 6.3m from the floor.

It can be seen from the chart that high-level temperatures were up to 13.5°C above those in the occupied zone. If the unheated periods are removed from the analysis the maximum temperature gradient is slightly less as seen in Table 3. The temperature rise at different levels is shown in the table, and the temperature gradient between each high sensor and the occupied zone is also calculated.

Table 2 Temperature gradients during heating periods only

	Average temperature rise °C	Maximum temperature difference °C	Height above occupied zone m	Temperature gradient C/m
Sensor 1-5	4.96	10.9	4.8	1.03
Sensor 2-5	4.22	10.1	3.6	1.17
Sensor 3-5	3.33	9.3	2.4	1.39
Sensor 4-5	2.08	7.4	1.2	1.73

Stratification was reduced significantly from 19 April 2006, when the ventilation system was operational. Destratification with SolarWall™ will minimise heat loss through the roof and will produce a better working environment. The average temperature difference between the highest sensor and the lowest sensor was 4.6°C between 17 February and 18 April. From 18 April to 6 July, it was 1.3°C. Using the SolarWall™ just when heat available reduced the average stratification by 0.36°C, but operating the ventilation system full time reduced it by 3.65°C.

Figure 11 Air stratification reduction from 19 April

4.4 ADDITIONAL BENEFITS

Additional benefits of the SolarWall™ installation include improved weather protection, improved appearance and avoiding overheating of the building.

4.5 SOLAR RADIATION AND SHADING

Solar radiation, has been measured up to a peak of 970W/m² on this building, and this energy would normally be conducted through the wall and affect the internal environment, however the SolarWall™ provides shading to reduce this effect. When air is not being drawn into the ventilation system, the heated air naturally rises within the cavity and is exhausted back through the perforations into the atmosphere near the top of the wall. As the SolarWall™ captures the direct radiation, the original elevation is in solar shade, and therefore there is a significant reduction in radiant heat through the wall.

Correlation of solar radiation with heat output allows a practical prediction of energy supply from installations in different locations if the solar radiation on a vertical surface is known for that location.

5 CONCLUSIONS

The SolarWall™ produces a significant amount of useful heat. Under certain operating conditions SolarWall™ heated air up to 28°C above ambient temperature.

The SolarWall™, together with the attached ventilation system which reduced air stratification in the building, led to a reduction in gas-fired heating requirement of 303,543kWh, equivalent to 58.9tonnes of CO₂ or 51% of the 2005/6 consumption.

In the twelve months April 2006 to March 2007 the heat collected by SolarWall™ and delivered to the building ventilation system amounts to 21% of the total heating energy requirement, 79,191kWh out of 375,104kWh.

The year 2006/7 was slightly warmer than 2005/6 (fewer degree-days) but the gas heating requirement per degree-day was reduced by 50%.

The 21% contribution to heating is significantly more than the 10% minimum contribution to obtain approval as a renewable energy installation under planning and environmental assessment requirements.

The greatest benefit was achieved in the month of December when the weather was clear, the air temperatures low and sun angles were low.

More solar energy was utilised in March and April than in February because of cloudy weather in February.

