**Geothermal Heat Pump System Technical Specifications**

**DISCLAIMER**

This technical specification is intended as a resource only. ***It is the responsibility of Government staff to ensure that all procurements follow all applicable federal requirements and agency-specific policies and procedures***. All procurement must be thoroughly reviewed by agency contracting and legal staff and should be modified to address each agency's unique acquisition process, agency-specific authorities, and project-specific characteristics.

THE PROVIDED REFERENCES ARE FOR INFORMATION ONLY AND REFERENCE HEREIN TO ANY SPECIFIC ORGANIZATION, CODE, STANDARD OR OTHERWISE, DOES NOT NECESSARILY CONSTITUTE OR IMPLY ITS ENDORSEMENT, RECOMMENDATION, OR FAVORING BY THE UNITED STATES GOVERNMENT OR ANY AGENCY THEREOF OR ITS CONTRACTORS OR SUBCONTRACTORS.

**INSTRUCTIONS FOR USING THIS DOCUMENT**

This document is meant to be used as a customizable template for federal government agencies seeking to procure **closed-loop** geothermal heat pump (GHP) systems including water-to-air and water-to-water heat pumps. Agencies are encouraged to add, remove, edit, and/or change any of the template language to fit the needs and requirements of the agency.

In summary, the below steps are recommended to use these Technical Specifications for a successful GHP system acquisition:

1. Conduct initial site due diligence and analysis to assess GHP viability at the site (see Appendix A).
2. Utilize the GHP System Technical Specifications below and include the required information obtained from step 1.
   1. These technical specifications assume that the agency will obtain a third-party commissioning agent who will support the agency from system design through to final acceptance. Although a third-party commissioning agent is recommended, an agency may opt for the contractor to perform commissioning and update the specifications accordingly. Appendix B includes suggested requirements for a third-party commissioning agent.

Sections that provide instructional language for the drafter are presented in (blue parentheses). Fill-in-the-blank areas are indicated in [red brackets].

**IMPORTANT:** The following items must be deleted from the template before solicitation:

* The title page, introduction, and instructions for using this specification;
* All instructions, options, and background information within the template in blue or red font as well as any parentheses or brackets around instructions

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# Abbreviations and Acronyms

