Building Your GSHP Industry Credentials

Jeff Hammond
IGSHPA

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Building Your GSHP Credentials

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Executive Director

International Ground Source Heat Pump Association

NY-GEO 2023 Conference

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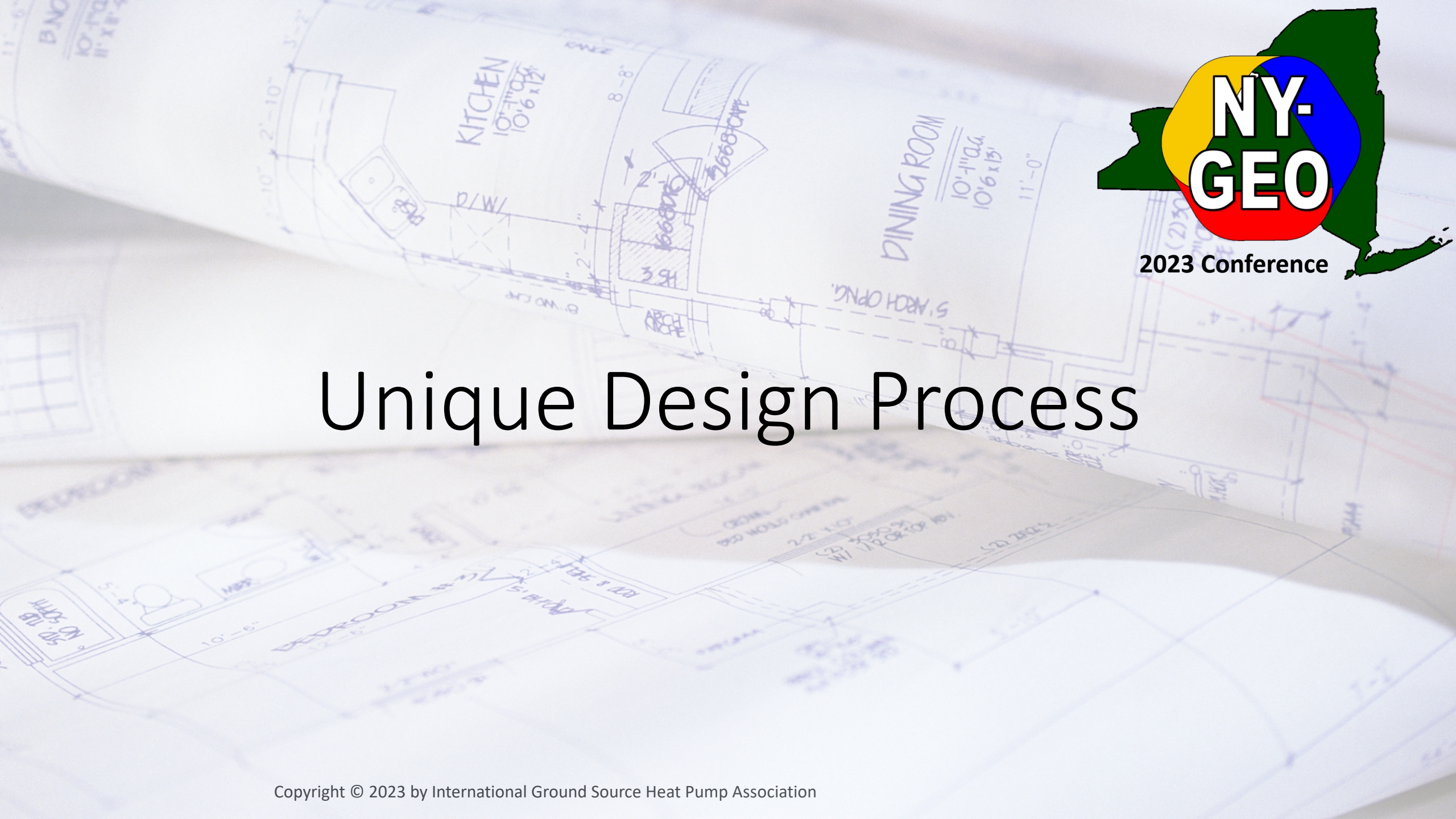
Rev. 25APR2023

Learning Goals

- Identify the unique design process for GSHP systems
- Understand the design resources available
- Recognize available training for GSHP designers

March of the Acronyms



Unique Design Process

The Design Process for GSHP Systems

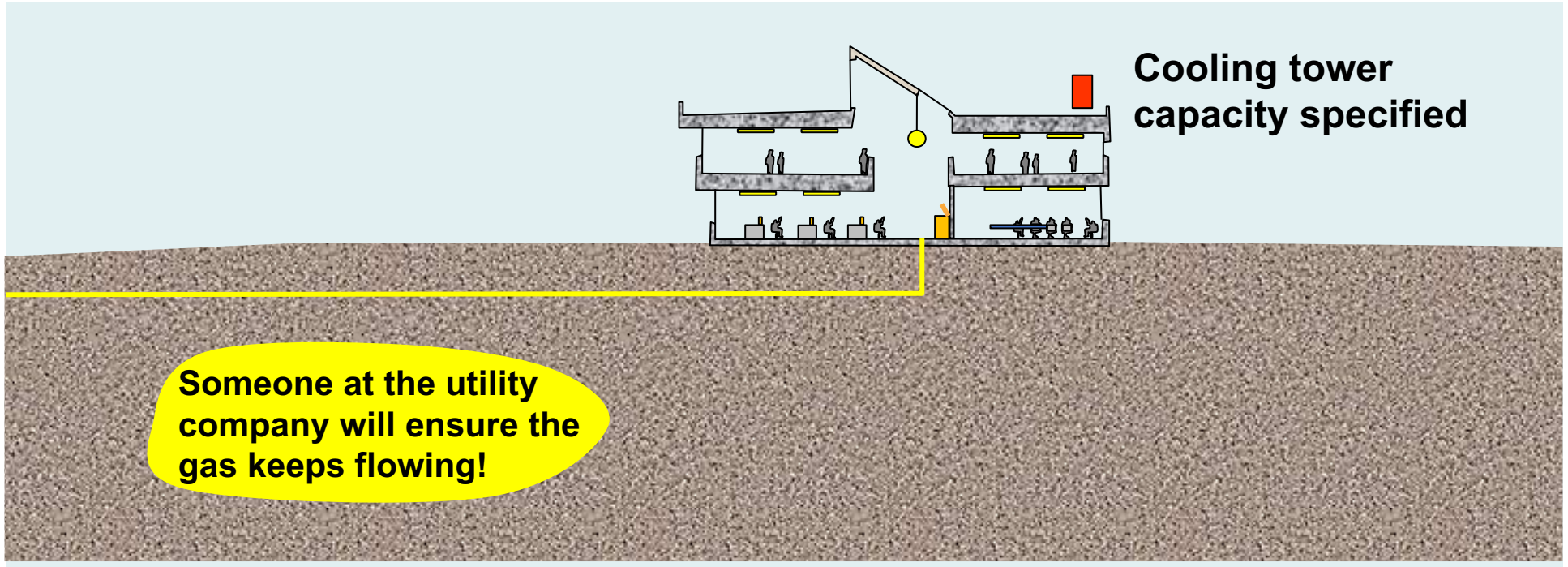
Design process used with conventional HVAC system *is not appropriate* for the design of a GSHP system.