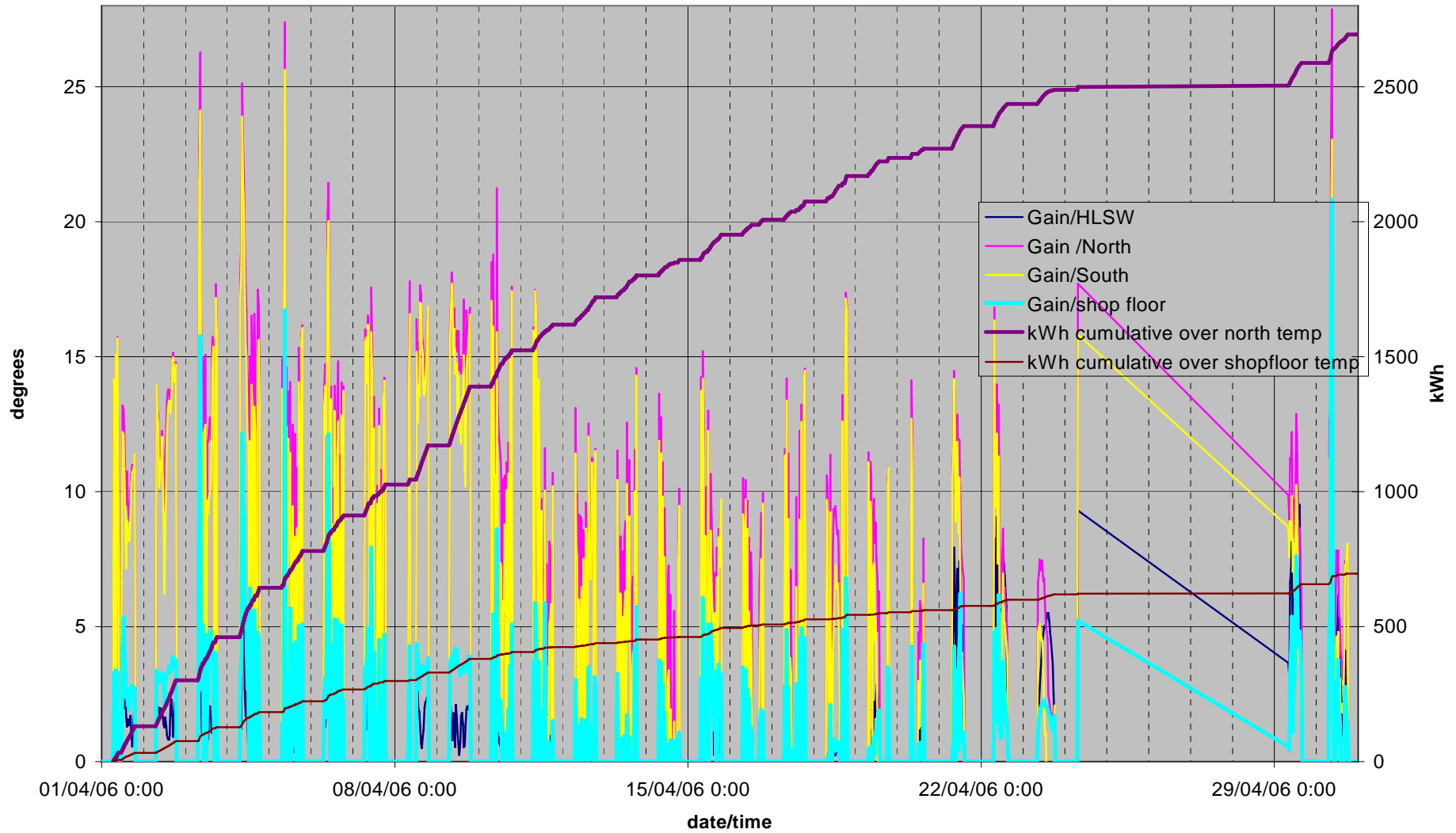
We recommend that consideration is given to optimising use of future SolarWall™ installations by:

- Optimising orientation
- Taking advantage of the high temperature air produced in summer
- Matching the size of installation to fresh air / heating requirements of the building.

