Closed-Loop Ground Heat Exchangers

1B. (1996) DESIGN METHODS AND COMPLIANCE

1B.3 (2003) Soil thermal values shall be used in calculating loop length. For horizontal ground heat exchanger applications, determination of the soil’s thermal properties with a conductivity test is unnecessary. Refer to IGHPA Soil and Rock Classification Manual, and Soil Conservation Service Survey for county/parish data, which can be obtained from the local SCS office.

(2004) For larger, commercial projects in which the heat exchanger will be installed vertically, the thermal properties of the soil/rock formation shall be determined by performing a thermal conductivity (in-situ) test. This test shall be performed according to one of the following methods:


1B.3.1.1 (2004) Test durations shall be a minimum of 36 hours.

1B.3.1.2 (2003) The collected data shall be analyzed using the line source method.

1B.3.1.3 (2004) Acceptable power:

1B.3.1.3.1 (2004) The standard deviation of the power shall be less than or equal to 1.5% of the average power.

1B.3.1.3.2 (2004) The maximum variation (spikes) in power shall be less than or equal to 10%.

1B.3.1.3.3 (2004) If 1B.3.1.3.1 or 1B.3.1.3.2 are not met, acceptable results can still be obtained if the maximum deviation of the u-bend loop temperature is less than or equal to 0.5°F (0.28°C) when compared to a trend line of the full data set.

1B.3.1.3.4 (2004) The heat rate supplied to the u-bend loop shall be between 15 and 25 Watts per bore foot (49.2 and 82.0 Watts per bore meter).

1B.3.1.4 (2004) The undisturbed formation temperature shall be measured by observing the temperature of the water as it returns from the u-bend loop to the test equipment at startup. An acceptable alternate method is to directly measure the loop temperature at various depths with a thermocouple probe.

1B.3.1.5 (2003) A minimum delay of five days shall be observed between loop grouting and test startup.

1B.3.1.6 (2004) Minimum test equipment specifications:

1B.3.1.6.1 (2004) Entering/leaving water temperatures shall be measured with ±0.5°F (±0.28°C) combined transducer-recorder accuracy.
1B.3.1.6.2 (2004) Heat Input rate shall be measured with 2.0% combined trans-recorder accuracy of reading (not full scale accuracy).

1B.3.1.6.3 (2004) Actual u-bend length shall be measured to within ±1% accuracy.

1B.3.1.6.4 (2004) Piping length between the test unit and the u-bend shall be equal to or less than 4 feet (1.22 m) per leg and shall be sufficiently insulated to minimize ambient heat loss.

1B.3.1.6.5 (2004) All hydronic components within the test unit shall be sufficiently insulated to minimize ambient heat loss.

1B.3.1.7 (2004) Test bore diameter should not exceed 6 inches (15.24 cm), and shall be grouted in accordance with IGSHPA Standard 2B.1. It is recommended that the minimum grout thermal conductivity should be equal to or greater than 0.75 Btu/hr-ft-°F (1.30 W/m °K).

1B.3.1.8 (2004) In the event a test should prematurely fail, the measured u-bend loop temperature shall naturally return to within 0.5°F (0.28°C) of the initial undisturbed formation temperature as measured in 1B.3.1.4.

1C. (1996) GROUND HEAT EXCHANGER MATERIALS

1C.2.2 (2004) Material. The material shall have a Hydrostatic Design Basis of 1600 psi (110.316 bar) at 73°F (23°C) per ASTM D-2837. The material shall be listed in PPI TR4 as a PE3408 piping formulation. The material shall be a high-density polyethylene compound having a minimum cell classification of PE345464C per ASTM D-3350.

Pipe Placement and Backfilling

2B. (1997) BOREHOLES


2B.1.1 (2003) Vertical boreholes shall have a minimum diameter such that it is large enough to accommodate the specified u-bend assembly and a tremie pipe with a minimum nominal diameter of 1 inch (2.54 cm).

2B.1.2 (2003) When penetrating more than one aquifer, all vertical bore holes must be grouted bottom to top with a material that is certified by the National Sanitation Foundation International to ANSI/NSF Standard 60, “Drinking Water Treatment Chemicals – Health Effects” and has a known heat transfer capacity and an adequate sealing characteristic. The grouting material shall be classified as either a pliable (such as a bentonite-based material) or rigid (such as a cement-based material) material.
2B.1.2.1 (2003) The thermal conductivity of the grouting material shall be determined by using the following method for the specific material classification:


2B.1.2.2.1 (2003) The maximum allowable permeability value shall be 1x10⁻⁷ cm/sec or lower if specified by State and/or Local code, regulation or law.

2B.1.2.3 (2004) The thermal and hydraulic conductivity characteristics of the grouting material mixture as specified by the manufacturer shall be independently verified by an “outside the company” laboratory in order to validate compliance to these standards.

2B.1.2.3.1 (2004) The laboratory verifying hydraulic conductivity shall be certified by AMRL (American Association of State Highway & Transportation Officials, Materials Reference Laboratory) and validated by the US Army Corps of Engineers to perform ASTM D-5084 at the time of verification.

2B.1.2.3.2 (2004) Copies of the individual reports shall be made available when requested.

2B.1.2.3.3 (2004) Thermal conductivity shall be determined and verified using the specific mixing instructions and specified additive materials of the manufacturer.