

To whom it may concern,

## **1.00 Introduction**

- 1.10** Nutherm have been involved in the design, supply and installation of Ground Source and Air Source Heat Pumps in UK and Ireland for over 10 years and have successfully completed over 1,500 projects in both domestic and commercial situations. I have personally been working in building mechanical services since serving my apprenticeship in 1977 and have worked at every level in the industry.
- 1.11** Our supplier, Waterkotte, began manufacturing Heat Pumps and supplying complete system solutions in 1970, since then they have been at the forefront of all major developments in the field. Indeed the industry as a whole look to Waterkotte for the lead in development and innovation to further the use, scope and efficiency of renewable energy exploitation from the environment, for heating and cooling in the built environment.
- 1.12** Broadly we welcome the RHI scheme as a vehicle to promote the uptake of renewable technologies in the UK but have a number of suggestions which could have a positive effect on the overall aims of the scheme to reduce carbon emissions and to decrease dependence on fossil fuels. To this end, the more attractive and cost effective the use of renewables can be made by enhancing function and efficiency, the greater the uptake will be.
- 1.40** We feel that the terms and conditions of the RHI scheme should be made available in condensed form for clarity among customers and the industry.

## **2.00 Too much regulation can have a negative effect.**

- 2.10** It was obviously the intention of the scheme, when back dating to July 2009, not to create a period in which no uptake of the scheme would take place until April 2011. Unfortunately, due to the fact that the consultation process is still ongoing and uncertainty exists as to how some things will be interpreted, a lot of potential customers are waiting to see the final definitive conditions before committing to any contract. This has the obvious consequence of leaving businesses in a state of flux until this process is complete. We need the complete terms for the scheme to be available as immediately as possible after the close of the consultation phase.
- 2.20** The goal posts have been moved a number of times and as sales are still slow most companies are having difficulty complying with this strict regulation phase. With this in mind, we feel that some assistance for supplying companies should be made available both to help with compliance and to ease cash flow when the anticipated growth does come.
- 2.30** Waterkotte has a vast range of heat pump models available with different gases for specific applications, so that the machine can be closely matched with the application to ensure high efficiency. Restrictions in their use can reduce efficiencies and lead to a barrier for innovation. At this stage, we find the cost of registering the

complete range of our products prohibitive. The stringent requirements, while understandable, are not achievable over such a wide product range, some of which we use very infrequently. All our heat pump range is available using R134a refrigerant but we cannot at this stage provide lab tests for these. For example, we recently completed a project at Edge Hill Teaching and Learning Centre in Ormskirk near Liverpool where the goal was to cool the new lecture theatre using ground water from the aquifer 80 m below. Active cooling only was envisaged by the original designer for the scheme, using water to water heat pumps with R 407c refrigerant.

- 2.40** After looking at the project as a whole, we were able to modify the design so that the heat that was being rejected to the environment in the original design was utilised via a district heating system to provide heating to three existing buildings using existing radiators, as well as to provide “free” hot water as a by-product from cooling. To facilitate this, R134a was chosen as the refrigerant as the character of the gas is much more efficient at the temperatures required, and also can produce higher temperatures suitable for radiator distribution and hot water production. Naturally the efficiency of the system is lower at high distribution temperatures than when rejecting energy to the ground at relatively low temperature, but the overall efficiency is increased as we used both sides of the machine’s output instead of rejecting all of the heat energy. The higher the temperature we can produce in a system like this, the more we can use this excess energy in existing buildings and hence keep the existing fossil fuel boilers off.
- 2.50** Another benefit from this of course, is that when we are simultaneously cooling and heating like this we do not need to run the ground source pump, as the lecture theatre is the heat source and the outlying buildings and hot water are the heat sink, saving approximately one quarter of the total system drive energy associated with the submersible pump, which uses a lot of energy as the aquifer is so deep. We also made best use of passive “free” cooling on the project.
- 2.60** We feel that too much emphasis has been put on the heat pump and the COP, rather than on “system” design and SPF (seasonal performance factor). A heat pump on its own is functionless. It must work as part of a system which, unlike fossil fuel systems, has a major effect on efficiency. The only real test of performance is of a complete system over a complete heating and cooling season.
- 2.70** A good example of this is the results of an independent field test carried out in Austria (see [www.agenda-energie-lahr.de](http://www.agenda-energie-lahr.de) ) where a large number of complete systems were monitored and measured over a number of complete seasons. The average SPF of the brine to water systems recorded was only 3.42 while Waterkotte achieved an SPF of 4.5 including hot water. When Waterkotte systems were removed from the sample the rest only achieved an SPF of 3.1. There are also regulations governing the COP of machines in Austria, and all machines in the test we presume have similar COPs. It is the system however that governs the SPF. We find that in this industry, many designers do not fully understand how to configure a

