

SECTION 23 57 33
GEOHERMAL ENERGY - DIRECT USE (HEATING APPLICATIONS)

SPEC WRITER NOTES:

1. Delete between // ----- //if not applicable to project. Also delete any other item or paragraph not applicable in the Section and renumber the paragraphs.
2. Provide the year of latest edition to each publication given in Article 1.7 APPLICABLE PUBLICATIONS.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23 related to geothermal energy direct use systems, //open loop// //and// //closed loop// as indicated.

SPEC WRITER NOTE: Edit the below to suite project.

- B. Geothermal for direct use heating applications: The system includes wellbores, open loop downhole piping, above grade plate-and-frame heat exchanger and associated circulation pumps for the generation of HVAC heating water //and/or domestic hot water//. The geothermal source is separated from the HVAC heating //and/or domestic hot water// equipment via the plate-and-frame heat exchanger.
- C. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

1.2 RELATED WORK

- A. //Section 01 00 00, GENERAL REQUIREMENTS.//
- B. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- C. //Section 01 90 00, General Commissioning Requirements//
- D. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- E. //Section 23 05 11, COMMON WORK RESULTS FOR HVAC.//
- F. Section 23 05 93, TESTING, ADJUSTING AND BALANCING FOR HVAC.
- G. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- H. //Section 23 08 00, COMMISSIONING HVAC SYSTEM.//
- I. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- J. Section 23 21 13 HYDRONIC PIPING.
- K. Section 23 21 23, HYDRONIC PUMPS.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, geothermal energy terms used in these contract documents, shall be as defined in ASTM E957.

1.4 QUALITY ASSURANCE

- A. The Wellbore Drilling Contractor shall be a National Ground Water Association (NGWA) Certified Well Driller (CWD). Furthermore, the driller/installer of the direct use geothermal well(s) and piping shall be Licensed by the State Government's well drilling regulatory body where the project is occurring, as Water Well Driller, Well Driller, Geothermal Borehole Driller, etc. as applicable in that jurisdiction, for the installation of Direct Use geothermal or injection wells. This licensed driller shall conform to all stand and local laws and regulations including, but not limited to the grouting materials and methods, drilling techniques and disposition of drilling spoils and fluids, acceptable pumps, piping, casing, and screen materials, injection well construction (if applicable), minimal burial depth and more as codified in their laws, rules, regulations and ordinances. //Additionally, if the design includes an injection well(s), the engineering, installation and permitting of all Underground injection wells shall be in full compliance with Federal (Environmental Protection Agency) and State regulations governing Underground Injection Control (UIC) regulations for Class Five (V) wells.//
- B. Local and state laws and ordinances as they pertain to buried pipe systems shall be strictly followed or a variance obtained.
- C. Geothermal energy direct-use system installer(s) shall demonstrate that they have successfully installed at least eight projects that, in aggregate, equal or exceed the size of the proposed project. References shall be provided for each of these installed projects.
- D. Warranties: The geothermal energy system shall be subject to the terms of FAR Clause 52.246-21.

SPEC WRITER NOTE: Authority Having Jurisdiction and consult with VA to determine applicability to project. Insert applicable authorities and regulations below.

1.5 PERMITS AND FEES

- A. The Wellbore Driller/Installer of downhole piping shall, without additional expense to the Government, be responsible for obtaining and paying for any and all necessary licenses and permits in connection

with the performance of its services; installer shall maintain said licenses and permits current until the work has been accepted by the Government, and alone shall bear financial responsibility for any and all violations of said licenses and permits. //See Paragraph 1.4.A and 3.1.D for requirements related to Underground Injection Control (UIC).//

1.6 SUBMITTALS

- A. Submit six copies in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections, to the //COR//.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 57 33, GEOTHERMAL ENERGY - DIRECT USE (HEATING APPLICATIONS)", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the geo-exchange field layout, equipment, and assemblies shall meet contract requirements.
- D. If equipment submitted differs in arrangement from that shown on the submittals, provide drawings that show the rearrangement of all associated systems. Approval shall be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the COR.
- E. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed the contract documents from the applicable other manufacturers and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- F. Submittals and shop drawings for independent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals shall be made only by groups.
- G. Shop Drawings: Include structural supports, //control sequences, // monitoring instruments and controls, interconnections and all other components, parts and pieces required to complete the functioning assembly. Where applicable, include shop drawings for foundations or other support structures.