Intent is to understand differences & avoid issues that increase cost & ensure system will work efficiently over the long term.

Design Process for Conventional HVAC

The design process for a conventional HVAC system does not include designing the energy source.

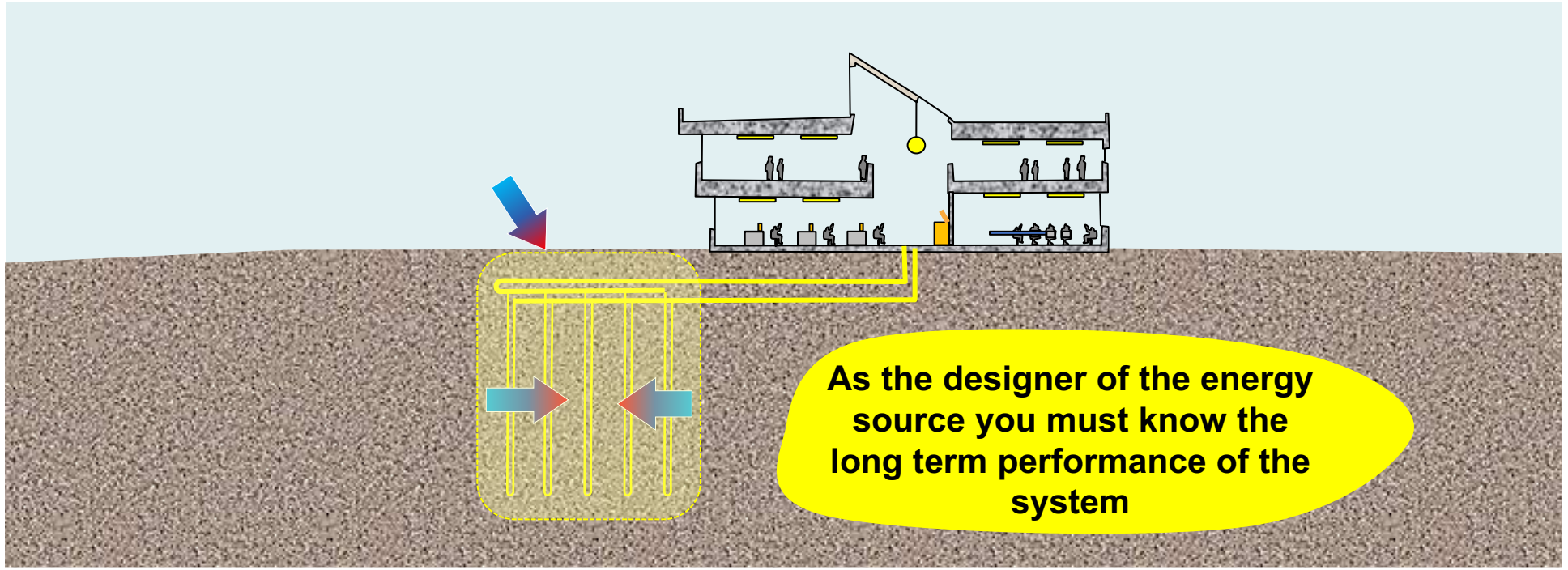
The gas line and cooling tower are sized on peak loads.



