Example Geothermal Wellfield Specifications

Closed Circuit Vertical Heat Exchanger (VHE)

Intended for general distribution to:
Geothermal Wellfield Designers, Engineers & Architects

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EXAMPLE GEOTHERMAL WELLFIELD SPECIFICATIONS

Closed Circuit Vertical Heat Exchanger (VHE)

DESCRIPTION OF WORK

A. This design has been prepared in accordance with the materials standards and accepted installation practices of the International Ground Source Heat Pump Association (IGSHPA). The wellfield contractor shall comply with these standards and practices along with all State and local regulations pertaining to the installation.

B. The wellfield contractor is responsible for all aspects involved with the complete geothermal wellfield installation. All materials, drilling, water supply, excavation, hauling of backfill, dewatering, building penetration, manifold/vault installation, leak testing, soil compaction, final flushing/purging, adding glycol and labor required shall be included in the bid price.

C. The wellfield contractor shall take note: There is no guarantee to the wellfield contractor that the location of any existing utilities are exactly as indicated on the plans. Some areas may require hand digging to locate that utility. The wellfield contractor must include in the bid price, the repair of any domestic water, electrical, communication or any service line that may be damaged during the construction of this project. Any offsets required to route over or under existing lines shall also be included in the bid price of the project.

QUALIFICATIONS

A. The wellfield contractor must have on this project a certified IGSHPA installer. The wellfield contractor performing this work must have a minimum of two years experience in performing underground closed circuit VHE work of this project's size or larger.

B. VHE fabricators must be heat fusion certified by an authorized high density polyethylene (HDPE) pipe manufacturer's representative of the brand of pipe used. Certification must include: successful completion of a written heat fusion exam as well as demonstrating proper heat fusion techniques under the direct supervision of the authorized HDPE pipe manufacturer's representative.

PRODUCTS

A. Pipe

The pipe shall be PE3408 HDPE with a minimum cell classification of 345464C per ASTM D3035 and a DR11 (160 psi) rating for u-bends and header pipe two inches and smaller and a minimum of DR15.5 (110 psi) for header pipe greater than 2 inch in diameter. This pipe will carry a warranty of no less than 50 years.

Each pipe shall be permanently indent marked with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards, cell classification number and date of manufacture.

The VHE will have a factory fused u-bend with pipe lengths long enough to reach grade from the bottom of the bore so no field fusions are required below the header pit. Approved pipe manufacturer is Performance Pipe.

B. Fittings

Pipe fittings shall meet the requirements of ASTM D2683 (for socket fusion fittings) or ASTM D3261 (for butt/saddle fusion fittings). Each fitting shall be identified with the manufacturer's name, nominal size, pressure rating, relevant ASTM standards and date of manufacturer. Saddle fusion is not allowed except when performed by a manufacturer normally engaged in that type of work. No field installed saddle fittings are allowed. Approved fabrication manufacturer is GHP Systems, Inc. and approved fitting manufacturers are Performance Pipe, Central Plastics and Viega.

C. Manufactured Infield Extended Headers

The header sections shall be factory assembled with all branches ready for connection to the u-bend pipe ends. The infield extended headers used to connect the VHE u-bends in each circuit shall be constructed as shown on project drawings. All 2" and smaller header pipe sections will come in one complete coil that is palletized. All 3" and larger header pipe sections will be shipped in long straight sections which are typically between 40' to 50' in length. All packaging shall be as necessary to minimize damage in transit/handling and facilitate ease in unloading and storage. The **infield extended headers** shall be GeoHeaders® as manufactured by GHP Systems, Inc. and will be manufactured with the same pipe and fitting specifications as listed in those sections.

D. Interior Manifold (Use in place of Vault)

The interior manifold shall be constructed as shown on project drawings. The **manifold** shall be the GeoManifold® as manufactured by GHP Systems, Inc. and will be manufactured with the following specifications.