- H. Product Data: Include detailed information for components of the geothermal energy system.
 - 1. Geothermal Well
 - 2. Grouts
 - 3. Ground Heat Exchanger
 - 4. Geothermal Pump Unit
 - 5. Circulation System
 - 6. Wiring
 - 7. Wiring Specialties
 - 8. Valves
 - 9. Piping Specialties
 - 10. Heat Transfer Fluid
 - 11. Heat Exchanger
 - 12. Insulation
 - 13. Instrumentation
- I. Certificates: Submit technical representative's certification that the installation has been implemented as intended by the system designer and where applicable, recommended by the manufacturer.
- J. Manufacturer's Instructions.
- K. Operation and Maintenance Geothermal Energy Systems Data Package:
 - 1. Safety precautions
 - 2. Operator restart
 - 3. Startup, shutdown, and post-shutdown procedures
 - 4. Normal operations
 - 5. Emergency operations
 - 6. Operator service requirements
 - 7. Environmental conditions
 - 8. Lubrication data
 - 9. Preventive maintenance plan and schedule
 - 10. Cleaning recommendations
 - 11. Troubleshooting guides and diagnostic techniques
 - 12. Wiring and control diagrams
 - 13. Maintenance and repair procedures
 - 14. Removal and replacement instructions
 - 15. Spare parts and supply list
 - 16. Corrective maintenance man-hours
 - 17. Product submittal data
 - 18. O&M submittal data

19. Parts identification
20. Warranty information
21. Personnel training requirements
22. Testing equipment and special tool information
23. Testing and performance data
24. Contractor information

L. Closeout Submittals:

1. Posted operating instructions for Geothermal Energy Direct Use Systems that provide for wiring identification codes and diagrams, operating instructions, control matrix, and troubleshooting instructions.
2. As-built drawings of geothermal heat field well and piping locations provided on no less than 3/16 inch scale drawings in AutoCAD .dwg digital file format.

1.7 APPLICABLE PUBLICATIONS

SPEC WRITER NOTES:

1. Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project, unless the reference applies to all mechanical systems. Publications that apply to all mechanical systems may not be specifically referenced in the body of the specification, but, shall form a part of this specification
2. Insert the year of approved latest edition of the publications between the brackets // // and delete the brackets if applicable to this project.

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Where conflicts occur these specifications and the VHA standards will govern.

B. American Petroleum Institute (API):

662-//2011//.....Plate Heat Exchangers for General Refinery
Services - Part 1 - Plate-and-Frame Heat
Exchangers; Ed. 1.0

C. American Society of Mechanical Engineers (ASME):

B31.1-//2020//.....Power Piping

- B40.100-//2013//.....Pressure Gauges and Gauge Attachments
- D. American Society for Testing and Materials (ASTM):
 - E1-//14(2020)//.....Standard Specification for ASTM Liquid-in-Glass Thermometers
 - E957-//03(2019)//.....Standard Terminology Relating to Geothermal Energy
 - E975-//2013//.....Standard Guide for Specifying Thermal Performance of Geothermal Power Systems
- E. International Code Council (ICC):
 - IBC-//2021//.....International Building Code
 - IECC-//2021//.....International Energy Conservation Code
 - IMC-//2021//.....International Mechanical Code
- F. International Organization for Standardization (ISO):
 - 9001-//2015//.....Quality Management Systems - Requirements
 - 14531-2-//2018//.....Plastics pipes and fittings - Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels - Metric series - Specifications - Part 2: Fittings for heat-fusion jointing
 - 15547-1-//2018//.....Petroleum, petrochemical and natural gas industries-Plate-type heat exchangers - Part 1: Plate-and-frame heat exchangers
- G. National Fire Protection Association (NFPA):
 - 704-//2022//.....Standard System for the Identification of the Hazards of Materials for Emergency Response

1.8 AS-BUILTS

SPEC WRITER NOTE: Coordinate O&M Manual requirements with Section 01 00 00, GENERAL REQUIREMENTS. O&M manuals shall be submitted for content review as part of the close-out documents.

- A. Comply with requirements in Paragraph "AS-BUILT DOCUMENTATION" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

SPEC WRITER NOTE: Geothermal Direct Use heating applications are suited for low to moderate temperature source wells: 32 degrees C to 120 degrees C (90 degrees F to 250 degrees F).