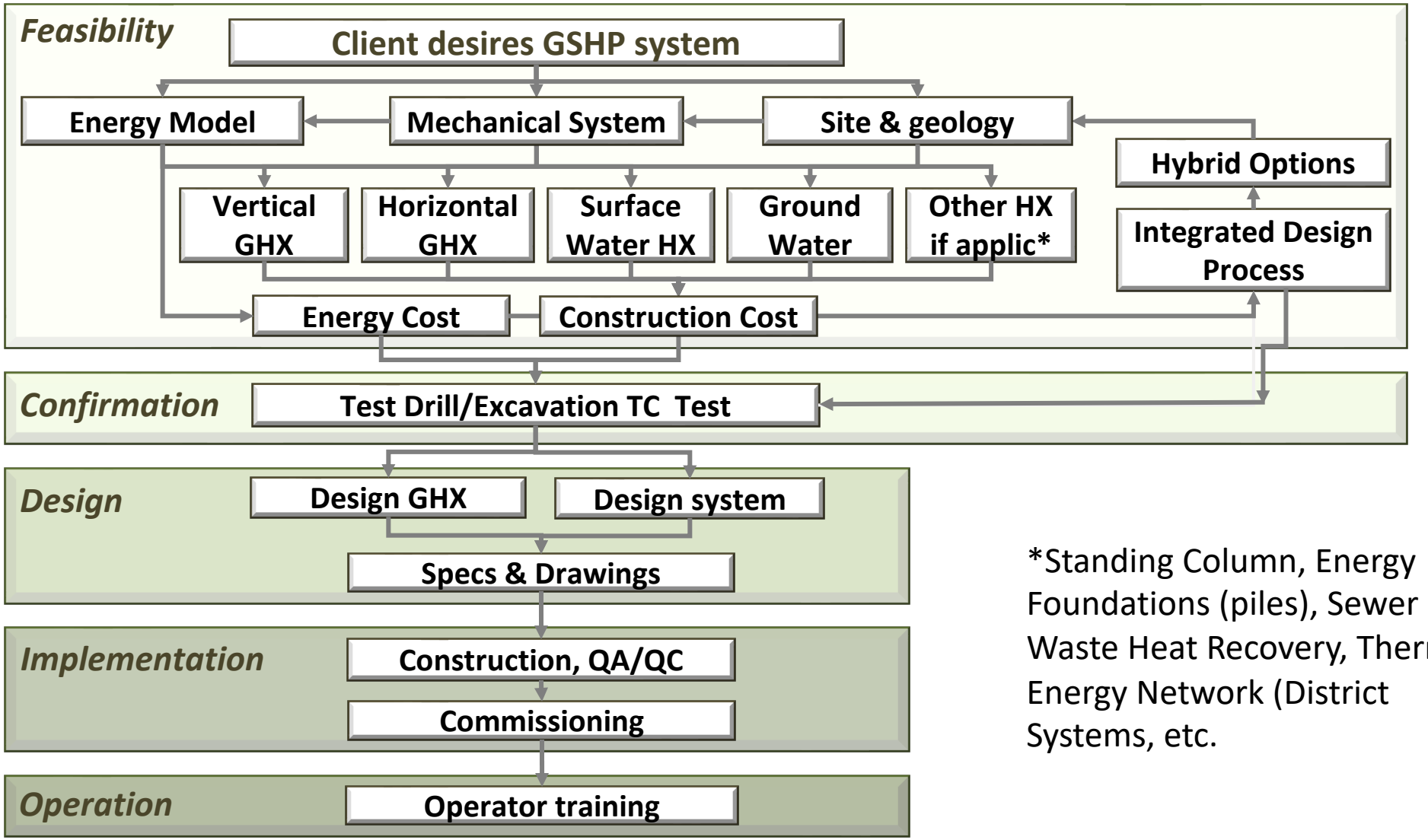
Designer Must Design the Energy Source

Hour by hour energy model of a building is only way to determine:

- Peak heating & cooling loads
- Monthly heating & cooling energy loads
- Energy balance between heating and cooling



Design Process for a GSHP System



*Standing Column, Energy Foundations (piles), Sewer Waste Heat Recovery, Thermal Energy Network (District Systems, etc.

Designing the Ground Heat Exchanger

Designing a GHEX is a compromise between reasonable pressure drop & adequate velocity for heat transfer. Pipe size, number of circuits, fluid and ensuring the GHEX operates within specified temperature parameters are as important as configuring the GHEX to be easily flushed and purged.

Available Resources

IGSHPA Membership

- Individual or business membership provides access to many resources
  - Listing on the business directory → networking with other members
  - Recognition as participating in the industry → credibility as a resource
  - Access to the member portal (more later on) → calculators, resources
  - Monthly newsletter → the latest IGSHPA and industry news
  - Notification of Town Hall and Dig Deeper webinars → Free training
  - Discounts on manuals, standards, conference registrations
  - And more!

Details on certification and training later in the presentation …

IGSHPA Membership

- Individual: $125/year ($50/year for certified individuals)
  - Listing on the individuals directory
  - 1 vote in elections/IGSHPA business
- Business: $420/year*
  - Includes employees as members at no additional cost
  - Listing on the business directory
  - 2 votes in elections/IGSHPA business
- Small corporate: $640/year**
  - Includes employees as members at no additional cost
  - Listing on the business directory
  - 3 votes in elections/IGSHPA business
- Large corporate: $1430/year***
  - Includes employees as members at no additional cost
  - Listing on the business directory
  - 4 votes in elections/IGSHPA business

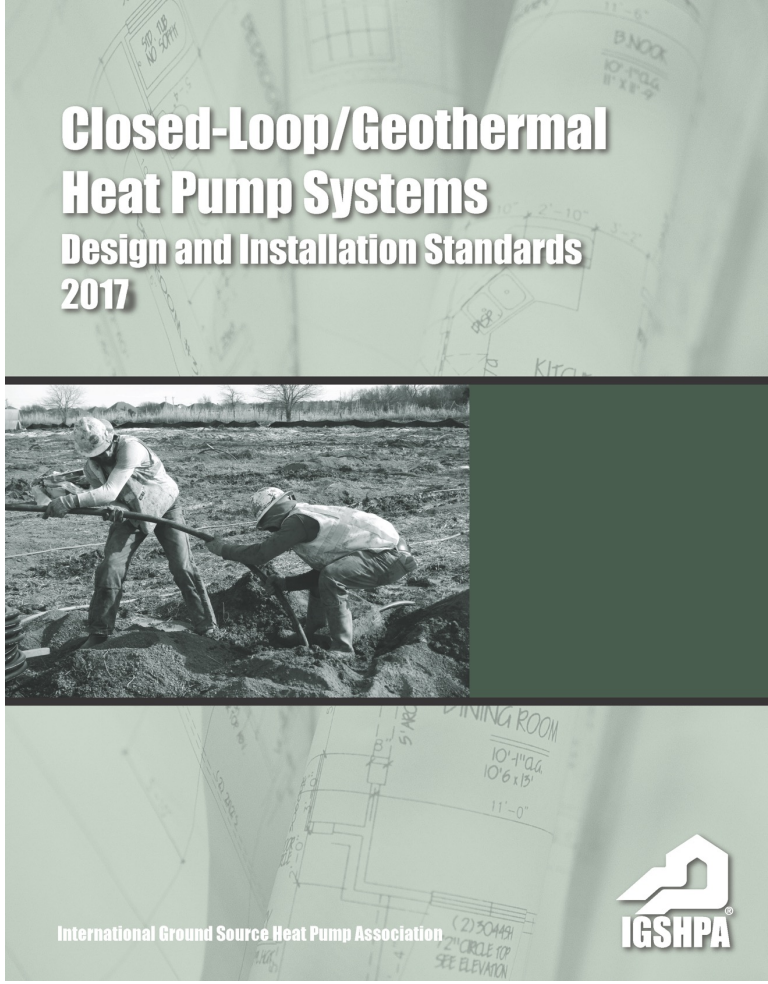
*Contractors, GHEX installers, MEP firms, other business types