High density polyethylene (HDPE) pipe and fittings, joined together with heat fusion, shall be used for all circuit and main header piping. All HDPE pipe and heat fused

materials shall be manufactured from high-density, high molecular weight PE 3408 polyethylene compound that meets or exceeds ASTM D 3350 cell classification 345464C, and is listed by the Plastic Pipe Institute in PPI TR-4 with HDB ratings of 1600 psi (11.04 MPa) at 73°F (23°C) and 800 psi (5.52 MPa) at 140°F (60°C). All 3" and larger HDPE piping will be DR15.5 and all 2" and smaller HDPE piping will be DR11. All circuits 2" and greater shall include butterfly valves constructed of lug type/lever with cast iron body, aluminum-bronze disc, EPDM Seat, 416 stainless steel stem, rated at 200 psi. All circuit setter flow balancing valves will have a fixed port venture orifice, have blow-out proof stem, flow measurement function independent of ball position, install in any position, and serve as a service shutoff with a tamper resistant memory stop to accurately reset to balancing. Circuits smaller than 2" and all fill ports shall be ball valves with full port opening with blow out proof stem, 600 psi non-shock cold WOG. Pressure/temperature ports shall be brass and have a dual seal core of Nordel, good up to 350°F for water and shall be rated zero leakage from vacuum to 1000 psig. Plug shall be capable of receiving a 1/8" pressure or temperature probe. A stainless steel pressure gauge with ¼" isolation valve will be included on both supply and return mains. The pressure gauge will be Sisco brand with 4 ½" dial size and read 0 – 100 psig. A stainless steel bimetal thermometer will be included on both supply and return mains. The pressure gauge will be Ashcroft brand with 3" dial size with 4" stem and reads 0 – 250°F. The manifold will be leak proof checked at factory with 100 psi pressure for a period of 24 hours or more.

E. **Composite Steel/Concrete Vault (Use in place of interior manifold)**

The vault shall be a composite steel and concrete structure constructed as shown on project drawings. The vault shall be shipped from factory preformed for a concrete pour with all reinforcement rods, manifolds, valves and piping secured in place. The vault weight by itself will overcome all buoyancy forces without any additional anchoring. The vault will come traffic load ready without any additional manhole rings, covers, bracing, or concrete pours. The approved vault is the GeoVault® as manufactured by GHP Systems, Inc and will be manufactured with the following specifications.

Structure: The interior shell shall consist of a heavy-duty steel frame and base where all joints have a continuous weld. The base frame and cross bracing shall be constructed of 1/4" – 3" x 8" square steel tubing. The base cross bracing shall be spaced a maximum of 2 feet on center with ¼" – 3" x 8" square steel tubing. The sidewall and ceiling frames and all cross bracing shall be constructed of ¼" – 3" x 3" angle iron. Sidewall and ceiling cross bracing shall be spaced a maximum of 2 feet on center. The steel interior walls/ceiling, stainless steel floor and stainless steel sump pump pit shall be constructed of 12-gage sheet that are specially treated with an epoxy coating on interior side. All interior sheet steel shall have a continuous weld on seams and a 2" weld every 12" at support framing and exterior form walls. #5 reinforcement rods shall be placed on a 12" spacing for sidewalls and #6

reinforcement rods shall be placed on a 12" x 12" grid spacing for the ceiling. All steel pipe sleeves will be schedule 40 and have a continuous weld on interior side. All reinforcement rods shall be located 3" within the concrete from the interior side and welded to steel framing every 2 feet or less. The outer shell of the walls and ceiling shall consist of 8" thick 4,000 psi concrete that is poured by the contractor on-site and vibrated into place. The manhole shall be constructed of ¼" sheet steel with a 3" flange that is anchored into ceiling concrete and welded to ceiling frame; all manhole welds being continuous. The manhole cover shall be constructed of ¼" steel tread plate with framing constructed of ¼" – 3" x 3" angle iron. The manifold stand's support channel shall run continuous between circuits and be constructed of ¼" – 3" x 3" angle iron with 1/8" – 1" tube supports every 3 feet welded to the floor.