2.1 GENERAL

- A. Provide materials to fabricate geothermal energy systems in accordance with this section. At the Contractor's option, provide factory-prefabricated geothermal equipment packages which meet the requirements of this section.

2.2 DOWNHOLE PIPING AND SPECIALTIES

SPEC WRITER NOTE: Take caution when specifying cross-linked polyethylene (PEX) piping in high temperature applications. Coordinate pressure rating at design temperatures and product temperature tolerances, including effects on product warranty. Consider metal piping systems if the pressure and temperature limits of PEX exceeds the manufacturers' limits

- A. The acceptable pipe and fitting materials for the underground portion shall be cross-linked polyethylene or metal piping as specified herein.
- B. Cross-linked polyethylene piping shall be:
1. Tubing manufactured by the high-pressure peroxide method (known as PEXa), and shall conform to ASTM F-876, and F-877 or D-2513. Polymer electro-fusion fittings for PEXa pipes of each dimensional specification shall conform to ASTM F-1055 or ISO 14531-2; metal cold compression-sleeve fittings shall conform to ASTM F-2080.
 2. PEXa tubing material of high-density cross-linked polyethylene manufactured using the high-pressure peroxide method of cross-linking with a minimum degree of cross-linking of 75% when tested in accordance with ASTM D-2765, Method B. The tubing material designation code as defined in ASTM F-876 shall be PEX 1006 or PEX 1008.
 3. Polymer electron-fusion fittings manufactured using a material in accordance to IGSHPA 2014, Section 1C.2.2.
 4. PEXa tubing manufactured in accordance to the dimensional specifications of ASTM F-876, and F-877 with a minimum working pressure rating of 1.1 MPa (160 psig) at 23 degrees C (73 degrees F).
 5. Fittings used with PEXa tubing intended for geothermal applications that shall be polymer electro-fusion fittings or cold expansion compression-sleeve metal fittings. Polymer electro-fusion fittings shall conform to ASTM F-1055 or ISO 14531-2 whereas cold-expansion

compression-sleeve fittings shall conform to ASTM F-2080, and shall have a minimum inside diameter of 82% of inside pipe diameter.

6. Required to have product standard information marked on PEXa tubing and fittings.

C. //Metal Piping Systems: For Direct Geothermal Systems that exceed the capacity of PEX piping, the following piping shall be utilized:

//____//

SPEC WRITER NOTE: Single-wall heat exchanger is the intent of the relatively high temperature system described in this Section. However, verify with local Authority Having Jurisdiction (AHJ) that double wall vented systems are not required to protect the local resources. Double wall systems are limited in their temperature and pressure tolerances. Coordinate with AHJ regarding code and certification requirements (e.g. NSF).

2.3 DOWNHOLE PLATE-AND-FRAME HEAT EXCHANGER

- A. Single wall heat exchanger conforming to API 662 and ISO 15547.
- B. Fixed frame with bolted, removable plate assembly.
- C. Plates shall be type 316 or 304 stainless steel or titanium (as scheduled on the Contract Drawings) and arranged for counter flow operation.
- D. Shall not be used for design pressures greater than 3.00 MPa (435 psig) and design temperatures greater than 120 degrees C (250 degrees F).
- E. Nominal thickness of gasketed plates before pressed shall be sufficient to meet design conditions but no less than 0.5 mm (0.02 inches).

2.4 CIRCULATOR SIZING, SYSTEM, AND COMPONENTS

- A. Comply with Section 23 21 23, HYDRONIC PUMPS as well as the additional requirements below.
- B. The circulator wattage for closed loop systems shall not exceed 150 watts/ton.
- C. //Proper sizing of the circulating pump shall be within the heat pump manufacturer's required flow rate range for the specified unit.
- D. Particulate contaminants shall be removed from piping system prior to initial startup.//
- E. Startup pressurization of the circuit to a minimum of 1.38 - 2.07 bar (20 to 30 psig) when installed in the summer with circulating water temperature of 20 - 30 degrees C (70 - 90 degrees F) and 2.76 - 3.45 bar (40 to 50 psig) when installed in the winter with circulating water

temperature of 5 - 10 degrees C (40 - 50 degrees F) is required. Standing column designs of circulating systems that ensure a flooded volute and meet the manufacturer's requirements are excluded from these pressure requirements.

- F. The circulation system shall incorporate provisions for flow and temperature-sensing capability for testing the performance of the water side of the air coils and heat exchangers. Pressure and temperature-sensing ports shall be within 600 mm (24 inches) of the air coils and heat exchangers.

