

### **What to Look for in Thermal Response / Conductivity Test Services**

Today's high efficiency Ground Source Heat Pump (GSHP) systems utilize Ground Heat Exchange (GHX) systems to transfer heat in and out of a site's underground earth formations to heat / cool buildings. Commercial GHP/GHX systems require accurate Thermal Response / Conductivity Test (TC) report to ascertain geological conditions prior to the final project design.

A valid and well designed TC test is performed by injection of a known amount of constant-rate heat energy into an underground formation for 48-72 hours. The TC test uses a grouted loop pipe installed in a borehole that is representative of the intended production and is located in one or more locations within the site of the proposed loopfield. The data that is acquired during the test period is subsequently analyzed using industry accepted guidelines and software design tools. The well designed TC test utilizing the GeoCube provides designers with the following information:

- Thermal Conductivity (k)
- Thermal Diffusivity ( $\alpha$ ) Estimate
- Undisturbed earth temperature

In addition, drilling logs from the borehole constructed for the TC test provide meaningful insight into geological and hydro-geological characteristics of the underground formations at the project site. This project-site specific information can provide valuable insight to a commercial production driller which reduces risk and uncertainty associated with the loopfield project proposals.

### **TC Test Standards:**

The goal of the TC Test is to provide accurate, repeatable data which will be used to model the design that will be replicated across many hundreds of project loopfield boreholes. Accurate and valid TC test results from the GeoCube are dependent on following standard test procedures. These test procedures are based on many years of research, development and experience from across the entire geothermal industry. GeoCube test procedures and subsequent data analysis are outlined by the American Society of Heating, Refrigeration and Air Conditioning (ASHRAE). The 2007 Edition of the ASHRAE HVAC Applications Handbook, Chapter 32, 12-13 should be the basis for the performance of any valid TC Testing.

### **TC Test Procedure:**

General elements of the test procedures include:

- Test Duration: 48-72 continuous hours of constant-rate heat injection and data collection.

- The constant heat injection rate into the borehole loop should fall between 15-25 watts per foot of borehole (not loop length). Steps should be taken (such as insulating pipes) to minimize heat loss/gain from the above-ground fixtures, pipes or materials.
- The power supply must be stable. The acceptable maximum standard deviation for input power is +/-1.5% from the average power level. Peak variations must be kept at less than 10% of the average power level

**OR**

- Resulting temperature variation of the actual average loop temperature, based on prediction of a linear regression analysis of temperature vs. the natural logarithm of time, should be held to less than +/- 0.5°F.
- Temperature measurement / recording accuracy +/-0.5°F.
- Power transducer / recorder accuracy +/-2%.
- A sufficient flow rate to obtain a temperature differential of 6-12 °F ( $\Delta t$ )
- The minimum waiting period between drilling and testing should be 5 days for  $k < 1.0$  formations and 3 days for  $k > 1.0$  formations.
- Undisturbed ground formation direct temperature measurement via probe insertion in the liquid filled loop at three depths and compute the average temperature or measure the loop exit temperature during circulation pump startup.
- During the test, the maximum interval of data point recording must be 10 minutes or less.
- All above ground exposures (such as pipes) must be insulated with a minimum of ½" of insulation. The test rig / fixture must be insulated with a minimum of 1" fiberglass equivalent insulation.

**Data Analysis / Reporting:**

The GeoCube utilizes high accuracy sensors that meet or exceed the guidelines published by ASHRAE for TC testing purposes. All data are electronically acquired by a data logging unit that is installed into the GeoCube housing. Data may be accessed on-site via the use of a data shuttle or remotely via telemetry (an optional feature). Additionally, redundant sensors and other advanced data logging features are available. Our TC data analysis software is included with the GeoCube unit and utilizes the industry standard line source theory, providing results that are compliant with ASHRAE 111-8TRP. ASHRAE 1118-TRP describes methods of "line source" analysis.

The GeoCube software provides for maximum data flexibility in the data analysis process. It not only calculates soil property results and borehole thermal resistances but also analyzes the data for consistency and quality to meet or exceed the ASHRAE requirements. The software can recognize significant data aberrations (such as a fluctuating power supply, the presence of groundwater contamination, etc.) and provide this information in the preparation of the auto-generated reports. Additionally, it is a straightforward process to sub-analyze the data over different time intervals (10-40 hours, 20-40 hours, 10-50 hours, etc), which is quite useful when a test specification requires an analysis across time frames. In general, reports should include summary figures as well as graphical data plots for end-user data evaluation and presentation purposes.

### **Conclusion:**

The need for commercial TC Testing and the procedures and data analysis methodologies are well established by the industry. The GeoCube, when used by a Professional Testing Consultant or by another industry professional, can provide in a timely fashion, the accurate, critical design and reporting data that is needed to properly size a geothermal loopfield. Whether you are hiring consulting services or developing in-house TC testing expertise, the GeoCube and its well established test procedures will provide a competitive edge. The GeoCube enables cost-effective testing, immediate access to test results and the peace of mind that your next GHX will be sized properly.