Manifolds: High density polyethylene (HDPE) pipe and fittings, joined together with heat fusion, shall be used for all circuit and main header piping. All HDPE pipe and heat fused materials shall be manufactured from high-density, high molecular weight PE 3408 polyethylene compound that meets or exceeds ASTM D 3350 cell classification 345464C, and is listed by the Plastic Pipe Institute in PPI TR-4 with HDB ratings of 1600 psi (11.04 MPa) at 73°F (23°C) and 800 psi (5.52 MPa) at 140°F (60°C). All 3" and larger HDPE piping will be DR15.5 and all 2" and smaller HDPE piping will be DR11. All circuits 2" and greater shall include butterfly valves constructed of lug type/lever with cast iron body, aluminum-bronze disc, EPDM Seat, 416 stainless steel stem, rated at 200 psi. All circuit setter flow balancing valves will have a fixed port venture orifice, have blow-out proof stem, flow measurement function independent of ball position, install in any position, and serve as a service shutoff with a tamper resistant memory stop to accurately reset to balancing. Circuits smaller than 2" and all fill ports shall be ball valves with full port opening with blow out proof stem, 600 psi non-shock cold WOG. Pressure/temperature ports shall be brass and have a dual seal core of Nordel, good up to 350°F for water and shall be rated zero leakage from vacuum to 1000 psig. Plug shall be capable of receiving a 1/8" pressure or temperature probe. A stainless steel pressure gauge with ¼" isolation valve will be included on both supply and return mains. The pressure gauge will be Sisco brand with 4 ½" dial size and read 0 – 100 psig. A stainless steel bimetal thermometer will be included on both supply and return mains. The pressure gauge will be Ashcroft brand with 3" dial size with 4" stem and reads 0 – 250°F. The manifold will be leak proof checked at factory with 100 psi pressure for a period of 24 hours or more.

Keyed Entry: The manhole cover of the vault will be fastened with four stainless steel pentagon head bolts requiring a special socket key for removal. These bolts will be counter sunk a minimum of 1" in a circular hole just large enough to accommodate the socket key to inhibit tampering/removal with conventional tools. Two socket keys will be included with each vault.

Seals: All HDPE pipe penetrations in the vault will utilize a Link-Seal® – EPDM modular hydrostatic seal to water proof and anchor the pipe. This seal will be

removable to allow replacement of the HDPE pipe should it ever be damaged at the point of vault penetration. The manhole cover and stainless steel sump pit will utilize EPDM gaskets for seals where bolted connections are made.

Sump Pump: A Little Giant series 6 with mercury switch will be supplied with the vault. The pump will be 1/3 HP, continuous duty rated, 60Hz, 120V - 9.0A. The pump will discharge at a rate of 46 GPM at the point it exits the vault.

Ventilation: Vault will come with its own ventilation blower and 8" flexible ducting. The blower will be industrial grade made with heavy duty metal construction and produce high velocity air movement. The blower will be Aloha model 39008 rated for 60Hz, 120V - 1.4A. The blower will produce 1,580 CFM open and 1,200 CFM connected to 20 feet of 8" industrial grade flexible ducting. The blower will be ceiling mounted at the opposite end of the manhole within the vault. The 8" flexible duct will be run from the blower up to the top of the manhole entry. The blower will be switched with the lights with this switch being located right below the manhole cover.

Electrical: The electrical service required for the vault is 60 Hz, 120V - 20A with GFCI breaker. The vault shall have all required electrical conduit and boxes ceiling mounted with 1" conduit exiting the vault. All outlets, light fixture(s), switch and weatherproof covers will be included with the vault. The vault is to be field wired by a licensed electrician in the state of installation.

The electrical components include:

1. Light Fixture(s): Sealed glass lens with aluminum guard and aluminum ceiling mounted base. The fixture is suitable for damp locations and uses a 100 W bulb.

2. Switch: The switch will be a 120V - 20A heavy duty double pole that will power the lights as well the ventilation outlet

3. Outlets: The two outlets used will be 120V - 20A heavy duty duplex. The utility outlet will be wired continuous power for sump pump and servicing equipment. The ventilation outlet will be switched with the lights for the blower.