system to maximise efficiency and sometimes as a result of a flawed procurement process, compromises are often made which discredit or under exploit these technologies. The lowest price tender process is also a major impediment to proper implementation. We do not want a situation here where generally the SPF is lower than the COP, when if best practice is employed the SPF should be greater than the COP. There are more heat pump providers than there are experts in the field.

### **3.00 Every aspect of the system affects the outcome i.e.**

- 3.10 Design.** This should only be implemented by specialists with a comprehensive knowledge of the systems, products and controls. Designers should carry full professional indemnity to the value of projects being carried out to protect the end user.
- 3.11 Installation.** This should be carried out by specialists with a comprehensive knowledge of the systems, products and controls.
- 3.12 The connection of the system to the ground for heat source / sink.** The design of this part of the system is crucial as, when heating, the higher the mean water temperature the higher the efficiency. This means that great care must be taken at the design stage to calculate and evaluate parameters like seasonal temperatures, thermal response, resistance and capacity of the strata, kWh heating and cooling per year requirement, hydraulic design of pipe work to reduce pumping cost and increase efficiency, along with control, etc.
- 3.13 Heat distribution system.** Care should be taken when designing this as again the lower the temperature the higher the efficiency .i.e. the heat pump should produce water at the temperature required by system to maintain comfort rather than at the highest possible temperature or via a low loss header or buffer tank where mixing can take place and hence reduce efficiency. Use should be made of weather and room temperature compensation to ensure comfort and lowest possible flow temperatures. Lowest temperature distribution systems should be employed. (Remember; 1 degree increase in flow temperature equals 6% decrease in efficiency.)
- 3.14 Hot water production.** Secondary heat exchangers can be used for hot water production. This approach allows primary water to be stored at lower temperatures and secondary water to be heated instantly to usable temperatures at point of use without storage. This approach can provide excellent results while complying with all legionella regulations and increasing overall efficiency.
- 3.15 Cooling.** Free passive cooling is available from ground source heat pumps. The only input power in this system is for the circulating pumps on both sides of the system. Obviously some cooling distribution would need to be present in the building i.e. fan coils, air handling units etc. An added benefit of this system is that the energy taken from the building (cooling) is transferred to the heat source, i.e. the building becomes the energy collector to recharge ground source. System efficiencies of up

to 3,500% are possible i.e. 1kW of input to the circulating pump can give 35kW cooling.

- 3.16 Active cooling.** This is also possible using a heat pump, the by-product of which can be used to heat outlying buildings, swimming pools, etc., and produce hot water. (Simultaneous heating and cooling). System efficiencies of up to 900% are possible, i.e. 1kW of input to the compressor can give 4.5kW of cooling and 4.5kW of heating. (Passive cooling can also take place simultaneously). These functions can also be used to recover process energy. It seems that this cooling is excluded from the scheme.
- 3.17 Control.** Control specially designed for heat pumps should be employed, rather than controls adapted from fossil fuel systems. We often see control strategies developed by BEMS programmers who do not fully understand the system to be controlled.
- 3.18 Service.** Efficiency of the system must be maintained.
- 3.19 System monitoring.** It is good practice for the system supplier to be able to access the systems remotely to assess the ongoing functionality and efficiency of the system. Information such as COP and SPF can be read remotely and graphs can be drawn to show performance over time. We are the only company using this technology to guarantee that 75% of total energy used on an annual basis comes from a renewable source, if we design, supply, install and service a complete system including under floor heating and hot water production. This type of approach could help to ensure that system efficiency is given high priority.