A-E architectural and engineering

AC alternating current

ACG AABC Commissioning Group

AEE Association of Energy Engineers

AHJ Authority Having Jurisdiction

AHRI Air-Conditioning, Heating, and Refrigeration Institute

ANSI American National Standards Institute

ASCE American Society of Civil Engineers

ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers

BTU British Thermal Unit

cfm cubic feet per minute

COP Coefficient of Performance

CSA Canadian Standards Association

EER Energy Efficiency Ratio

GHP Geothermal Heat Pump

hr hour

HVAC Heating, Ventilating, and Air-Conditioning

IFC International Fire Code

IGSHPA International Ground Source Heat Pump Association

ISO International Organization for Standardization

kW kilowatt

kWh kilowatt-hour

MMBtu Millions of British Thermal Units

NEBB National Environmental Balancing Bureau

NEC National Electrical Code

NEPA National Environmental Policy Act

NFPA National Fire Protection Association

NSF National Sanitation Foundation

O&M Operations and Maintenance

OSHA Occupational Safety and Health Administration

PVC Polyvinyl Chloride

SOW Statement of Work

TAB Test, Adjust, and Balance

UL Underwriters Laboratories

UV Ultraviolet

# Generally Applicable Requirements

## Install Geothermal Heat Pump System (GHP)

1. The Contractor shall design and build a minimum [specify tonnage] Geothermal Heat Pump (GHP) system. The GHP system shall be comprised of a Ground Heat Exchanger, Heat Pump(s) and accompanying piping and necessary HVAC upgrades to the supported facilities. The Contractor shall provide all labor, material, equipment, engineering, maintenance, and capital to design, install, and commission a GHP system as required herein.
2. The GHP will serve the following facilities [List all buildings served by the GHP system].
3. The GHP system will provide [Specify the MMBTU/hr, tonnage, supply heating and cooling design temperatures, return heating and cooling design temperatures, domestic hot water loads if needed] from the Ground Heat Exchanger(s).
4. The GHP Ground Heat Exchanger shall be installed at [specify location(s) and provide site plans identifying available land].
5. The GHP Heat Pumps shall be installed at [specify location(s) here]. Contractor-provided Heat Pumps shall be maintained to meet all warranty requirements. The GHP system shall achieve a minimum [specify Coefficient of Performance (COP), Energy Efficiency Ratio (EER), at design heating and cooling conditions and expected average heating and cooling conditions, AHRI 870 requirements].
6. Outdoor GHP components and associated ancillary equipment shall have working space clearances required by local code, and any outdoor electrical circuitry shall be within weatherproof enclosures marked with the environmental rating suitable for the type of environment in compliance with the National Electrical Code (NEC).
7. Ground Heat Exchanger (GHX) heat transfer fluid shall consist of water and may consist of an acceptable antifreeze and inhibitors in accordance with General Section, clause 5.7 of CSA/ANSI/IGSHPA Standard C-448. Water quality and antifreeze type shall meet the requirements in above referenced clause. The concentration of antifreeze shall be determined by the Designer or Contractor to provide freeze protection to at least 5˚C (9˚F) below the minimum GHX design temperature.
8. The Contractor shall coordinate with the agency’s third-party commissioning agent. The commissioning agent will prepare a written commissioning plan that provides a description of the means and methods necessary to document and verify that the system and its associated controls and safety systems are in proper working condition. The Contractor will address, with Agency concurrence, all deficiencies identified in the third-party commissioning report.
9. The Contractor shall provide [X] year(s) of turnkey GHP operations & maintenance (O&M) and warranty service. (Identify whether the Contractor or a designated O&M provider will be responsible for GHP O&M. One year is the recommended minimum for contractor-provided O&M.) [The Contractor shall provide a bid for an O&M contract for [X] years.].
10. The Contractor is responsible for all permits, approvals, environmental compliance, freight, financing, procurement, monitoring, site inspection, billing, and incidentals as necessary to design, construct, and connect the complete GHP system to the site facilities.
11. The Contractor shall provide and install safety systems as required by the applicable local codes and standards, in addition to the National Fire Protection Association (NFPA) 90A and/or the International Fire Code.

## Existing Feasibility Studies and Engineering Studies Done by Others

The Contractor is responsible for ascertaining relevant site conditions to determine project feasibility and final GHP Ground Heat Exchanger sizing. If any existing engineering studies or facility conditions reports are provided through this solicitation with the site information package or from an Agency representative, the Contractor shall independently verify all information provided.

## Codes, Standards, and Regulations

The Contractor shall be in compliance with one of the nationally recognized model building codes and with other applicable national, state, and local codes. The latest edition of the local and nationally recognized codes and any updated supplements in effect at the time of contract award shall be used throughout the project design and construction. Codes and standards applicable to the GHP project can be found below.

The GHP components must comply with all codes and standards relevant to the operation and installation the GHP system, including the Ground Heat Exchanger, Heat Pump(s), accompanying piping and necessary facility upgrades. HVAC upgrades must be certified to comply with the latest version of the following requirements:

1. All work must follow current requirements:
   1. Canadian Standards Association (CSA)/American National Standards Institute (ANSI)/International Ground Source Heat Pump Association (IGSHPA) C448 Bi-National American-Canadian Standard
   2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems
   3. NFPA 70, “National Electrical Code”
2. Ground Heat Exchanger
   1. National Sanitation Foundation (NSF)/ANSI 358-1. Polyethylene Pipe And Fittings For Water-Based Ground-Source “Geothermal” Heat Pump Systems
   2. CSA/ANSI/IGSHPA C448 Bi-National American-Canadian Standard, General Section, Clause 5.4.1.1
3. Heat Pump
   1. International Organization for Standardization (ISO) 13256-1 (Water-to-air)/ ISO 13256-2 (Water-to-Water)
4. Other codes and standards that will apply include:
   1. ANSI C12.1 (electricity metering)

## Electrical Distribution Systems

(Include if relevant) Modifications or upgrades to the Agency-owned electrical system required for the GHP system are the responsibility of the Contractor (e.g., service panel, generator coordination). The Contractor is responsible for the proper circuit sizing, overcurrent protection, and coordination of the circuit(s) beyond the point of interconnection to the Agency distribution system, including modifications to the site’s electrical equipment and circuits. Any needed upgrades or modifications to existing Agency electrical distribution systems must be included in the review and approval process outlined in the submittal section herein.