All alternate vaults must at a minimum meet the following criteria to be considered for approval by engineer.

1. **Quality Assurance:** The vault shall come from the factory with the HDPE manifold mounted in place and all main and circuit piping stubbed out of vault housing. The manufacturer shall be specialized in the manufacturing of

commercial geothermal vaults, have manufactured at least 200 geothermal vaults and shall have manufactured geothermal vaults for a minimum of 5 years. Proof of experience shall be required for approval.

2. **Structural Integrity:** Vault shall come from the factory traffic load rated and capable of handling all traffic and service/utility equipment loads encountered regardless of the vaults location. If additional structural support (such as a concrete surface pad with manhole ring and cover) is required to meet this criterion, it must have a PE stamped design. The vault shall have a flat base that extends out to the complete width and length of the vault. This wide base will have a reinforced footing surface area that carries a load of no more than 12 lb per square inch of the installed vault's weight.

3. **Buoyancy:** The weight of the vault housing itself must overcome all bouncy forces at the installed depth. The vault must not be able to float in a flooded open vault pit during installation. If any additional vault weighting/anchoring is required to meet this criterion, it must have a PE stamped design. The design calculations will use complete saturated soil conditions.

4. **Component Replacement:** All vault supply/return pipe penetrations must utilize a positive hydrostatic seal (equivalent to Link-Seal®) to allow field replacement should the pipe be damaged. Pipe cannot be heat fused (or extrusion welded) to vault structure or be secured in any fashion which promotes crack propagation in the pipe or hinders pipe replacement. All valves and gauges within the vault must be able to be replaced without any heat fusion repair required.

5. **Safety/Servicing:** The vault shall have switched lighting, switched fresh air ventilation (minimum 1200 CFM), service outlet and a sump pit/pump. The vault shall have a minimum of a 30" square manway or a 34" diameter manway with an OSHA approved ladder and a tamper resistant non skid cover with a gasket seal. There must be a minimum 2' wide walkway between circuits with a minimum 6' high unobstructed ceiling. All ceiling mounted lights, ventilation blower, outlets and etc. must be mounted to the side of this walkway.

F. **Grout (Design option 1)**

The thermally enhanced bentonite based grout used to seal the VHE shall have a minimum of 63% solids. This grout will also have a permeability rate of less than

$1X10^{-7}$cm/sec. The silica sand used will have a 4030 mesh or finer. The minimum grout thermal conductivity is 0.90 Btu/hr-ft-°F (50lb bentonite/200lb silica sand). Approved grout manufacturers are Black Hills Bentonite (TG Lite), Wyo-Ben Inc. (ThermEx) and Baroid (Barotherm Gold).

G. U-bend Pipe Separators (Design option 2 - use with 0.57 TC grout)

The u-bend pipe separators used to position the u-bend pipes against the borehole wall directly across from one another shall be the GeoClip® brand manufactured by GBT, Inc. These separators will be positioned every ten feet on the u-bend pipe.

H. Warning Tape

Warning tape used must be foil backed, two inches wide or greater with a continuous message printed every 36 inches or less reading: "CAUTION GEOTHERMAL PIPELINE BURIED BELOW". The tape shall be highly resistant to alkalis, acids and other destructive agents found in the ground.

EXECUTION

A. Drilling

The vertical boreholes will be drilled to a depth allowing complete insertion of the VHE to its specified depth. The maximum borehole diameter will be six inches. If a larger diameter is required, it must be approved by the design engineer.

B. U-bend Pipe Assembly

The u-bend pipe shall be filled with water and pressurized to 100 psi to check for leaks before insertion. If necessary, an iron (sinker) bar can be attached at the base of each u-bend to overcome buoyancy. This iron bar will have all sharp edges adequately taped to avoid scarring and/or cutting of the polyethylene pipe. No driving rod that is pulled out after u-bend insertion will be allowed. The entire assembly is inserted to the specified depth in the borehole.