#### **4.00 Mono Valiant, Mono Energetic and Bivalent Systems.**

- 4.10** This scheme excludes Bivalent systems. We can understand the thinking behind this but there are situations where it is a decided advantage to use fossil fuels as backup provided they are properly controlled. We have seen many projects where, when a preset bivalent temperature is encountered, the heat pump is switched off and the boiler takes over until the ambient temperature increases again. This is of course unacceptable, however, if a proper integrated control strategy is adopted the boiler should only come on to assist the heat pump when the heat pump is unable to achieve the comfort levels required in the building. This can allow stringent design of the heat pump system to reduce initial capital cost and ensure that the design matches the base load rather than the peak load ensuring higher efficiency and less cycling in the system. The accepted design strategy is to design for approx 75%-80% of peak load from the heat pump which equates to about 95%-98% of total load. It is of course also important that the heat emission system can cope with the total peak load within the temperature range of the heat pump so that the boiler can only assist the heat pump and not take over from it. To design a heat pump to meet peak loads (mono valiant) is not good practice and mono energetic is really only practical on smaller projects. In retrofit situations the existing boiler can sometimes be retained for backup but it is imperative that it is controlled by the heat pump control.

## **5.00 Waterkotte control strategy for back up is as follows:**

- 5.10** - Heat pump works to weather compensated return water set point
- If the system fails to increase return water temp in a pre-set period then backup is called for
  - The backup assists the heat pump until the set point is reached
  - Then both switch off
  - When return water cut in temp for heat pump is reached the heat pump only, is activated and backup is only called again if no increase in return water temperature is detected.
  - If the system is designed properly this should only be activated on extreme occasions but has the advantages of load matching and customer confidence in the system.
  - In practice our systems rarely call the backup, as systems usually performs better than design i.e. brine 0 water 35 and the thermal mass of the building can often adequately deal with peaks.

## **6.00 Air source.**

- 6.10** Our air source heat pump system has an SPF of 4.2 with floor heating, including hot water production and can maintain full rated output and hot water @ 60 degrees centigrade, even at minus 15 degrees centigrade outside air temperature. The importance of a system approach to this technology cannot be over stated, if efficiency is to be kept high and the technology is not to be dogged with patchy results as has occurred in the past. The advent of inverter technology has been a major breakthrough.

## **7.00 Solar integration.**

- 7.10** When incorporating solar or other renewables into a heat pump system it is important to properly integrate the solar thermal as part of the system rather than as an add on. This can insure that best advantage is made of direct solar and that it can be properly allocated between heating and hot water while not compromising the efficiency of the heat pump by having to work at a buffer tank temperature dictated by a high temperature source such as solar. Our heat pump range has a built in solar integration control as standard, and the solar is connected directly to the heat pump.

## **8.00 Cop out from system approach should not be allowed.**

- 8.10** Many heat pump manufacturing and installation companies only take responsibility for the heat pump and collector, isolating themselves from problems with the heat distribution system, by providing an intermediate buffer or low loss header between their “system” and the building distribution system. This buffer in itself has a negative effect on efficiency as mixing takes place here and the heat pump must work at a higher temperature than is required. Also, often the only control for flow temperature is a mechanical thermostat set at the heat pump max flow temperature, with no consideration to the flow temperature required by the system for comfort. We even sometimes see mixing valves between the heat pump and heat distribution. As the complete system’s efficiency depends so fundamentally on the distribution, it is not right that the heat pump “expert” should have no liability over the design and control of this part of the system. Who else can be responsible for this part of the design?
- 8.11** We know of course why they do not want to be involved in this part of the system, especially in a retro-fit situation. Firstly they want to sell “boxes” not systems and if problems occur they want to be able to easily ascertain the fault i.e. does the heat pump heat the buffer? If so it is not their problem.

## **9.00 Conclusion**

- 9.10** There are many things we can do to ensure that heat pumps take their rightful place as the most efficient, cost effective one stop solution to the energy needs of modern buildings. RHI should learn from our experience and the experience of other professionals and encourage and reward best practice in the field. To this end I would be happy to discuss any of the issues relating to the RHI with your representative.

Yours sincerely,

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