**Smaller manufacturers and utilities

***Larger manufacturers and utilities

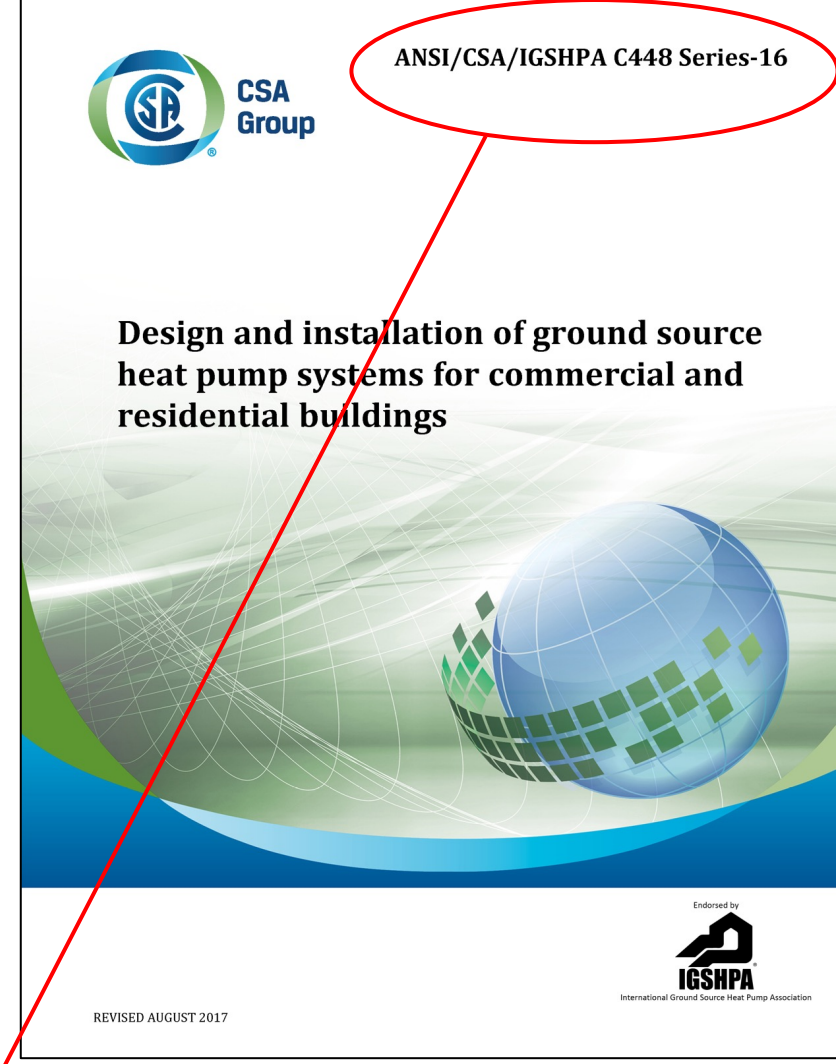
2017 IGSHPA Standards

- IGSHPA Standards have guided the industry for years (original publishing date was 1996)
- Updated regularly by IGSHPA Standards Committee
  - Latest edition is 2017
- IGSHPA Standards committee completed a report in 2019 for sunsetting the 2017 Standards in favor of ANSI/CSA/IGSHPA C448 bi-national standard
- IGSHPA board of directors voted to sunset the 2017 Standards upon release of next bi-national standard



ANSI/CSA/IGSHPA C448

- Starting in 2014, CSA (Canadian Standards Association) partnered with many U.S. stakeholders to begin development of a bi-national standard
  - IGSHPA
  - NGWA
  - PPI
  - Utilities
  - Government/Regulatory
  - Engineers
  - Contractors/Drillers
  - Researchers/Academia
  - Equipment & Pipe Manufacturers/Distributors
  - And more …



IGSHPA designation added in 2017

C448 Standard History

- 1992: First edition of C445 Design & Installation standard (Residential)
- 1994: First edition of C447 Design & Installation standard (Commercial & Institutional)
- 2002: C448 combined C445 & C447 into one standard (through 2013 edition)
- 2016: CSA, ANSI, IGSHPA, PPI, NGWA, and many others updated C448 to a bi-national standard (Canada and U.S.) → ***ANSI/CSA/IGSHPA Standard C448-16***
- Late 2023: Next edition to include IGSHPA Standards Committee recommendations and much new content and technology*

*District Geothermal Systems (Thermal Energy Networks)
Waste Water Energy Transfer (Sewer Waste Heat Recovery)
Energy Foundation (Energy Piles)
Updates to piping, heat transfer fluids, setbacks, etc.

Why Is the C448 Standard Important?

- Standard provides unified / consistent requirements
- Gives the industry a single resource for training development / personnel certification in North America (Canada/U.S.)
- Performance-based; only prescriptive where necessary
- Helps avoid differences between AHJs (e.g. “well” vs. “bore” requirements)
- Sets the course for real growth of the GSHP Industry via a performance-based Standard that delivers true end-user value with all market stakeholders

- <u>Provides guidelines, but … A standard is not a design manual</u>

C448 Guidance (Commercial)*

- Standard provides references for design guidance
  - Site survey
  - Piping materials
  - Installer qualifications
  - Grouting requirements (vertical, horizontal bore)
  - Setbacks
  - Backfilling
  - Pressure testing
  - Pipe Fusion/joining

*Examples to follow

Examples – Allowed Piping Material

5.4 Underground and underwater piping systems requirements

5.4.1

5.4.1.1
Acceptable plastic pipe and fitting materials for the underground portion of a ground heat exchanger include polyethylene and cross-linked polyethylene, as specified in this Standard.