## Work Planning

The Contractor shall notify the Agency of any Contractor-planned utility service interruption not later than [insert # of business days] prior to beginning the scheduled work that requires the utility service interruption. The Agency shall coordinate all utility outages and secure a final date when the outage may proceed. Every reasonable attempt shall be made to secure the Contractor’s requested date. Under no conditions shall the utility service be interrupted by the Contractor without prior written approval by the Agency.

## Permits and Licensing

The Contractor shall be responsible for all state, local and National Environmental Policy Act (NEPA) environmental permitting, in addition to all engineering, drilling, and construction permitting:

1. Preparing all permitting and licensing applications for the project.
2. Paying all fees and complying with all requirements.
3. Providing any supporting documentation, data, and information that may be required for permitting.
4. Coordinating and acting as the primary liaison with permitting and licensing agencies.

## Local Authority Having Jurisdiction Involvement

The Contractor shall involve the local Authority Having Jurisdiction (AHJ) to provide permitting (where locally required), and design review and approval. The Contractor shall submit all required construction documents, as required to obtain a building as applicable, for AHJ review. The installation shall not proceed until AHJ approval [and building permit, if applicable] has been granted.

## Federal, State, and Local Rebates and Incentives

The Contractor shall complete and submit in a timely manner all documentation required to qualify each system for available rebates and incentives. Tax incentive eligibility due diligence shall be the responsibility of the Contactor and not the Agency.

# Engineering and Construction

## GHP Project Description

The Contractor shall include GHP design submittals including:

* Design operating conditions (entering and leaving Ground Heat Exchanger temperatures during both cooling and heating, return-air temperatures [including wet bulb in cooling], airflow rates, and liquid flow rates).
  + (Optional) [Long-term (30 year) simulation of bore field temperatures]
* Heat pump specifications at rated conditions.
* Pump specifications including flow rate, pressure drop, and pump power, expansion tank size, and air separator.
* Fluid specifications (system volume, inhibitors, antifreeze concentration if required, water quality, etc.).
* Pipe field header details with circuit piping, Ground Heat Exchanger layout, including pipe type (i.e., HDPE, PE-RT PEX), standard dimension ratio, diameters, spacing, and clearance from building and utilities.
* Ground Heat Exchanger specifications: Heat exchanger type, borehole depth, number of boreholes, approximate borehole diameter, borehole separation, and grout/fill specifications (i.e., thermal conductivity, acceptable placement methods to eliminate any voids).
  + Assumptions or tested parameters for ground thermal conductivity and any deviations between the proposed depth, spacing, or diameter and any test boreholes
  + (Optional, if relevant) [Consider incorporation of the existing district system or wastewater heat recovery system]
  + (Optional, if relevant) [extend to which the ground heat exchanger serves existing or new loads and the trigger conditions for any supplemental heating or cooling systems]
* Piping material specifications and visual inspection and pressure testing requirements.
* Purge provisions and flow requirements to ensure removal of air and debris without reinjection of air when switching to adjacent subheader circuits.
* Connections to building loop(s) and coordination of building and Ground Heat Exchanger flushing.
* Design details
  1. Equipment controls information, integration into building control systems and sequence of operations
  2. All ancillary equipment manufacturers, product names, and capacities
  3. Maintenance requirements
* Decommissioning plans
* Demolition plans of existing equipment

## Equipment Location

The Contractor shall identify appropriate locations for all key GHP components that will meet the following criteria:

* Ease of maintenance and monitoring
* Efficient operation
* Secured location and hardware
* Compatibility with existing facilities
* Clearance areas for equipment access
* All balance of systems (e.g., wiring, component, conduits, connections) shall be suited for conditions for which they are to be installed.

## Thermal Conductivity or Thermal Response Tests

(Include if relevant) Agency will provide all previously collected test bore data, including ground thermal properties (at a minimum, these should include ground/formation thermal conductivity, undisturbed ground/formation temperature, and ground/formation thermal diffusivity), thermal response test results, hydrology data and drilling conditions to Contractor. Wherever possible the test bore should be incorporated into the final ground heat exchanger.