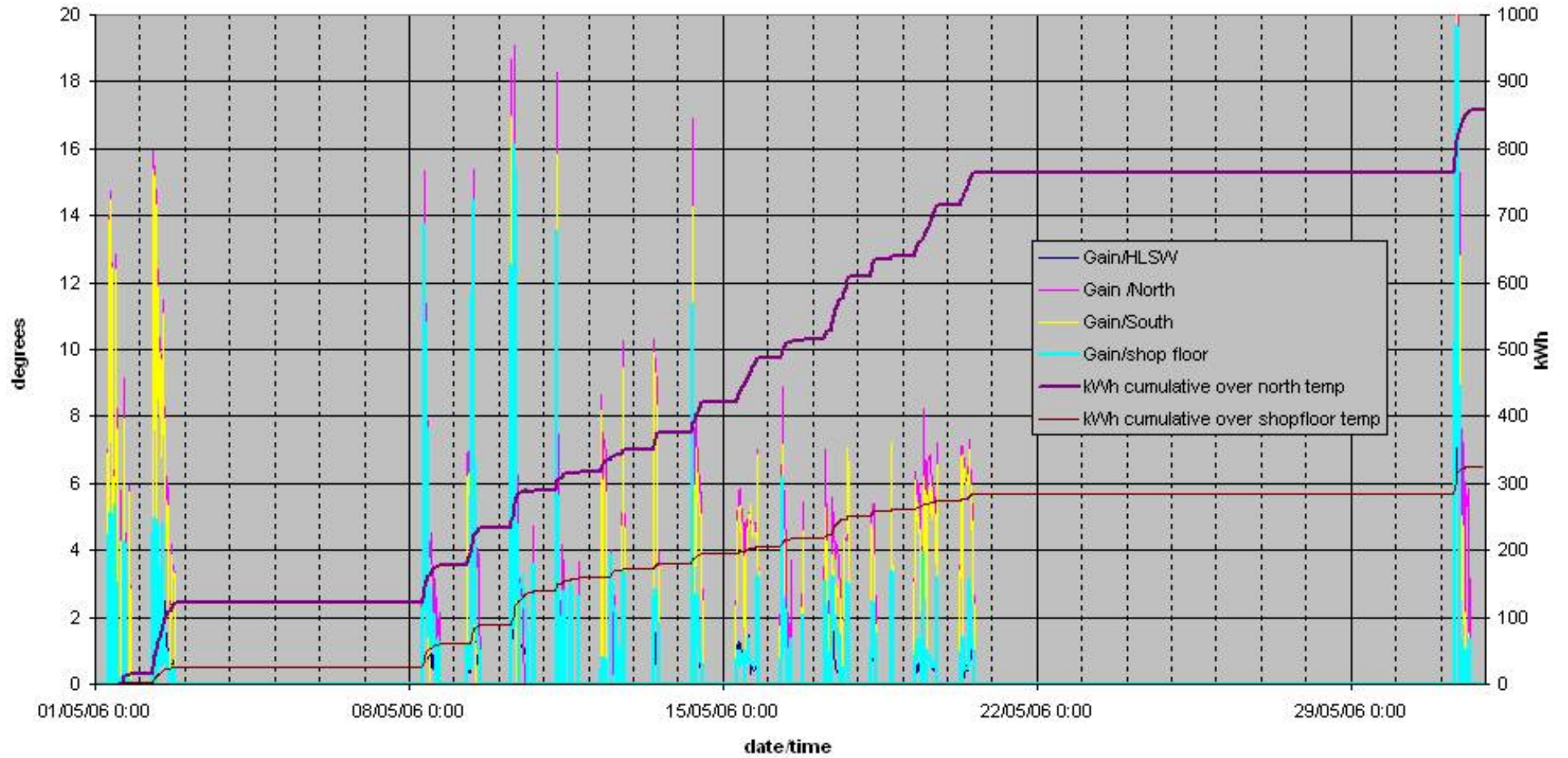
Heat output from SolarWall™ installations in other locations can be predicted by correlation of measured heat output and measured solar radiation at this location.

Additional benefits of the SolarWall™ installation include improved weather protection, improved appearance and avoiding overheating of the building.

