REPORT ON AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF USING THE CCWW PRESSURE EQUALISATION PROCESS TO RE-ENGINEER RATHER THAN REPLACE FAILED DOUBLE GLAZED SEALED UNITS

Author: Dr D A Oloke

(School of Engineering and the Built Environment,

University of Wolverhampton)

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1.0 Background

The innovative Crystal Clear (Pressure Equalisation) process enables the process of 'reengineering' rather than 'replacement' of failed double glazed sealed units. Figures reported by WRAP/ Environment Agency indicate that 6.5 million domestic double glazed units are currently being replaced per annum - generating over 700,000 tonnes of waste glass, with over 500,000 tonnes of this amount going to landfill.

As a relatively new business registered in November 2007 (although its process has run successfully in North America since 1989 with over 300,000 successful applications to date) the initial marketing focus for Crystal Clear Window Works was on carrying out the process in the domestic consumer market. The company is, however, at the present time seeking to become more involved with the much larger commercial and social housing sectors (the social housing market presently estimated at £9 billion pa). So far, the company has been successful in having the process accepted and adopted by housing associations and commercial maintenance companies such as: Inspace Partnerships (Hinckley & Bosworth and Birmingham), Connaughts Bromford South West, Wales and the West, Salix Homes Salford, with interest from an ever increasing number of other associations across the UK.

Marketing to the housing associations requires a totally different approach to marketing to the domestic residential market, which is concerned primarily with cost savings. Housing Associations are routinely inspected by the Government's Audit Commission who use 14 "key lines of enquiries" many of which focus on their environmental impact and commitment to landfill reduction. Additionally, the Government's Carbon Reduction Scheme (which will require all housing associations to account for their carbon emissions) comes into force from April 2010.

This report has been prepared for Crystal Clear Window Works in order to illustrate and quantify the CO_2 savings generated when carrying out repair rather than replacement of the failed units. The report quantifies the CO_2 reductions made (i.e. embodied energy savings in production and utilisation of new materials with associated transport etc) by adopting the process to rescue rather than replace the failed units.

It is envisaged that this report will assist the housing associations to assess the levels of CO_2 savings they can generate in their own organisations. With typical industry failure rates of 4 units per 100 homes pa this is a significant figure. Furthermore, by combining the CO2 savings with the financial savings (which can also be demonstrated), housing associations should be drawn to examining the process as an innovative environmentally and financially advantageous alternative solution to the huge problem which they all face.

The widest dissemination of the report and the information it contains will facilitate a demonstration of the efficacy of the process more widely in the social housing arena. Hence, more housing associations should be able to see the myriad benefits and advantages – a development which should result in their subsequent adoption of the processes.

It is also envisaged that this will stimulate more glazing companies to consider becoming dealers which in turn will bring the process to more housing associations across the UK generating even more opportunities for increasing financial savings for the housing associations, huge carbon savings and landfill avoidance benefits for the environment.

2.0 Aim, Objectives and Scope of Report

The aim of the report is to quantify the CO_2 reductions made by adopting the Pressure Equalisation Process. Presenting an overview description on the Pressure Equalisation Process at the outset, the report then proceeds to quantify achievable reductions.

In the pursuit of this aim, the report has been structured to contain the following sections:

Section 1: Introduction and Background Study

Section 2: Aim, Objectives and Scope of Study

Section 3: A Review of the Process

Section 4: Energy and CO_2 Calculations for assessing the impact of the Pressure Equalisation Process

Section 5: Conclusions and Recommendations

Section 6: The references used to compile the report are given at the end of the report.

3.0 A Review of the Pressure Equalisation Process

Glass is one of the most environmentally expensive products to manufacture, using large amounts of fossil fuels in both its manufacture and distribution. Failed sealed units are not widely recycled and extensive studies done by independent bodies show that trying to recycle sealed units and windows is generally both financially costly and energy intensive.