## Temperature Balance

Contractor shall monitor the extraction and rejection of heat into the ground over the course of the first year of operation to ensure that the local ground temperature remains within the system basis of design. (Suggested for large-scale GHP systems): [Design algorithms for the sizing of Ground Heat Exchangers shall include the ability to calculate the Ground Heat Exchanger design over a 10-year modeling period for a vertical and diagonal Ground Heat Exchanger; and over a minimum of 1 year for a horizontal Ground Heat Exchanger.]

## Professional Engineer and Licensed Design Professionals

All architectural and engineering (A-E) services shall be performed by design professionals with a Professional Engineer (PE) license in the state in which the project is being built with responsible control for each respective design discipline.

## Registration Seals

Each submitted final design drawing, calculation document, and specification manual shall be signed and dated by, bear the seal of, and show the State Certificate Number of the Architect or Engineer who prepared the document and is responsible for its preparation.

## Coordination of Professional Services

The Contractor shall be responsible for the professional quality, technical accuracy, and coordination of all investigations, evaluations, drawings, testing, cost estimates, submittals, written reports, construction, operations, and all deliverables, as required by this document or as required to complete the work of this contract.

## Coordination of Subcontractors’ Credentials

The Contractor shall ultimately be responsible for the completeness, accuracy, coordination, and submission of all submittals described above. Contractor may delegate the preparation of submittals to subcontractors or suppliers as long as the intent of Sections 2.5, 2.6, and 2.7 of this specification is met.

## Modifications and Alterations of Government Property

Modifications, alterations, and/or additions to existing facilities shall be designed and certified to satisfy applicable requirements of this Statement of Work (SOW) document and the governing codes and standards referenced in this SOW document. The Agency shall coordinate with building occupants and approve all modifications, alterations and/or additions prior to completion of design.

## Structural

The Contractor shall furnish the design for the structural components of the GHP, concrete pads/foundations as required, and conduit required for the complete GHP. All final (Issued for Construction) drawings, specifications, and calculations shall be stamped by a state-licensed Civil/Structural Professional Engineer.

## Civil

The Contractor shall ensure that any land disturbed for installation of the Ground Heat Exchanger or accompanying piping is restored to its original condition.

## Conduit and Preventing Water Intrusion

Conduit routing and fittings must be selected to prevent water intrusion into pump enclosures. Conduits are to connect through the bottom of enclosures and provide fittings to allow water to drain prior to entering any electrical enclosure. Any exterior PVC conduit must be Schedule 80.

## Locating Equipment

Heat pumps shall be located indoors, with adequate space for service access. Where necessary, outdoor installation is only permitted for equipment rated for such applications, such as rooftop heat pumps.

Major electrical components, including any pumps, shall be installed in code-compliant enclosures.

## Expected Service Life

Unless noted otherwise, all materials furnished for the project shall have an expected service life of [15–20] years including the ground-source heat pumps. The Ground Heat Exchanger shall have an expected service life of [50] years (Water-to-air distributed heat pumps have lifetimes of 15–25 years, and water-to-water heat pumps have lifetimes of approximately 20–25 years.).

## Site Service Conditions

Materials shall be in accordance with CSA/ANSI/IGSHPA Standard C-448 and designed to withstand the year-round temperatures and conditions to which they are exposed (sunlight, heat, humidity, rain, wind, sand/dust, seismic activity, salt air, fog, marine corrosiveness, etc.).

## New Equipment

The Agency shall not accept used, reconditioned, after-market, or grey-market products or equipment. Any offeror supplying used, reconditioned, after-market, or grey-market products may be held responsible for damages to the Agency.

## Markings (Labeling)

Include all required and desired labeling language in the design drawings for Agency review. Provide all required markings per NFPA 70, IFC and CSA/ANSI/IGSHPA C-448 Commercial Section, Clause 10 (Packing and Identification):

* All GHP systems shall be labeled and identified at the loop charging valves. The labels shall be of a permanent type with the following information:
  + Antifreeze type and concentration
  + Service date
  + Contractor name
  + Contractor phone number and responsible party or person
* Equipment markings should never be removed and should be able to withstand the environmental conditions in which the equipment is installed (e.g., “Ultraviolet (UV) rated” for outdoor labels, or on an embossed steel placard, designed for outdoor use and fastened with adhesive and rivets).
* Markings must be visible or easily accessible during and after installation. The Contractor shall be responsible for all field-applied markings as required by local, state, and federal codes.