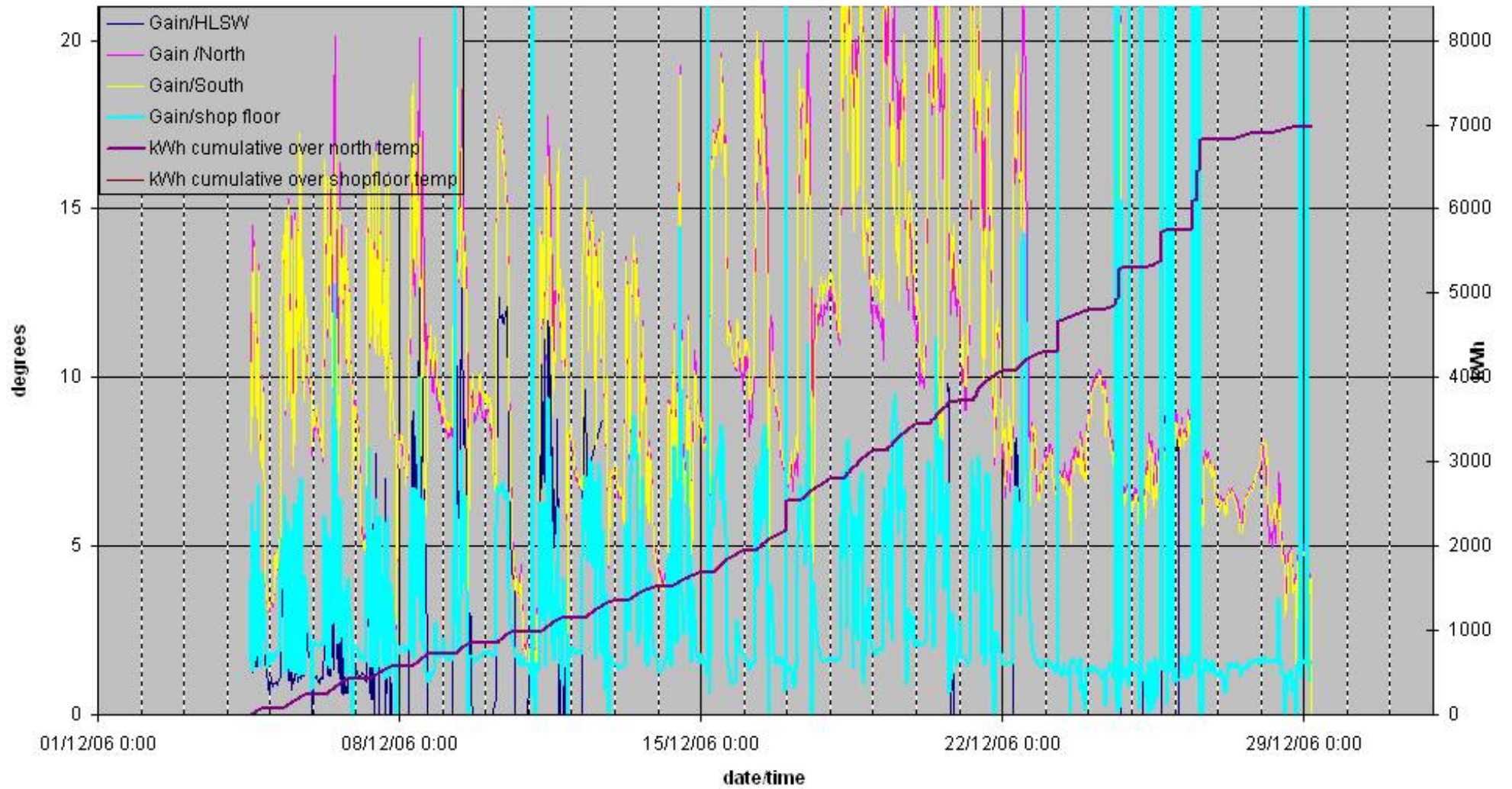
Appendix: A Energy collection data for April



Appendix: B Energy collection data for May



Appendix: C Energy collection data for December



Appendix: D Terms and conditions of business

BSRIA Limited

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A private limited company registered in England No. 3942728

1 DEFINITIONS

- 1.1 **The Company' shall mean, BSRIA Limited and where the context permits, its employees, agents or subcontractors.**
- 1.2 **The Client' shall mean, any person or persons, firm or corporate body that instructs, or is co-sponsor with, The Company to carry out test, investigations, consultancy, research consultancy or similar work.**
- 1.3 'Agreed' shall mean, agreed between The Client and The Company.
- 1.4 'Equipment' shall mean, plant, machinery or other devices of any kind in respect of which The Company undertakes to carry out tests, make **investigations or issue reports, certificates, information or advice.**
- 1.5 "Results" are new and unique intellectual property generated as a consequence of a programme of work.
- 1.6 "Deliverable" shall mean any certificate, report, presentation, software or other Results arising from the operation of a contract to be supplied to The **Client.**
- 1.7 "Proposal" shall mean the offer for supply of services by The Company together with any agreed variations forming a contract between The Company and The Client.