5.4.2.1.1
PE pipe and tubing shall
a) comply with CSA B137.1, ASTM D2737, ASTM D3035, ASTM F714, or AWWA C901;
b) be manufactured from a PE compound that has a pipe material designation code of PE 3608, PE 3708, PE 3710, PE 4608, PE 4708, or PE 4710 as defined in the applicable standards in Item a), with a cell classification as per ASTM D3350 appropriate for the material designation code, and a colour and ultraviolet stabilizer code of C or E. Code E compounds shall be stabilized against deterioration from unprotected exposure to ultraviolet rays for not less than 3 years, as evidenced by meeting the test criteria specified in ASTM D2513 ;and
c) meet the requirements specified in Table 1.

Examples – Allowed Fittings in Buried Portion of Heat Exchanger

5.4.4 Pipe joining

5.4.4.1
The only acceptable methods for joining buried polyethylene pipe systems shall be
a) a heat fusion process; or
b) stab-type fittings quality controlled to provide a leak-free union between pipe ends that is stronger than the pipe itself.

5.4.4.2
Polyethylene fusion transition fittings with threads or flanges shall be used to adapt to ferrous and non-ferrous metals, or plastics other than those listed in Clauses 5.4.2 and 5.4.3. Polyethylene fusion transition fittings with threads or barbs shall be used to adapt to high strength hose. Barbed fittings utilizing mechanical clamps shall not be connected directly to polyethylene pipe, with the exception of stab-type fittings as described above. All mechanical connections shall be accessible.

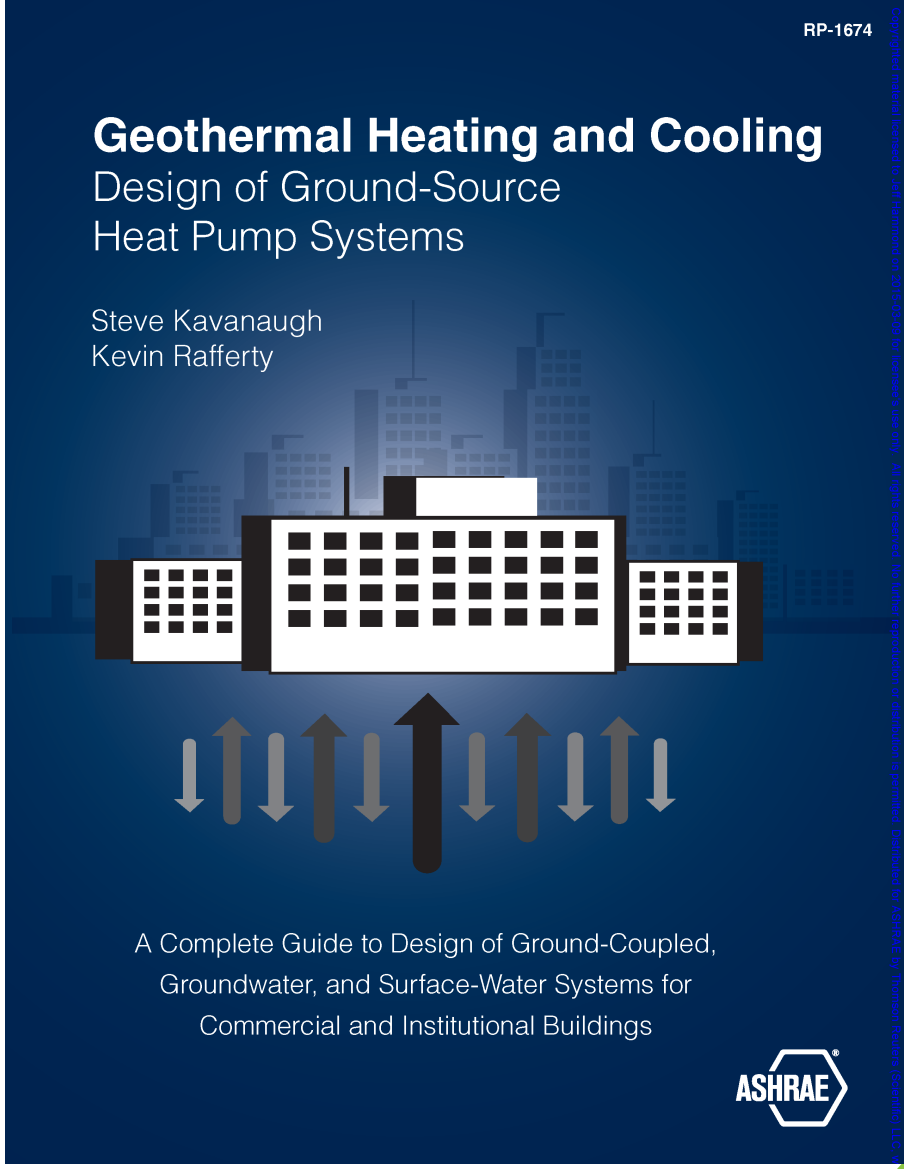
Availability

ANSI/CSA/IGSHPA C448 Design and installation of ground source heat pump systems for commercial and residential buildings

- ANSI (PDF or paper copy): US$155
- CSA (PDF or paper copy): CDN$155
- IGSHPA (PDF): US$100 for IGSHPA members
- Current version is now available online for free view access ****NEW****
  - Link on IGSHPA website (standards section – igshpa.org/standards)