## GHP Warranties

The Contractor shall provide the following warranties:

* 1. Full turnkey system warranty for 2 years from successful completion of the commissioning. The Contractor shall respond within [3] calendar days of Agency’s request for maintenance.
  2. Heat pump warranty for 5 years, not including labor, after the date of successful completion of commissioning (Obtaining extended parts and labor warranties is recommended, where agency funding allows.).

## Operations and Maintenance

[The Contractor or designated O&M provider] shall conduct annual O&M and continuous monitoring to verify that the GHP is performing as intended per the manufacturer recommendations and submit an annual report to the Agency. The Contractor shall perform all required maintenance to the GHP for [1] year. Additionally, the Contractor shall:

1. Provide O&M training and supporting manuals to Agency personnel.
2. Provide an annual O&M Report, including:
   * GHP system performance including at a minimum: annual heat removed from and add to field (see section 2.4); supply water temperature and flow rate (gal/min) from field and return water temperature and flow rate to field during peak heating and cooling operation; average, minimum, and maximum COP of all heat pumps in heating and cooling mode.
   * System outages with root cause summary and start and end time periods
   * Summary of all O&M operations; repair and replacements
   * Summary of safety incidents, causes, and resolutions

## Data Acquisition and Monitoring

The Contractor shall provide a turnkey data acquisition and display system that allows the Agency to monitor, diagnose, and track the operating data of the GHP. A minimum requirement is the provision of a web-based monitoring and tracking system. The Contractor shall provide an internet connection to the GHP, distinct from Agency internet. (Agency requirements may vary. Ensure that the data acquisition and monitoring solution is compliant with agency cybersecurity requirements. Remote sites without internet access may not wish to require remotely programmable capability.) Monitoring and tracking systems shall include a historical database and real time data portal capturing the data in hourly intervals. A minimum of 36 months of data shall be stored by the Contractor and be made available for Agency download via the web portal. The data shall, at a minimum, comprise the following information and frequency of collection:

# Date, time

# Ground Heat Exchanger flow rate (gal/min) recorded in at least 15-minute intervals

# Supply temperature in at least 15-minute intervals from the field and to large heat pump(s)

# Return temperature in at least 15-minute intervals to the field and from large heat pump(s)

# Heating output and/or cooling output, MMBTU/hr, kW

# Pump(s) electrical power (kW) in at least 15-minute intervals

# Heat pump(s) electrical power (kW) and COP in at least 15-minute intervals

* Makeup water used by the Ground Heat Exchanger in at least daily intervals

# Commissioning and Inspections

## Commissioning

Contractor shall coordinate with a third-party Commissioning Agent on the following tasks. (NOTE: FEMP strongly recommends the use of a third-party commissioning agent to support the project from design through final acceptance. Appendix A provides a list of third-party Commissioning Agent requirements for the design and programming phase, construction phase, and acceptance phase. If an agency is unable to procure a third-party commissioning agent, the section below may be modified to place commissioning responsibility upon the Contractor.)

1. Commissioning Agent shall complete commissioning in accordance with Agency safety and commissioning plans, its own quality-control plan, and manufacturer's recommendations. The Contractor shall cooperate with the Commissioning Agent to document all performance measurements.
2. The Commissioning Agent shall give the Agency and Contractor ten (10) business days’ advance notice prior to starting commissioning. An Agency manager or representative may request to be present during any or all phases of the start-up, commissioning, and testing activities. (It is strongly recommended that an Agency representative witness all start-up, commissioning, and testing activities.)
3. All subsystems and components shall undergo functional performance tests to demonstrate correct installation and operation.
4. The system shall be started-up and all possible modes of operation shall be tested.
5. Commissioning shall include the building automation systems.
6. A commissioning report shall be provided to the Agency, Contractor and AHJ prior to final inspection and approval.

## Inspections

The third-party Commissioning Agent is responsible for verifying that ground source heat pump (GHP) systems are installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent and local codes and regulations. The Contracting Officer or the delegated Contracting Officer’s Representative may inspect the systems at any time during construction or after the systems have been put in operation. The Contractor may be ordered to stop work or shut the systems down if unsafe conditions or code violations are noted.