2 GENERAL

- 2.1 These conditions shall apply to all work undertaken by The Company for The Client but are overridden by any explicit clauses contained within the Proposal for work. No additions or variations to these conditions shall apply unless agreed in writing between The Client and The Company.
- 2.2 The Company will conduct its business in accordance with professional standards and maintain a high standard of independence, objectivity, integrity and confidentiality.
- 2.3 The Company's terms and conditions shall prevail over all other terms and conditions received unless agreed by The Company's representative in writing.
- 2.4 If The Client is an agent acting on behalf of a principal, the obligations of The Client as set out herein may be transferred to the principal provided that The Company has agreed in writing to this arrangement before being given instructions to proceed with the work.
- 2.5 The Company reserves the right to decline to accept an order for work without being required to give a reason.
- 2.6 The Company provides information, advice and services in good faith based upon information available at the time. The Company accepts no liability for the consequences of its information opinions and advice whether direct or indirect.
- 2.7 The failure by either party to enforce at any time or for any period any one or more of the terms and conditions of this agreement shall not be a waiver of them or of the right at any time subsequently to enforce all terms and conditions of this agreement.
- 2.8 Any disputes or claims shall be governed by and construed in accordance with English law and the jurisdiction of the English courts.
- 2.9 All unresolved disputes between the Parties shall be referred to arbitration in London before a single arbitrator to be appointed, in default of agreement otherwise, by the person for the time being of the President of the Institute of Arbitrators. Both parties also agree that all disputes arising with respect to this contract will be arbitrated upon within the English legal system.
- 2.10 Where conflict of interest does not exist and unless explicitly agreed within a Proposal for work The Company shall not be bound to decline to quote for or accept any offer for work from any source as a consequence of existing or proposed contracts.

3 FEES

- 3.1 **The fees payable by The Client will be in accordance with the schedule shown in the Proposal provided by The Company.**
- 3.2 Any variations to the work content will be agreed in writing by **The Company and The Client** and **The Company** reserves the right to provide a new schedule of fees against the new work programme.
- 3.3 Quotations shall be open for acceptance within 30 days unless agreed otherwise.
- 3.4 In the event of **The Company** agreeing with a representative of **The Client** to carry out any work without **The Client's** written acceptance of a quotation, then **The Company** shall be entitled to reasonable remuneration for the work performed.
- 3.5 Unless otherwise indicated in the **Proposal The Company** reserve the right to submit regular progress claims monthly in arrears.
- 3.6 Where expenses are to be charged in addition to a contract fee **The Client** agrees to reimburse **The Company** for all reasonable travel, subsistence and incidental expenses without further authorisation. In the case of expenses incurred abroad The Company will invoice in Sterling based on the actual exchange rate prevailing at the time of transaction.
- 3.7 **The Client** shall pay for all costs and charges incurred by **The Company** in collecting any **Equipment** for testing and in packing and returning the **Equipment** after testing.
- 3.8 Unless otherwise stated in the **Proposal** all transactions will be in Pounds Sterling. Both parties agree to accept this in respect of all invoices and payments. Unless otherwise explicitly provided by an individual contract, no account will be taken of any exchange rate fluctuations during the life of the contract. Each party accepts as their own responsibility the variation, whether favourable or unfavourable, that they may see in local currency terms in respect of the contract.
- 3.9 All quotations issued exclude VAT and local taxes unless otherwise stated, VAT and local taxes will be added at the rate ruling at the date the invoice is submitted.

4 PAYMENT TERMS

- 4.1 **Payment shall be made by The Client within 30 days of an invoice being submitted by The Company.**
- 4.2 Where it has been agreed that payment for all or part of a **contract** is to be made in advance work will not commence until payment is actually received as cleared funds.
- 4.3 **The Company** shall have the right to suspend all work or withhold **Deliverables to The Client** should payments not be made on time to the agreed schedule. Any adverse impact that this suspension has upon the completion schedule or the quality of the product for **The Client** shall be at **The Client's** sole responsibility. This right applies not just to the contract in arrears but also any other contracts with **The Client**, whether or not payments against these contracts are in arrears.
- 4.4 All invoices shall be paid without deduction. **The Company** does not accept retentions or un-negotiated discounting of any description.
- 4.5 In the event of an error or query on the invoice this should be notified to **The Company** without delay. A credit note will be issued to correct errors or omissions and payment of the net amount is then due.
- 4.6 **The Company** shall be entitled to charge interest on accounts outstanding for more than 30 days and for any sums unjustifiably withheld under clause 4.4 at 2% above the prevailing minimum lending rate of the Bank of England.
- 4.7 In the event of insolvency of **The Client The Company** will be entitled to have a general lien on all goods and property of **The Client** that is within **The Company's** possession and, following 14 days notice to dispose of such goods and property in such manner and at such prices as **The Company** thinks fit to apply the proceeds towards sums owing to the **The Company** by **The Client.**
- 4.8 **The Company** operates within the Inland Revenue rules in respect to the CIS5 certificate scheme. **The Company** holds a current certificate, which can be inspected at the registered office.
- 4.9 **The Company** Bank details are as follows, where all payments should be made by **The Client** unless otherwise agreed