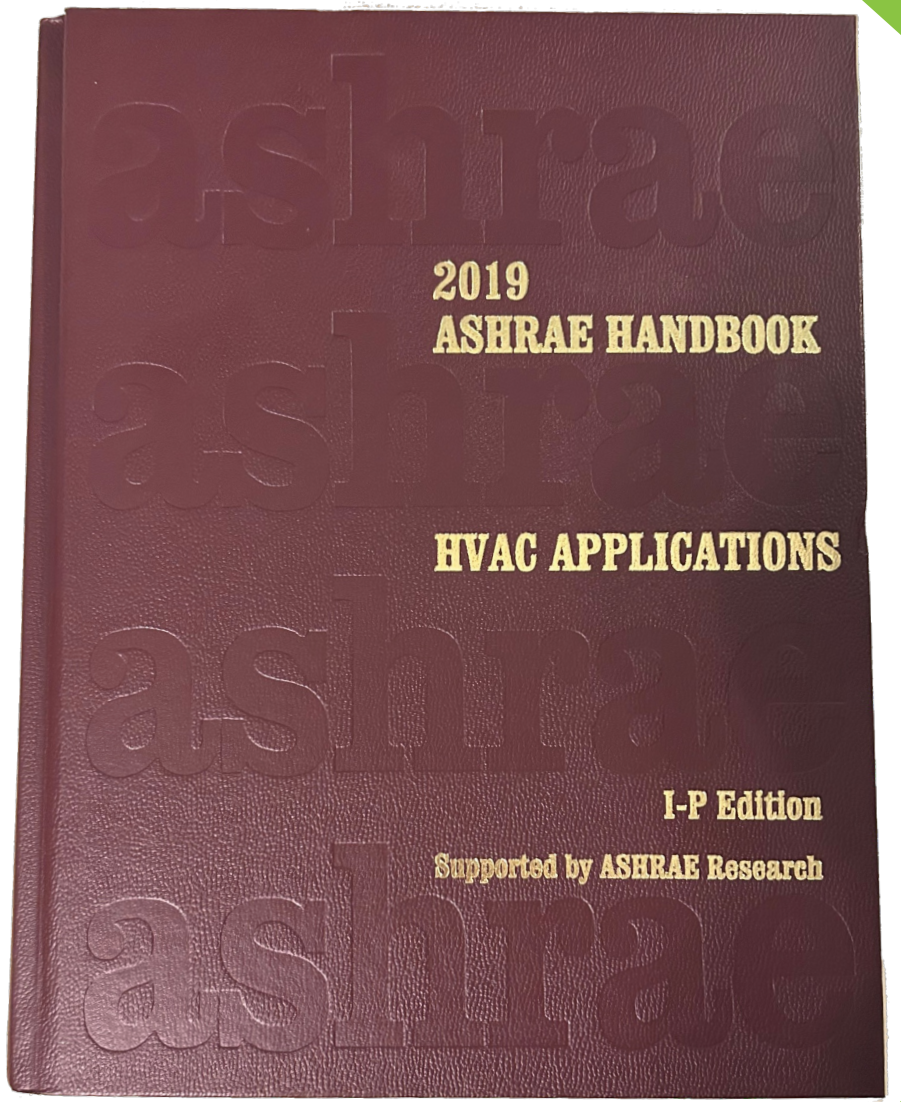
Design Manual

- ASHRAE Kavanaugh/Rafferty Manual is the industry standard (2014 edition)
  - Heat pump equipment
  - Fundamentals of vertical GHEX design
  - Surface water systems
  - Piping and pumping
  - Impact of pump Watts/system efficiency
  - Ground water systems
  - Performance and installation costs

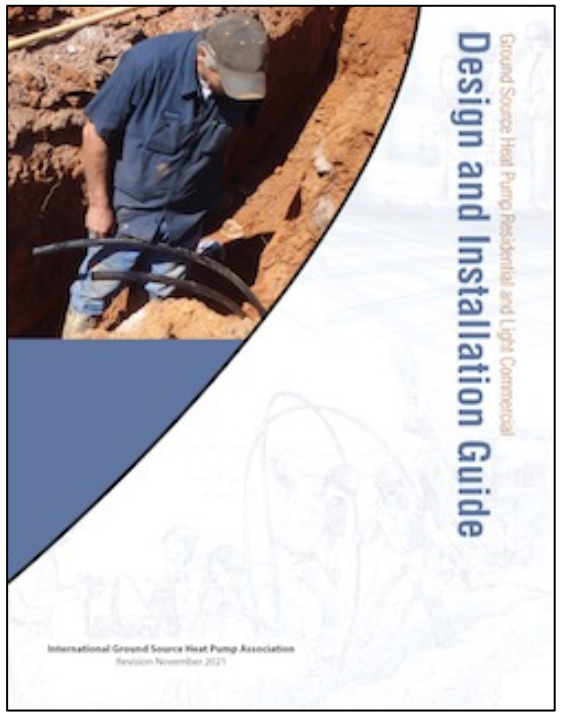


ASHRAE Handbook

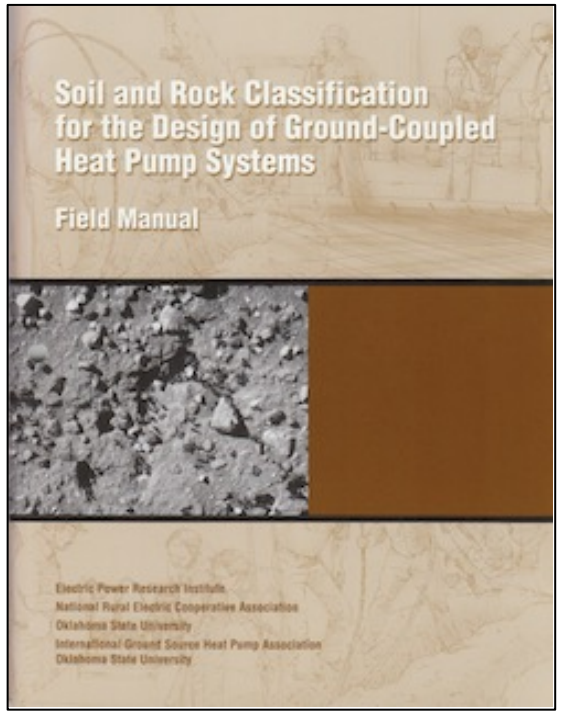
- 2019 ASHRAE Handbook: HVAC Applications
  - Terminology
  - GHEX types
  - Thermal conductivity testing
  - GHEX design
  - Hybrid systems
  - Piping
  - Heat transfer fluid / antifreeze
  - Ground water systems
  - Surface water systems
  - DX systems