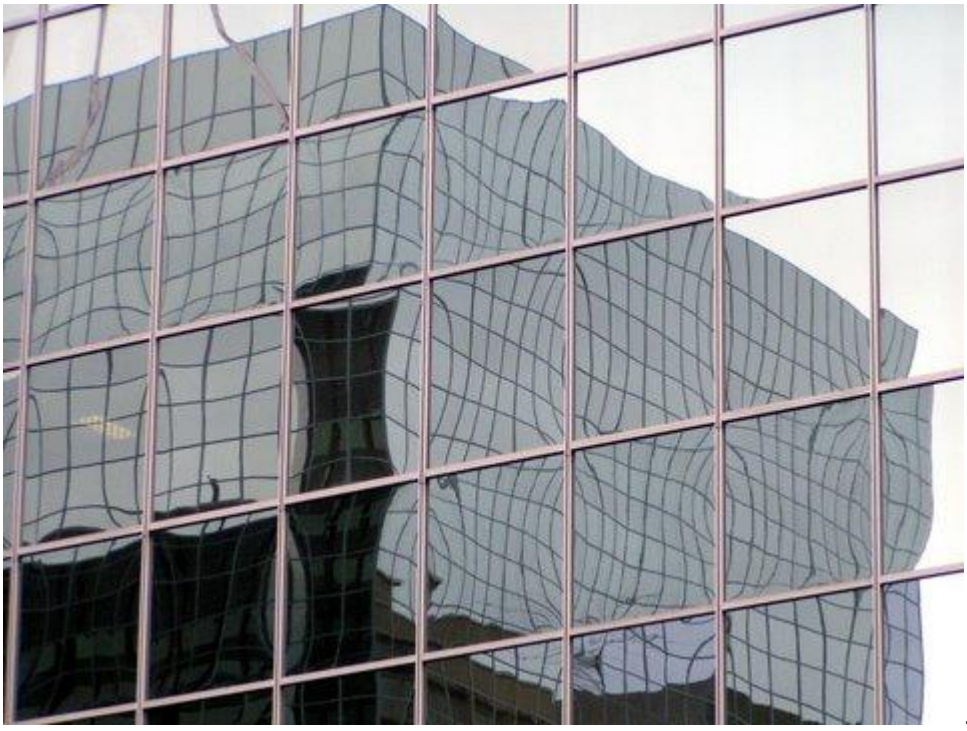
Sealed units are replaced on an enormous scale annually due to moisture ingress caused by seal failure. This failure is caused by one or more of the following: poor fitting, lack of drainage or seal de-lamination due to pressure build up from inside the unit.

Simply replacing the unit is in a lot of cases not solving the problem and the ingress of moisture in the unit is likely to return within a few years.

By re-engineering it, the life of the unit is extended and this at the same time avoids the unnecessary expense of replacing it. The savings made are not only financially but also environmentally very attractive.

When the unit has been re-engineered and pressure equalised it will not react to the environmental barometric changes – it will not go into negative deflection when the temperature drops like hermetically sealed units do, nor will it swell in the summer heat.

By preventing the constant swelling and contraction, pressure on the perimeter seals is prevented. The newly installed venting system allows the unit to effectively breathe, expelling air when needed and drawing air into the unit as required. The pressure equalisation means that the air space between the two panes of glass is constant therefore a 28mm unit sustains a 20mm air space even in the coldest weather unlike hermetically sealed units that contract and lower the unit's R value at the very time where the maximum insulation is needed. Negative deflection of sealed units is easy to spot, distorting the reflected images as shown in the picture of a government building in Ottawa.



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The air entering and being evacuated from the unit will also contain moisture vapour. This moisture vapour must be controlled to prevent fogging or misting as it passes through the unit.

Whilst installing the venting system into the unit, therefore, a Super-Hydrophilic nano coating is also applied to the glass by injection. The coating has two purposes – the first being an anti-fog nano polymer that is invisible to the eye which prevents moisture from forming fog or water droplets on the glass surface. The second purpose of the coating is it acts as a hydrant, effectively seeking out water and hydrating it – a drain is then made in the unit to prevent further build up of moisture to complete the process.