1. An initial inspection for Substantial Completion will be made when the work is complete to the point that the Commissioning Agent is ready to begin starting, testing, and commissioning the system. Following this inspection, the Agency will provide the Contractor with a punch list describing any incomplete work that must be complete prior to the Contractor’s request for final inspection.
2. The Contractor shall give the Contracting Officer ten (10) business days’ advance notice, in writing, of the date the work will be ready for initial inspection.
3. A final inspection of all systems shall be made only when all construction is complete in accordance with the terms and conditions set forth in the Contract and all punch list items identified in the initial inspection are complete. If, upon examination by the Contracting Officer and/or Agency inspection personnel, the project is determined not sufficiently completed to have warranted a final inspection, the Contractor may be charged for any additional cost of re-inspection.
4. The Contractor shall give the Contracting Officer ten (10) business days’ advance notice, in writing, of the date the work will be fully completed and ready for final inspection.
5. The Contractor’s request for final inspection will not be approved unless documentation below, at a minimum, has been provided to, and accepted by, the Contracting Officer, in addition to all other contract requirements:

* Final as‑built drawings (record drawings), meeting as-built requirements
* Preventive maintenance work schedules and procedures
* Operations and maintenance manuals (electronic and hardcopy)
* Training manuals (electronic and hardcopy)
* Equipment documentation and spare parts lists
* Certificates of Authority Having Jurisdiction (AHJ) inspections

1. After commissioning is complete, the Contractor shall instruct and train Agency designated personnel on normal system operation and how to shut down the system in the event of an emergency. The Agency may reasonably request additional training, and the Contractor will conduct such training at the Contractor’s expense. Training may take place over multiple sessions to accommodate Agency’s staff availability. The training session(s) may be recorded.
2. As soon as practicable, following final inspection, the Contracting Officer will inform the Contractor, in writing, of any discrepancies and/or omissions noted at the final inspection. The Contracting Officer shall also state the time allowable for replacement of material and performance or re-performance of any unsatisfactory work necessary before written notification of system acceptance testing.
3. Upon written notification that all deficiencies identified during the final inspection have been corrected, the Contracting Officer may schedule a follow-up inspection to confirm all corrected work is acceptable. The Contractor shall then coordinate with Commissioning Agent, Agency, and AHJ to schedule system acceptance testing.

## Summary of Process

In summary, inspections and commissioning will follow the following sequence:

* Initial inspection for Substantial Completion of construction
* Pending successful initial inspection, commissioning may begin
* Final inspection may be scheduled following completion of commissioning and approval of all documents shown in Section 3.2(5) of this specification.
* The Contractor will be responsible for completing any re-work identified in the final inspection prior to scheduling system acceptance testing.

# Final Acceptance

1. The Contractor shall notify the Commissioning Agent and Agency not less than ten (10) business days prior to the anticipated date of system acceptance testing. The Agency shall have the right, but not the obligation, to be present at and observe the system acceptance testing, at the Agency’s sole cost. (It is strongly recommended that an Agency representative witness all testing activities.).
2. In addition to Agency system acceptance test standards, the test shall include, at a minimum, the following:
   1. Review all commissioned systems’ functional test procedure forms.
   2. Review tests that have been done and carefully evaluate that all subsystems and components work under foreseeable operating conditions.
   3. Review a complete record of all pre-functional tests, equipment startups, and functional performance verification tests.
3. Approvals as required by the local AHJ will be a pre-requisite for acceptance and for authorization to operate the system(s).

Upon successful completion of system acceptance testing, the Contractor shall send a Completion Notice and a copy of the system acceptance test report to the Contracting Officer so that the Agency can complete their final acceptance. The Agency and Commissioning Agent shall have ten (10) business days after receipt of the Completion Notice to review the system acceptance testing results and verify that the system installation is complete, safe, aesthetically acceptable, functional, constructed to all code requirements, does not interfere with Agency or tenant operations, and otherwise meets all other requirements. The Contracting Officer will notify the Contractor in writing of Final Acceptance.

