Case study; Ground Source Heating for Social Housing

February – April 2012

- Client; Wales & West Housing Association, Gibson STS
- Suppliers; Apex Drilling, Vaillant, Carbon Zero Consulting
- Locations; South, Mid and North Wales
- Input; Borehole array design and Thermal Response Testing

Carbon Zero Consulting were contracted to provide Ground Source Heating (GSHC) design advice for a project to replace oil boilers with ground source heat pumps on 3 social housing estates. Ground source heating was specified as the technology of choice in preference to air source – as greater long term efficiency and quiet operation were seen as 2 particular benefits.

Wales & West Housing Association were keen to obtain *independent* design input to provide confidence that the borehole ground arrays would be designed using sound engineering principles to ensure efficient, long term operation of the GSHP systems.

A total of 28 houses and 6 apartments were refurbished including replacement of oil boilers.

Site visit and preparation

A site visit was made to each housing estate to establish viable drilling locations. In general, the boreholes were to be drilled in the garden or driveway of each property.

An energy assessment was performed on each house by Gibson STS. The first stage of energy efficiency improvement was to increase the level of internal insulation and to improve windows where necessary. This information was then used by Vaillant to specify and provide heat pumps of the required heat output to replace existing boilers.

Borehole design and geological advice

Carbon Zero Consulting undertook all the geological and ground source design works. A Carbon Zero Consulting 'Georeport' was prepared for each of the 3 sites. The content of the Georeport calculated the borehole length required for each house taking into account the geology, thermal conductivity (λ) and heating requirement of each house. A 'desktop' value for formation thermal conductivity (λ) was derived using our knowledge of the underlying geology and hydrogeology. Two approaches were taken for borehole length calculation;

- Carbon Zero Consulting in-house design spreadsheet (DCLB)
- MIS 3005 look up tables, using a desk-top value for thermal conductivity.

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The MIS3005 guidelines require ground source design to maintain the loop temperature (at entry to the heat pump) above 0°C. Allowance was also made for the potential for thermal interference between boreholes on the same or adjoining property. The output of each report was a unique borehole length to be drilled for each property; some required 2 boreholes or a single deep (over 150m) borehole.

Further assistance was provided to the client and Apex (drilling contractor) by issuing an assessment of mining activity and other geological and drilling risks for the 3 drilling locations.

Thermal Response Testing (TRT)

Following completion of the drilling of the first borehole on each site, a Thermal Response Test (TRT) was performed. Carbon Zero Consulting utilized in-house equipment and expertise to perform three TRTs.

A period of 5 days 'rest' was allowed after grouting of loops into the first borehole on each site to allow the borehole and formation to return to thermal equilibrium. A TRT utilizing 6.5kW of electrical heat injection was used for a period of 50 hours.

The result of each TRT provided a *measured* value for λ – and borehole thermal resistance. The measured λ value was then used to re-calculate borehole lengths. In each case the original desk-top λ value was sufficiently close to the measured value for there to be no change to the depths of the remaining boreholes.

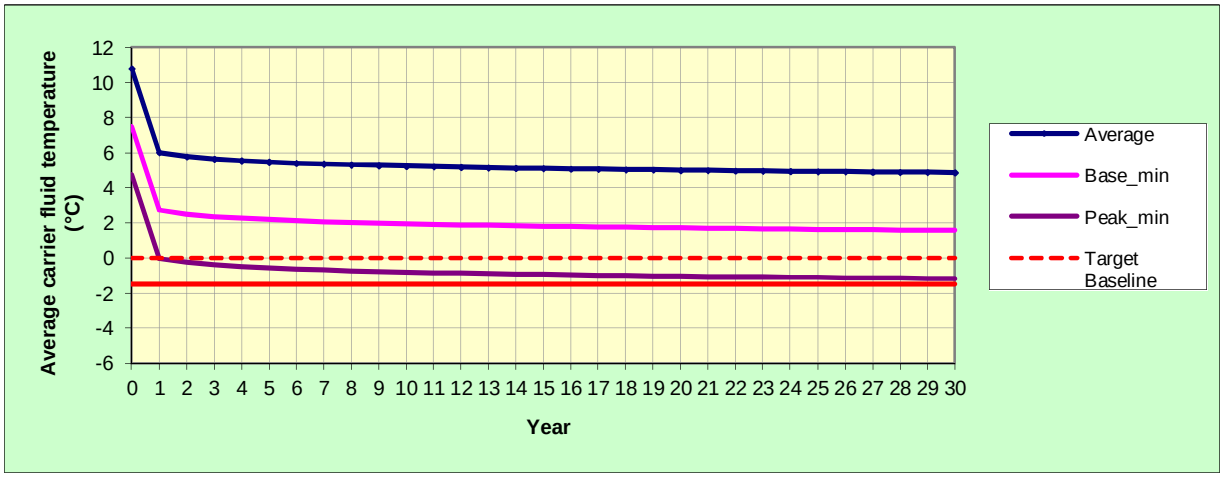

Figure 1. Example output from DCLB showing loop temperature design over 30 year period.