The super hydrophilic material itself is also both innovative and extremely interesting. It was developed in one of the major UK universities and has already been successfully patented. Its use in Crystal Clear's Pressure Equalisation Process is in turn facilitated by the equipment devised by Crystal Clear without which it could not be used.

The application of a breather tube has for many years been common practice in the Industry especially in colder climates to allow the unit to acclimatise before sealing up the unit on-site, but what is often overlooked are the other additional benefits a pressure equalised unit offers. One of these is the fact that chemical fogging is prevented thereby allowing chemicals to be expelled from the unit preventing the spacer and seal causing bowing or complete de-lamination in very cold conditions. Another advantage of the venting system is the prevention of cold cracking.

Cold cracking is caused by the pressure on the glass as it tries to distort as the air molecules contract inside the unit causing the unit to crack or implode – a common problem in stained glass top lights.

Units with blinds fitted internally benefit from the system as the negative deflection caused by cold weather prevents the blinds from operating correctly.

With this new technique, therefore, Crystal Clear Window Works have finally solved the problem of sealed unit failure by controlling the expansion and contraction, creating a pressure equalised unit with a stable R value and preventing the fogging up of units as well as removing trapped moisture from already failed units.

(For more details and case studies: Please visit – www.crystalclearwindow.co.uk).

4.0 Energy and CO_2 Calculations for justifying the Pressure Equalisation Process

Generally, the energy consumption associated with buildings and construction materials can be categorised as follows [1]: energy in use; embodied energy; and inherent energy.

Energy in use is the energy required by the occupants of an existing or planned building, primarily for space heating, water heating and lighting; whilst embodied energy is the energy

needed to transform a product from raw materials in the ground to the final article. Inherent energy deals more with the chemical energy contained in a material – which can be released through combustion or chemical processing.

The measurement of embodied energy from basic data is difficult, involving assessments of the energy expended in, for example, quarrying and crushing operations for aggregates, or oil inputs and moulding of plastics. However, it is important to note that:

i) Whether the unit being used is kiloWatt hours per tonne (kWh/t), kilojoules per kilogram (KJ/kg), gigajoules per square metre (GJ/m2), or CO2 equivalents, the information must be based on "primary", rather than "delivered" energy. Primary energy represents the total energy used, while delivered energy is the energy received at the point of use (*ibid*).

ii) Another reason measurements of embodied energy may vary is relating to transport effects on the calculation. However, for materials with high bulk (e.g. timber, brick, sand etc.) transport energy will be a substantial element in the total.

In any case, transportation plays a major role in the choice of the Pressure Equalisation Process. With the replacement option, the technician needs to go to site and measure the unit to be replaced – then come back to the office, order a replacement unit which has to be transported to the glazing company who then need to take it to site for fitting. The glazing company has also had to have glass delivered to it by the glass manufacturer typically not a local company and in larger higher CO_2 generating vehicles. It can sometimes have been measured incorrectly or have internal cosmetic imperfections or colour match issues - which cause the unit to be rejected necessitating further visits. Typically, a company replacing units also has to use bigger vans (with higher CO_2 generation) than the small vans used by Crystal Clear. Associated with CO_2 generation for the replacement option is also the need to consider the CO_2 generated in transporting the waste glass (often in a larger van) from site to the glazing company and then from there to disposal (landfill or recycling).

According to McKinnon [2], larger vans generate an average of 250 CO_2 grammes per tonne per kilometre, whilst smaller vans generate about 175 CO_2 grammes per tonne per kilometre. A comparison between the CO_2 estimates can thus be made considering both options. i.e. the Replacement and the Pressure Equalisation Process (assuming distance to the property is 25km and 6.5 million domestic units that require replacement annually based on WRAP figures [5]).