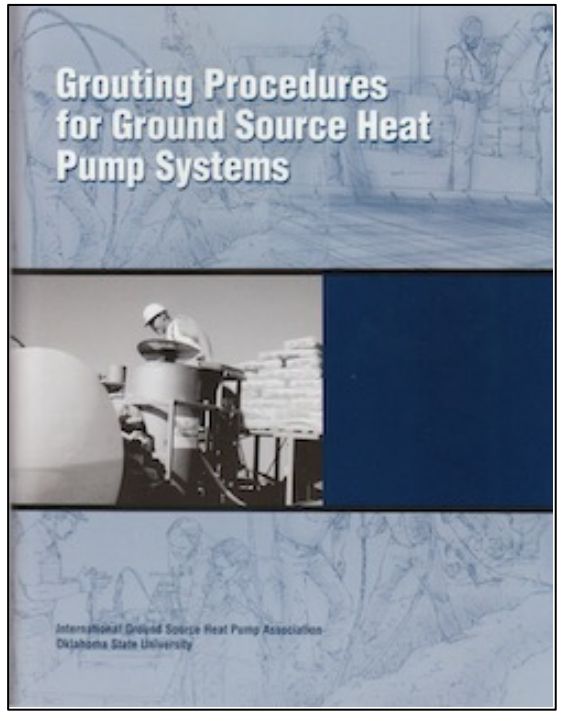
IGSHPA Manuals*



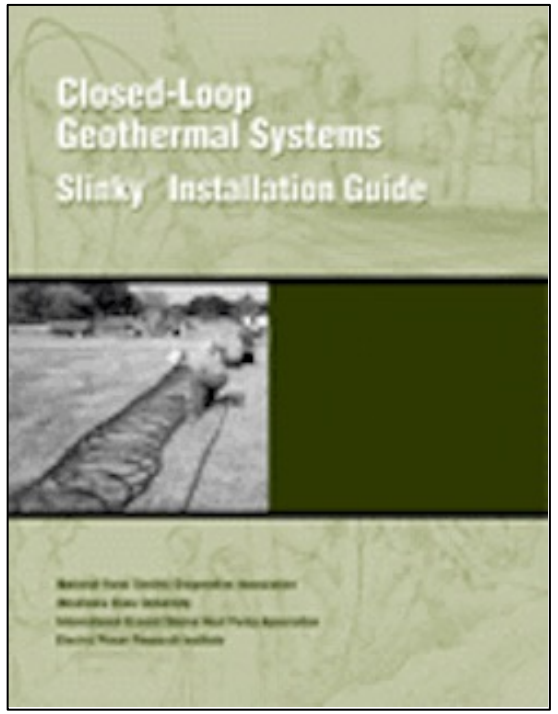
Residential / Light Commercial Design & Installation



Soil & Rock Classification (Commercial & Residential)



Grouting Procedures (Commercial & Residential)



Slinky Installation Guide (Primarily Residential)

*Paper and licensed PDFs available at igshpa.org

GHEX Software

- Ground Loop Design (GLD)
  - http://www.groundloopdesign.com
  - Large commercial / hourly loads
- GLHEPro
  - https://betsrg.org/ground-loop-heat-exchanger-design-software
  - Large commercial / hourly loads
- LoopLink PRO
  - https://looplinkpro.com
  - Light commercial / peak loads
- GSHPCalc (free software)
  - http://geokiss.com/free-design-software/
  - Light commercial / peak loads

Pressure Drop Calculation Software (free)

- PPI (Plastics Pipe Institute) BCD Plastic Pipe Design Calculator
  - https://www.plasticpipe.org/BuildingConstruction/BCD-Calculator/BuildingConstruction/BCD-Design-Calculator.aspx?hkey=e3dfb814-1cb0-4d28-a552-ad759a02963f
- Geo-Flo
  - https://geo-flo.com/calculators/

Max Borehole Depth Calculator

- IGSHPA Member Portal (free to members)
  - Hydrostatic Buckling / Pipe Collapse Calculator
  - Created in cooperation with PPI
  - Helps determine the maximum depth based upon
    - Pipe DR
    - Ovality
    - Fluid type
    - Grout
    - Other application factors

Antifreeze Calculator

- IGSHPA Member Portal (free to members)
  - Calculates volume of antifreeze / freeze protection based upon:
    - Antifreeze type
    - Amount of piping up to 6” diameter
    - HDPE, PEX, copper, and rubber hose (or SS hose w/rubber internal hose)

Standard Specification

- IGSHPA Member Portal (free to members)
  - GHEX requirements
  - Personnel qualifications
  - Pipe and fitting requirements
  - Grout requirements
  - Valving requirements
  - Water treatment
  - Antifreeze
  - Installation
  - Commissioning

Training Resources

Hourly Building Simulation Software Training

- ASHRAE BEMP (Building Energy Modeling Professional) certification
  - https://www.ashrae.org/professional-development/ashrae-certification/certification-types/bemp-building-energy-modeling-professional-certification
- EnergyPlus building energy software tools
  - https://www.buildingenergysoftwaretools.com/?capabilities=Training+Services&keys=EnergyPlus
- eQUEST/DOE2 building energy software tools
  - https://www.doe2.com/equest/
- Carrier HAP (Hourly Analysis Program)
  - https://www.carrier.com/carrieruniversity/en/us/training-courses/courses/?selectedfacets=Building%20Modeling|Topic%20Area
- Trane Trace
  - https://www.trane.com/commercial/north-america/us/en/education-training/design-analysis-software-category.html