*Barclays Plc, PO Box 61, Bracknell, Berkshire, RG12 1GJ
Sort Code 20-11-74 Swift Code BARCGB22 Bank Account No.30231967*

5 LIMITATION OF LIABILITY

- 5.1 **The Company** shall exercise all reasonable skill, care and diligence in the discharge of the duties performed and in producing any report, certificate, information or advice. However, **The Company** shall not be liable for any loss or damage, whether direct or indirect, arising from the use of reports, certificates, information or advice issued by it.
- 5.2 **The Company** shall not be liable for any damage, loss or expense suffered by **The Client** by reason of any delay in carrying out any test, investigation or consultancy or in issuing any reports, certificates, information or advice to **The Client.**
- 5.3 The liability of **The Company** for loss or damage to any **Equipment** on the premises of **The Company** by fire, theft or accident shall be limited to £100 or the cost of manufacturing such **Equipment** if less than £100.

6 OPERATION OF CONTRACT

- 6.1 **The Client** shall nominate a suitable representative from within his organisation to act as liaison between **The Client** and **The Company**.
- 6.2 All commitments with respect to the timing and scope of a project given to **The Client** by **The Company** - whether verbal or written are made in good faith. **The Company** agrees to use its best endeavours to fulfil such commitments to clients on the timing and the scope of consultancy and other projects but it does not guarantee performance in either respect.
- 6.3 Where the **Proposal** specifies that services will be provided by named individuals, **The Company** agrees to take all reasonable steps to ensure that these persons will remain on assignment for the full length of the contract.
- 6.4 Testing of **Equipment** will normally be carried out in accordance with the standards for the time being laid down by the British Standards Institution or other recognised authority. In the event of such standards not being applicable testing will be carried out according to a specification to be agreed before the commencement of the testing with **The Client**.
- 6.5 By arrangement tests may be witnessed by **The Client** or his representative, but **The Company** shall be entitled to charge for any additional costs thereby incurred.
- 6.6 **The Company** shall not bear any liability for any damage to the **Equipment** arising from or attributable to tests, investigations undertaken.
- 6.7 **The Client** shall indemnify **The Company** against any claim, loss, damage, or expense suffered by **The Company** or its employees or property or of **the Client** or **Client's** representatives as a result of undisclosed defects or dangerous or potentially dangerous features of **Equipment** submitted for test, investigation or consultancy. Disclosure of defects or dangers shall be made in writing to **The Company** prior to testing.
- 6.8 Except by prior arrangement **The Company** shall not be bound to accept delivery or agree to the collection of **Equipment** outside the hours of 8.30 to 17.00 on Mondays to Fridays, excluding public holidays.
- 6.9 **The Company** shall not be liable for any loss or damage resulting from the failure of **The Client** to give any special instructions regarding unpacking on the outside of each package or container.
- 6.10 **The Company** shall not be liable for any losses which result from the failure of **The Client** to clearly identify any piece of **Equipment** submitted to **The Company** for testing, investigations or consultancy carried out in premises other than those of **The Company**. **No idea what this is all about**
- 6.11 Where tests are to be carried out on site **The Client** shall be responsible for obtaining any necessary permission or permit for **The Company's** employees to have access to all relevant parts of the premises. **The Client** shall ensure that the owners or occupiers of the premises have insurances to cover any liabilities that may arise from injury to **The Company's** staff while on the premises, accidental damage to **Equipment** or property of **The Company** while on the premises, damage or injury to third parties caused by or resulting from the tests, investigations or consultancy of **The Company**.

7 TERMINATION

- 7.1 Any contract may be terminated by either party before completion by giving one month's notice in writing (except in the case of a membership contract which is six months). The Client will be responsible for any charges incurred or committed up to the date of termination on the quantum meruit basis.
- 7.2 Where an event caused by third party events outside either party's control or influence causes such delay that the purpose of the contract is wholly or significantly destroyed, either party shall be entitled in these circumstances to cancel the remaining portion of the contract. In such circumstances **The Client** will not make any further payments of fees but there will be no refund of payments already made (including any payments for that part of the contract that remains unfulfilled) and **The Company** will be entitled to recover any costs already incurred
- 7.3 **The Company** shall have the right to discontinue immediately all work for **The Client** should he or another person petition for his bankruptcy, or he be declared insolvent, or he be placed into administrative receivership or be generally unable to pay his bills as they become due.