Therefore, savings from only having to make one journey in a smaller vehicle rather than two in a larger vehicle can be computed as follows:

- Transit Type larger van required for carrying replacement units - CO_2 Generation with two or more trips = 162,500 tonnes

- Combo type smaller vehicle needing only one trip but generating less CO_2 = 34,125 tonnes

Hence, saving per annum (pa) minimum = **128,375 tonnes of CO2**

Savings and CO_2 reductions would also increase where the distance to the property is greater than 25km or if the typical distance to property were 40km transport savings would be over 205,000 tonnes of CO_2 pa.

The above estimates have been based on the assumptions stated. As mentioned these figures would likely increase for the Replacement Option should there be a need to have re-visits to the property to correct any errors in specification and/or installation. Based on the above, however, the CO_2 generated by the Pressure Equalisation Process represents less than 22 % of the amount generated via the additional transport costs of the Replacement Option - a saving of over 78% plus the fact that the glass itself does not have to be replaced (saving more CO2 and unnecessary consumption of additional precious raw materials).

Furthermore, considering the production process itself, CO_2 per $1m^2$ of double glazed units can also be computed.

Assume 1m X 1m using 4mm float (not toughened) glass

Volume of glass in double glazed unit is $0.008m^3$ (1 X 1 X 0.004 X 2)

Density of float glass 2500 kg/m^3

Weight of glass in $1m^2$ double glazed unit with 4mm glass = 20 kg

Embodied energy of float glass 0.015 GJ/kg = 0.30GJ per m^2 X 4mm float [3]

OR

For toughened glass, embodied energy = 0.0235 GJ/kg = 0.47GJ per m^2 X 4mm toughened [3]

CO_2 production coefficient 0.0980 tonnes/GJ using emission factors (as recommended by the International Panel for Climate Change) [4]

CO_2 per $1m^2$ double glazed unit – 4mm float glass = 29.4 kg CO_2 per unit of $1m^2$

CO_2 per $1m^2$ double glazed unit – 4mm toughened glass = 46.06 kg CO_2 per unit of $1m^2$

Based on WRAP figures 6.5 million domestic units are replaced every year in the UK [5]. By implication, therefore, CCWW repair could save a minimum of 200,000 tonnes of CO_2 being generated every year and the financial cost estimated by the GGF (Glass and Glazing Federation)

[6] at £1.8 billion. This figure of 200,000 tonnes is based on the glass used being all float rather than toughened glass (which generates over 50% more CO_2.) The percentage of toughened glass is significant. GGF estimate the split of normal versus toughened glass is 80/20 - so this will have the effect of increasing the CO_2 from 200,000 tonnes to close to **220,000 tonnes**.

Hence total savings based on estimated transport and embodied energy savings =

128,375 tonnes + 220,000 tonnes = 350,000 tonnes (Approx).

In addition we know that by not having to replace the glass we save:

a. glass being transported from manufacturer to glass distributor in large HGV's;

b. glass being transported from glass distributor to unit manufacturer;

c. glass being transported from collection at customer property via glazing company to either landfill or recycling; and

d. energy on the stabilised R value which pressure equalisation affords in the critical winter months.

Furthermore, according to a recent Press Release by Birmingham City Council [7], from April 2010, Inspace Partnerships will be responsible for carrying out repairs and maintenance to all council homes in South Birmingham. They have been selected to provide a repairs and maintenance service to some 40,000 council homes in South Birmingham and they already provide a similar service to the Council's tenants and leaseholders in the north of the city. If this figure is taken as an approximate average number of housing units to be managed by the Housing Associations that have signed up to the scheme to date, it can be safe to assume that about 120,000 housing units are already set to benefit from this innovative process and the potential for increasing this number is significant as other Housing Associations adopt the process.