Peak Load Calculation Training*

- ACCA (Air Conditioning Contractors of America) light commercial HVAC online certification program
  - Manual N (commercial loads) and Manual Q (ductwork design)
  - https://www.acca.org/certification/light-commercial-design/online
- Wrightsoft videos and training
  - Right-N software based upon ACCA Manual N
  - https://www.wrightsoft.com/icp/Training_Support.aspx
- Elite Software videos and training
  - Chvac software based upon ASHRAE peak heating/cooling load methods
  - https://www.elitesoft.com/web/training/welcome.html

*Light commercial design

IGSHPA CGD (Certified GeoExchange Designer)

- GHEX Design and GSHP System Integration
  - Designing Closed Loop, Ground Heat Exchanger, Configurations & Layouts
  - Soil/Rock Classification and Conductivity
  - Borehole Grouting
  - Thermal Conductivity in-situ testing
  - Ground Loop Heat Exchanger Software
  - Ground Source Heat Pump System Performance
- Created for professional engineers, registered architects, installers, and contractors
- Provides AEE (Association of Energy Engineers) and IGSHPA certification

Details at igshpa.org

-- Continues --

IGSHPA CGD (Certified GeoExchange Designer)

- CGD qualifications
  - Engineering graduate and/or Professional Engineer or Registered Architect with three years combined experience in commercial geothermal heat pump design and/or heating, ventilation and air-conditioning
  - Four-year, non-technical degree with five years combined experience in commercial geothermal heat pump design and/or heating, ventilation and air-conditioning.
  - Two-year technical degree with eight years of combined experience in commercial geothermal heat pump design and/or heating, ventilation and air-conditioning.
  - Ten years or more of combined experience in commercial geothermal heat pump design and/or heating, ventilation, and air-conditioning.

IGSHPA AI (Accredited Installer)*

- GHEX Design and HVAC System Integration
  - Closed Loop Ground Heat Exchanger Design
  - Soil/Rock Classification and Conductivity
  - Borehole Grouting
  - Ground Loop Heat Exchanger Software
  - Ground Source Heat Pump System Performance
- Created for installers, contractors, dealers, manufacturers, distributors, architects, mechanical engineers, trenching/drilling contractors
- Provides NATE (North American Technician Excellence) and IGSHPA certification

Details at igshpa.org

-- Continues --

*Residential/Light commercial design

IGSHPA AI (Accredited Installer)*

- AI qualifications
  - Be licensed by the state/province as required
  - Understand traditional HVAC system design, installation, and terminology
  - Understand and apply ACCA Manual J (CSA F280 in Canada) calculations for residential buildings apply ACCA Manual N (HRAI SAR-C2 in Canada) for light commercial buildings
  - Have knowledge of general construction techniques
  - Be familiar with local code requirements
  - Understand basic refrigeration (including heat pumps) and basic electrical

*Residential/Light commercial design

IGSHPA CGI (Certified Geothermal Inspector)

- Inspection / Project Oversite Training
  - GSHP System Benefits
  - IGSHPA Standards, ASHRAE and NGWA Guidelines
  - Local and State GSHP Codes
  - Outside Heat Exchange Configurations
  - Building Site and Loop Field Layout
  - Heat Fusion and Antifreeze Solutions
  - System Startup and Commissioning
  - Sample Inspection forms and checklists
- Created for code enforcing inspectors, MEP firm project managers, utilities, installers, developers, architects, manufacturers, distributors, HVAC contractors, trenching/drilling contractors
- Provides IGSHPA certification

Details at igshpa.org

-- Continues --

IGSHPA CGI (Certified Geothermal Inspector)

- CGI qualifications
  - A 4-year mechanical engineering graduate and/or P.E. or R.A. with three years of verified experience in geothermal heat pump system project design or installation
  - Any other four year technical or non-technical degree with five years of verified experience in geothermal heat pump system project design or installation
  - Current IGSHPA trained professional
  - Three years of verified experience in building inspection

IGSHPA CRD (Certified Residential Designer)

- Residential Design Training
  - System Components
  - Heat Pump Types
  - Design Process
  - Energy Requirements
  - Load Calculation Requirements
  - Parameters that affect different types of heat pump performance, site, geology and soil conditions
  - Heat pump and GHEX design
  - Economics of design
- Created for installers, contractors, dealers, utilities, home builders, manufacturers, distributors, architects, trenching/water well drilling contractors
- Provides IGSHPA certification

Details at igshpa.org

-- Continues --

IGSHPA CRD (Certified Residential Designer)

- CRD qualifications
  - Understand traditional HVAC system design and terminology
  - Understand and apply ACCA Manual J (CSA F280 in Canada) calculations for residential buildings apply ACCA Manual N (HRAI SAR-C2 in Canada) for light commercial buildings
  - Understand ductwork and hydronic layout/design
  - Have knowledge of general construction techniques
  - Be familiar with local code requirements

Summary

- Design of GSHP systems is unique
- There are many design resources available
- IGSHPA membership can help keep you up to date on the industry and provide additional resources
- There is a lot of training available for GSHP designers (in-person and virtual / video)
- Certification programs exist through several organizations
- With a little homework, GSHP system design can be your forte!

Questions

1. What is unique about the design process of GSHP systems?
   a. Although there are some minor calculation differences, GSHP systems are not unique.
   b. As the designer of the energy source, you must know the long-term performance of the system.
   c. GSHP systems require peak heating and cooling loads, whereas conventional systems require off-peak heating and cooling loads.
   d. None of the above.

Questions

2. Why is the C448 bi-national standard important?
   a. The standard provides unified/consistent requirements, helping to minimize differences.
   b. The standard is also a design manual.
   c. The standard is primarily prescriptive in nature.
   d. All of the above.

Questions

3. How can designers obtain training on GSHP system design?
   a. Through IGSHPA courses.
   b. From providers of hourly building simulation software.
   c. Through OFRH (Organization for Renewable Heating).
   d. All of the above.
   e. A and B.

Discusions

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jeff@igshpa.org

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