8 USE OF DELIVERABLES

- 8.1 **No Deliverable** or abridgement, abstract or reference of same shall be used in any company prospectus, advertisement, or other publication or reproduced on the Client's products or on the packaging thereof without the prior written consent of **The Company**.
- 8.2 Certificates issued by **The Company** may be published by **The Client** or his Agent provided this is in full without and without modification.
- 8.3 Without the prior consent of **The Company**, no indication shall be given by any advertisement or by markings on **Equipment** or the packaging thereof or by any other means that implies approval, endorsement of products or services subjected to tests or investigations by **The Company**.
- 8.4 **No Deliverable** shall be used in any legal or arbitration proceedings without notification to **The Company**, except to the extent that may be required by law.
- 8.5 **The Company** reserves the right to make facsimile copies and to publish test certificates for the purpose of verification of authenticity by third parties.

9 COPYRIGHT & INTELLECTUAL PROPERTY

- 9.1 **BSRIA** shall retain copyright in all reports, certificates, presentations or other material delivered in whatever form unless otherwise agreed in writing.
- 9.2 The source code version of any software program created and developed by **The Company** either alone or in conjunction with **The Client** shall be and remain the exclusive property of **The Company** and notwithstanding the release of the source code to **The Client**, which shall be at the absolute discretion of and upon terms determined by **The Company**. All confidential information and intellectual property rights in the source code shall remain vested in **The Company**.
- 9.3 **The Company** shall on request grant to **The Client** a non-exclusive licence to use the software programs and where appropriate the program documentation upon such terms as **The Company** shall in its absolute discretion determine.

10 CONFIDENTIALITY

- 10.1 **The Company** agrees to hold all information provided by **The Client** confidential where **The Client** so specifies, save where such information is known to **The Company** already, or exists already in the public domain, until, either the information enters the public domain, or **The Company** is given the same information by a third party, or is released from its confidentiality requirement by **The Client**, or **The Client** is found in breach of contract with **The Company** by a court of law (including non-payment of account) or three years have elapsed - whichever is the sooner.
- 10.2 **The Client** agrees to hold confidential all information contained within and concerning about **The Company's** Proposal(s), fee structures, fees and personnel.

11 CONFLICT OF INTEREST

- 11.1 **The Company** will decline any new contract with a third party that would create a conflict of interest with **The Client's** previously Agreed instructions.
- 11.2 In the event that a conflict of interest becomes apparent during the conduct of work **The Company** will bring this to the attention of **The Client**. and **The Client** will then be free to vary the contract with **The Company** in the light of this revelation to the extent that it is affected by the potential conflict of interest. Such a declaration by **The Company** will be general in nature, so as not to prejudice the confidentiality with the third party. **The Company** will have the right to resign its contract in such circumstances if, in its judgement, it is unable to proceed with the contract and maintain its fiduciary duty. **The Company** shall receive payment in full for work undertaken and expenses incurred to the date of disclosure, including all due contract stage payments but not including any entitlement to pro-rata payment for any amounts payable on completion such as performance fees.

12 LIMITATION OF LIABILITY

- 12.1 Without prejudice to other more restrictive limitations elsewhere in this contract, liability on the part of **The Company** is limited to the value of the contract with **The Client** or the value of the loss whichever is the smaller. **The Company** accepts no liability for the consequences of its information, opinions and advice, whether direct or indirect.
- 12.2 Whilst **The Company** agrees to use its best endeavours to perform the contract for **The Client** as specified, **The Company** will not be responsible for any delays or failure to complete the contract which are beyond **The Company's** control and which could not have been reasonably predicted.
- 12.3 Neither party shall be liable to the other for any indirect, special or consequential damages

13 ILLEGAL ACTIVITIES

- 13.1 **The Company** will not carry out any illegal activities on behalf of **The Client** nor will it incite employees or subcontractors to act in breach of the law. Any requirement in this respect will nullify a contract and **The Company** will be entitled to recover in full its fee and expenses.
- 13.2 **The Client** agrees not to make any illegal use of any information provided by **The Company**.

Revised 11th November 2005