In order to permit each Housing Association to calculate the CO_2 impact on its own stock the following calculation is based on running of 10,000 homes, the majority of which will be fitted with double glazing.. Based upon average rates of IGU failure of 4 IGU's per 100 homes per annum we have established that their CO_2 saving would be about **21.5 tonnes per annum** as a result of adopting the CCWW pressure equalisation restoration processes **plus the financial savings of typically 50%.** Savings for larger associations would obviously be greater pro rata to their size.

In addition to the foregoing, Housing Associations can benefit immensely from the guarantee which can be offered with the Pressure Equalisation Process. The process can be offered an insurance-backed guarantee which protects the Customer for 20 years (provided by QANW -

Quality Assured National Warranties). Traditionally, replacement guarantees do not normally exceed 5 years and are not insurance backed.

5.0 Conclusion and Recommendations

The Pressure Equalisation Process is most innovative and sustainable. It represents a best practice approach that is not only offering evident cost savings but also the most environmentally friendly option currently on offer.

With more pronounced and persistent calls for Local Councils and Developers to demonstrate their commitment to Carbon Reduction, the process provides both industry and policy makers a viable alternative to solving a real and on-going problem.

As an example, current DTI Sustainability Strategy is to reduce the CO_2 below the existing standards to approximately 1 tonne CO_2/home/year, or 25kg CO_2/m^2/year for non-domestic buildings. This is about 25% of current consumption figures and is right on the upper limit of what has been proven to work in the UK [8]. The CO_2 savings indicated by the adoption of the Pressure Equalisation Process could assist in contributing to this target at a rate of at least 95 % faster (per property) than the traditional replacement process based on the savings demonstrated by transportation alone. More so when the benefits are evaluated with consideration of the number of the properties where the treatment might be warranted over the year, this does represent a significant contribution. In quantitative terms, CO_2 generation reduction has been shown to have a potential savings of 350,000 tonnes of CO_2 generation per year based on embodied energy assessments for production and transportation of the units where the Pressure Equalisation Process is adopted. This is despite the fact that for the purposes of this report the energy savings achieved by other contributions to transportation savings and stabilising the R value have not been included.

Summing up, however, this report has given an overview of the approach and has demonstrated its benefit over current/ traditional methods of solving the problems of failed double glazed sealed units – which have hitherto been based on the principle of 'replace' rather than 'repair'.

It is important that the information presented herein is disseminated to major relevant stakeholders in the supply chain to facilitate a wide spread adoption of the process. The process has seen a successful uptake in the domestic sector, and the potential for it to generate greater impact in the wider commercial sector is huge.

6.0 References

[1] SUSTAINABLE HOMES: Embodied Energy in Property Development - A Guide for Registered Social Landlords.

[2] McKinnon, A.C. (2007) 'Increasing Fuel Prices and Market Distortion in a Domestic Road Haulage Market: the Case of the United Kingdom' European Transport, no. 35.

[3] Hammond, G. and Jones, C. (2008) Inventory of Carbon and Energy (ICE) Version 1.6a, Sustainable Energy Research Team (SERT), Department of Mechanical Engineering, University of Bath. www.bath.ac.uk/mech-eng/sert/embodied (Accessed 2/2/2010)

[4] The Intergovernmental Panel on Climate Change. http://www.carbontrust.co.uk/policy-legislation/ (Accessed 9/2/2010)

[5] WRAP – Material Change for a better environment http://www.wrap.org.uk/construction/index.html (Accessed 2/2/2010)

[6] The Glass and Glazing Federation http://www.ggf.org.uk/ (Accessed 3/2/2010)

[7] Birmingham City Council Press Release. '£30 million savings made by council' Nov. 30 2009, (Accessed 1/2/2010).

[8] DTI Sustainable Strategy Document (2008). http://www.berr.gov.uk/files/file46535.pdf (Accessed 12/2/2010).

Crystal Clear Window Works Ltd (www.crystalclearwindow.co.uk) have their head offices located at: Derby Road, Burton-on-Trent, DE14 1RS.