If any of these requirements are not met, then the Agency shall provide the Contractor with a detailed notice of such failure (a "Rejection Notice") within the ten (10) business day period, with details regarding the required remedy (including repetition of either partial or full system acceptance testing, if appropriate), at the discretion of the Contracting Officer or Contracting Officer’s Representative, and the time allowed to complete remedy. The Contractor shall promptly remedy, at Contractor’s cost, the items identified in the Rejection Notice and conduct any additionally required system acceptance testing (if required by the Rejection Notice) until the system acceptance testing indicates that the system meets the contract requirements. In each such case, the Contractor shall send a new Completion Notice to the Agency with a copy of the results of the new system acceptance testing as provided above and the foregoing procedures shall be repeated.

Written acceptance shall be final and conclusive except as regards latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Agency’s right under any warranty or guarantee, subject to the system performance warranty.

In summary, the following requirements must be fulfilled before final acceptance:

* Submission of as-built drawings and all documents required prior to final inspection described in Section 3.2 of this specification.
* Training fulfillment documentation.
* Commissioning report provided to Agency.

# Appendix A: Site GHP Due Diligence Requirements

**Agencies should complete initial site due diligence and analysis prior to developing this specification. Key actions include:**

* Conduct a detailed site survey and drill test borehole(s) to determine ground thermal properties and drilling conditions. Hire an independent third-party to drill test borehole(s) in accordance with the recommendations of ASHRAE RP-1118. Thermal conductivity testing should follow the latest version of the ASHRAE handbook on HVAC Applications, Chapter 35 Ground-Source Heat Pumps and Geothermal Energy.
* Follow the recommended design steps for GHP systems provided below. These steps are excerpted from the ASHRAE “Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems” Guide, section 4.1.
* Lay out interior piping and exterior piping network, compute head loss through the critical path, and select pump(s) to provide recommended flow rates. Note that building distribution system updates (everything “downstream” of the heat pump) are typically the responsibility of the agency. This may include ancillary heating/cooling equipment (i.e., boilers, chillers).
* Determine the required electrical demand and electrical connections for new heat pumps. Determine the suitability of the existing electrical systems or available capacity for new electrical services.

# Appendix B: 3rd Party Commissioning Agent Requirements

(Note, these requirements are derived from IGSHPA’s *National Certification Standard for the Geothermal Heat Pump Industry (2013)*, Section 4.4--“Ground Source Heat Pump Commissioning Agent.”) The third-party Commissioning Agent shall develop a commissioning plan, complete commissioning in accordance with Agency safety and commissioning plans, follow all manufacturer recommendations, and document all performance measurements.

1. The GHP system shall be commissioned by a third-party Commissioning Agent who holds a Professional Engineering license or who reports to a Professional Engineer who reviews and signs off on the Commissioning tasks. The Commissioning Agent shall also have commissioning certification through one of the following professional organizations:
   1. IGSHPA Accredited Installer or IGSHPA Ground Heat Exchanger Installer (Preferred)
   2. ASHRAE
   3. Associated Air Balance Council Commissioning Group (ACG)
   4. Building Commissioning Association (BCA)
   5. National Conference on Building Commissioning (NCBC)
   6. National Environmental Balancing Bureau (NEBB)
   7. Association of Energy Engineers (AEE)
   8. IGSHPA Certified GeoExchange Designer (CGD) or CSA/IGSHPA Certified GSHP Commercial Designer (GCSD) certification
   9. Other commissioning standards may be reviewed and approved by the Agency.
2. The Commissioning Agent shall develop a commissioning plan, from design review through final acceptance per section 4.4.4 of the IGHSPA National Certification Standard listed below.
3. The Commissioning Agent shall perform all work required for testing, start-up, and commissioning.
4. The Commissioning Agent shall give the Agency and Contractor ten (10) business days’ advance notice prior to starting commissioning. An Agency manager or representative may request to be present during any or all phases of the start-up, commissioning, and testing activities. (It is strongly recommended that an Agency representative witness all start-up, commissioning, and testing activities.)
5. All subsystems and components shall undergo functional performance tests to demonstrate correct installation and operation.
6. The system shall be started-up and all possible modes of operation shall be tested.
7. Commissioning shall include the building automation systems.
8. The Commissioning Agent shall provide a commissioning report to the Agency and AHJ prior to final inspection and approval.

For more information on Commissioning Agent Requirements, see IGSHPA’s National Certification Standard for the Geothermal Heat Pump Industry document located at:

<https://www.osti.gov/servlets/purl/1116539>