2.5 DOWNHOLE AND CIRCULATION PUMPS

- A. Comply with Section 23 21 23, HYDRONIC PUMPS as well as the additional requirements below.
- B. Shall be ISO 9001 certified.
- C. Shall be sized according to manufacturer's guidelines and end user's needs.
- D. Hydronic systems with a total pump power exceeding 10 hp shall be variable flow.

2.6 HEAT TRANSFER FLUID

- A. Shall meet local and state requirements and be acceptable by component manufacturers.
- B. Shall meet requirements of ICC IMC Section 1207.
- C. The geothermal energy system shall have a permanent label at the loop charging valve identifying the antifreeze type and concentration, service date, and the name and phone number of the service company.
- D. Heat transfer fluids used shall be one of the following:
 1. Food-grade propylene glycol-water solution at a concentration specified by the product manufacturer.
 2. Methanol-water solution up to 20 percent methanol by volume.
 3. Ethanol-water solution up to 20 percent ethanol by volume.
 4. Nontoxic compounds meeting IGSHPA 2014, Sections 3B and 3C, and which are compatible with system components manufacturers' specifications.
- E. The fluid shall conform to the following requirements, and tests shall be performed in accordance with specified test methods on the fluid:
 1. Flash point shall not be lower than 90 degrees C (194 degrees F), determined in accordance with ASTM D-92.

2. Five days biological oxygen demand (BOD) at 10 degrees C (50 degrees F) shall not exceed 0.2 gram oxygen per gram not be less than 0.1 gram oxygen per gram.
 3. Freezing point shall not exceed -8 degrees C (+18 degrees F), determined in accordance with ASTM D-1177.
 4. Toxicity shall not be less than LD 50 (oral-rats) of 5 grams per kilogram. The NFPA 704 hazardous material rating for health shall not be greater than 1 (slight).
 5. The fluid, tested in accordance with ASTM F-1105, shall show neither separation from exposure to heat or cold, nor show an increase in turbidity.
- F. The fluid, as received by the purchaser, shall be homogeneous, uniform in color, and free from skins, lumps, and foreign materials detrimental to usage of the fluid.
- G. Water used to dilute the antifreeze heat transfer fluids shall be of potable quality. Final heat transfer fluid solutions shall not be flammable.
- H. Packaging and Identification:
1. Fluid shall be packaged in containers of a type and size agreed upon by purchaser and vendor, or shall be delivered in bulk, as ordered.
 2. Containers of fluid shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the fluid to ensure carrier acceptance and safe delivery.
 3. An up-to-date Material Safety Data Sheet (MSDS) shall be supplied to each purchaser on request and concurrent with each delivery.

2.7 INSULATION

- A. Comply with Section 23 07 11, HVAC AND BOILER PLANT INSULATION.

2.8 INSTRUMENTATION

SPEC WRITER NOTE: Either reference the applicable section (A) or specify products herein (A-C).

- A. //See Section 23 21 13, HYDRONIC PIPING, for pressure gauge and thermometer requirements.//
- B. //Use corrosion resistant materials for wetted parts of instruments.
- C. Pressure Gauges: ASME B40.100, brass body, and minimum 90 mm (3.5 inches) diameter dial face.

- D. Thermometers: ASTM E1, //liquid-in-glass type// //dial type, liquid-filled tube and bulb//.//

SPEC WRITER NOTE: For small systems, do not use monitoring system, due to high initial cost and the labor to maintain it. For projects where a direct-digital control system exists or is otherwise being installed, consider integrating the geothermal system into it.

- E. //Monitoring System:

1. Kilojoule Btu Meter: Sensing and Monitoring device to measure and display the heat energy produced by the geothermal system, with minimum sensitivity of 0.5 percent over the entire scale. Provide electromechanical kJ Btu counter plus digital-panel meter indicating sensor temperatures, differential temperature, flow rate, and watt Btu per minute or hour.
2. //Water// //and// //Heat Transfer Fluid// Leak Detection: UL-listed system consisting of a sensor probe, control panel, and LED indicators for //water; yellow,// //and// //heat transfer fluid; red,// with audible alarm at minimum 75 dB sound level; reference 10 exponential minus 12 watts.//

- F. //System Controls and Monitoring:

1. Comply with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install the geothermal energy system in accordance with this section and the printed instructions of the manufacturer.
- B. Prior to any excavation, trenching, or drilling, all buried utilities, drainage, and irrigation systems shall be located and flagged by the appropriate utility and Contractor representative.
- C. //Surface discharge shall be compliant per the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) regulations.//
- D. //Reinjection Well shall be compliant per the Environmental Protection Agency (EPA) Underground Injection Control (UIC) regulations for Class V (Shallow Non-Hazardous Injection) wells.//
- E. Borehole Construction shall be performed per IGSHPA 2014, Section 2B.
 1. Surface water shall not be used as a source of water during the drilling of a borehole unless it is obtained from a municipal water

supply system. Water used for drilling purposes shall be potable water that contains a free chlorine residual of no less than 10 milligrams per liter. Chlorine residual level shall be checked with chlorine test strips.

F. Piping installation shall be compliant with ICC IMC Section 1206.

G. Pipe Joining Methods

1. PEXa tubing shall not be butt-fused or socket-fused to fittings. Polymer electro-fusion fittings shall be used with PEXa tubing when installed in accordance with manufacturer's published procedures. Cold-expansion compression-sleeve fittings shall be used for all PEXa connections when installed according to the manufacturer's published procedures and is permitted to be direct buried with manufacturer approved corrosion covering.

H. Circulator System

1. Loop charging valve handles shall be removed and/or the ports sufficiently plugged to prevent accidental discharge of system fluid and pressure.
2. Boiler-type service valves shall not be used.
3. Transition fittings between dissimilar materials shall be located inside or accessible.
4. All indoor piping shall be insulated where condensate shall cause damage.
5. All aboveground piping subject to condensation or freezing shall be insulated.
6. All pipes passing through walls shall be sleeved and sealed with non-hardening caulking material.

SPEC WRITER NOTE: Some antifreeze solutions require more fitting torque than others to prevent leaks and corrosion of external surfaces when the antifreeze is exposed to oxygen.

7. Threaded fittings shall be visually inspected for quality and a thread sealant specified for use with the antifreeze selected shall be used.

I. Any penetrations of walls or horizontal assemblies shall be compliant with ICC IBC Section 714.

J. Instrumentation: Install instruments as recommended by the control manufacturers.// Locate control panels //inside mechanical room//
// //.

- K. //Meters shall tie into the building direct digital control system per the requirements of Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//

3.2 FIELD QUALITY CONTROL

- A. Field Inspection: Prior to initial operation, inspect the geothermal energy for conformance in the contract documents and ASME B31.1. Inspect the following information on each unit:
1. Manufacturer's name or trademark.
 2. Model name or number.
 3. Certifying agency label and rating.
- B. Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct testing in the presence of the COR.
1. Piping Test: //Pneumatically test new piping for leakage using air at a pressure of 200% of design operating pressure.// //Test new water piping for leakage using water at a pressure of at least 690 kPa (gauge) (100 psig) per ICC IMC Section 1208, but no less than 150% of design operating pressure.// Install a calibrated test pressure gauge in the system to indicate loss in pressure occurring during the test. Apply and maintain the test pressure for one hour, during which time there shall be no evidence of leakage, as detected by a reduction in test pressure. Should a reduction occur, locate leaks, repair, and repeat the test.

SPEC WRITER NOTE: Use pneumatic test if non-aqueous heat transfer fluid is used, to avoid contamination of fluids with water and to eliminate seepage problems.
 2. Operation Tests: Perform tests on geothermal energy system, including pumps, controls, controlled valves, and other components in accordance with manufacturer's written recommendations.
 3. Test entire system in accordance with Section 23 05 93, TESTING, ADJUSTING AND BALANCING FOR HVAC.

3.3 FOLLOW-UP VERIFICATION

- A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the geothermal energy system is in good operating condition and properly performing the intended function.

3.4 STARTUP AND TESTING

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. //The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and CxA. Provide a minimum notice of 10 working days prior to startup and testing.//

3.5 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and Contractor testing required above and required by the System Readiness Checklist provided by the CxA.
- B. Components provided under this section of the specification shall be tested as part of a larger system. Refer to Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and related sections for Contractor responsibilities for system commissioning.//

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //8//
// // hour//s// to instruct each VA personnel responsible in operation and maintenance of the system.
- B. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- C. A complete set of operating instructions for the geothermal energy system shall be laminated or mounted under acrylic glass and installed in a frame near the equipment.

---END---