C. Grouting Procedures

The VHE is to be grouted from the bottom on up in a continuous fashion using a one inch or larger HDPE tremie pipe. The tremie pipe will be pulled out during the grouting procedure maintaining the pipe's end just below grout level within the borehole. All State regulations will be met for borehole grouting of the VHE.

D. Heat Fusion Pipe Joining

All underground pipe joining will be heat fused by socket, butt or saddle (sidewall) fusion in accordance to ASTM D2610, ASTM D2683 and the manufacturer's heat fusion specifications. The operator shall be heat fusion certified and experienced in executing quality fusion joints.

E. Excavation and Backfilling for Piping

The wellfield contractor shall do all excavating, backfilling, shoring, bailing and pumping for the installation of their work and perform necessary grading to prevent surface water from flowing into trenches or other excavations. Sewer lines shall not be used for draining trenches and the end of all pipe and conduit shall be kept sealed and lines left clean and unobstructed during construction. Only material suitable for backfilling shall be piled a sufficient distance from banks of trenches to avoid overloading. Unsuitable backfill material shall be removed as directed by the design engineer.

Sheathing and shoring shall be done as necessary for protection of work and personnel safety. Unless otherwise indicated, excavation shall be open cut except for short sections. The wellfield contractor shall install geothermal locating (warning) tape 18 inches above all horizontal/header piping.

Prior to drilling or trenching, the wellfield contractor shall be responsible for reviewing with the general contractor the location of underground utilities. Existing utility lines uncovered during excavation shall be protected from damage during excavation and backfilling.

F. Pipe Installation

The u-bend pipe ends will be sealed with fusion caps or tape prior to insertion into the borehole. Reasonable care shall be taken to ensure that the geothermal wellfield pipe is not crushed, kinked, or cut. Should any pipe be damaged, the damaged section shall be cut out and the pipe reconnected by heat fusion.

The VHEs must be connected as indicated on the plans. The header design accounts for balanced flow as well as flushing and purging flow rates. No variations can be made in the circuit hookup or the pipe sizes that are indicated without approval from the design engineer. The minimum bend radius for each pipe size shall be 25 times the nominal pipe diameter or the pipe manufacturer's recommendations, whichever is greater. The depth of all headers and supply and return piping is indicated on the plans and must be maintained.

Circuits will be pressure tested before any backfilling of the header trenches is executed. The individual circuits will be pressure tested with water at 60 psi; however, not to exceed DR 11 pipe working pressure at bottom of the u-bend pipe.

G. **Flushing/Purging and Glycol**

During installation, all debris shall be kept out of the pipe. Ends of the HDPE pipe shall be sealed until the pipe is joined to the circuits.

Flushing and Purging: Each supply and return circuit shall be flushed and purged with a water velocity of two feet per second. The lines shall be left filled with clean water and then pressure tested. If connection to the manifold is not immediate, piping must be capped. The wellfield contractor must coordinate with the mechanical contractor on propylene glycol antifreeze installation. The mechanical contractor is responsible for the interior piping's propylene glycol antifreeze. See Mechanical Specifications for antifreeze specifics.

Glycol Charging: Follow all manufacturers' instructions for product handling.

1. Circuits: Isolate and charge one circuit at a time. Close all main valves and all other circuits. Gradually introduce premixed propylene glycol solution, through the fill port, until a concentration of 25% is obtained. Repeat procedure for each remaining circuit.

2. Mains: Close valves to all circuits, isolate and charge one pair of mains at a time. Open valves on primary supply/return mains in mechanical room. Open bypass valve in mechanical room or vault.

3. Allow untreated water to be displaced from the system as solution is introduced. Handle discharged water according to manufacturer's recommendations, state and local regulations.

4. While charging, repeatedly check concentration at vault manifolds to minimize product loss. Immediately discontinue introducing solution when testing confirms a concentration of 25%.

SHOP DRAWINGS

Before geothermal wellfield construction begins, the wellfield contractor must submit shop drawings to the design engineer. The shop drawings shall include all applicable manufacturer's specifications, warranties, and material safety data sheets for all materials used in the geothermal installation. No substitutions will be allowed without authorization from the design engineer.