NY-GEO 2024
October 22 -23 | BROOKLYN, NY

# Finishing Strong:
# Geothermal System Commissioning

**Zachary Fink / *ZBF Geothermal, LLC***

DESIGN TRACK • DAY 1 • 4:00 PM

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# Learning Objectives

- Major points on the borefield installation, inspection and operation.
- Circulation pump operation relative to design parameters.
- Heat pump operation – key things to check!
- The importance of controls to orchestrate system operation.
- Developing an Operators Manual.

# Geothermal System Commissioning


- Why is commissioning and training important?
  1. Verifies the system is working as as designed
  2. Helps ensure the lowest cost of operation
  3. Helps ensure the correct materials of construction are utilized
  4. Training helps protect the system ensuring long term operation of the geothermal system

# What to Commission

- Not just the borefield! (but that's important!)
- Consider the system as a whole.  Heat pumps need to be working correctly for the borefield to perform correctly
- Pumps need the correct flow rates, control, modulating based on pressure or temperatures, to avoid excess pumping energy and warming up the borefield
- Balancing devices (waste heat recovery, boilers, dry coolers, etc) need to be configured to run as the design intent

# Commissioning Starts Early

- Commissioning Agent prepares a plan showing the systems that will be commissioned along with the methodology for testing
- Most Commissioning Agents will start their reviews in the design phase to ensure that the system meets the owners requirements and allows for ease of commissioning.
  - The Cx agent sometimes also works as the energy consultant on the project and is responsible for passive house certifications, Energy Star, LEED, etc

Horizon Engineering
Associates LLP

**Commissioning Plan**

**Lend Lease Corp**

1 Java

# Establish a Clear Understanding of Responsibilities

- Commissioning agents should start reviewing submittals during the construction process to ensure all metering, sensors, and controls are in place
- A list of all items being commissioned should be developed as part of the commissioning plan
- Mechanical contractors, drillers, etc likely need to be on site during the commissioning process

**2.5 Systems to be Commissioned**

The following equipment/systems will be commissioned during this project:

| Mechanical Systems | Electrical Systems |
|---|---|
| • Energy Recovery Units<br>• BOH & Amenities Packaged HVAC Units<br>• Misc. BOH & Amenities Terminal Units<br>• Water Source Heat Pumps<br>• Fans<br>• Plate Frame Heat Exchanger<br>• HVAC Pumps<br>• Chemical Treatment System | • Lighting Controls<br>• Distribution and Power Panels<br>• Apartment Electrical Panels<br>• Switchgear<br>• Transformers<br>• Generator<br>• Automatic Transfer Switch (ATS)<br>• Pull the Plug<br>• Coordination Study Review |
| **Plumbing Systems** | **Fire Protection** |
| • Domestic Hot Water Heater<br>• Domestic Hot Water Pump<br>• Domestic Cold Water Pump and Tanks<br>• Sump/ Elevator/ Ejector Pit Pumps | • Fire Pump<br>• Jockey Pump<br>• Fire Alarm System |
| **Miscellaneous Systems** | **Controls Systems** |
| • Security<br>• Data/ Telecom<br>• ARC System | • Building Management System (BMS) |

# Borefield Commissioning

- Ensure the system is flushed and all air is removed
  - Flush at a velocity > 4ft/sec to remove trapped debris as well as air
  - Check filter bags to ensure system is clean of debris
  - Typically 20 passes in each direction are required to ensure a clean system
  - Clean water can be verified by filling a water bottle and making sure not sediment is at the bottom
- Water side balancing is required
  - Ensure circuits are balanced and within 5% of each other

# Establish Forms to be Utilized

Trade:

1) Description of System: Geothermal circuiting
(CW piping, HP steam piping, duct system, etc.)

2) Location of System: Manifold Room 1
(building, floor, etc.)

3) Test Parameters:

a) From: 1A supply

To: 1A Return (point to point of test)

b) Test Pressures 90 psi (required by spec or code)

c) Duration of Test 1 hour (length of test)

d) Testing Medium water (air, nitrogen, water, etc.)

4) Start of Test: Date: 4/4/2024 Time: 10:29 am Pressure: 91 psi

5) Witnesses:

| | Company Name | |
|---|---|---|
| Comm Agent: | FST | x |
| CM: | Lend Lease | x |
| Contractor: | Brightcore | x |
| 3rd Party | AEL | x |

6) Completion of Test: Date: 4/4/2024 Time: 11:38 Pressure: 93 psi

7) Witnesses:

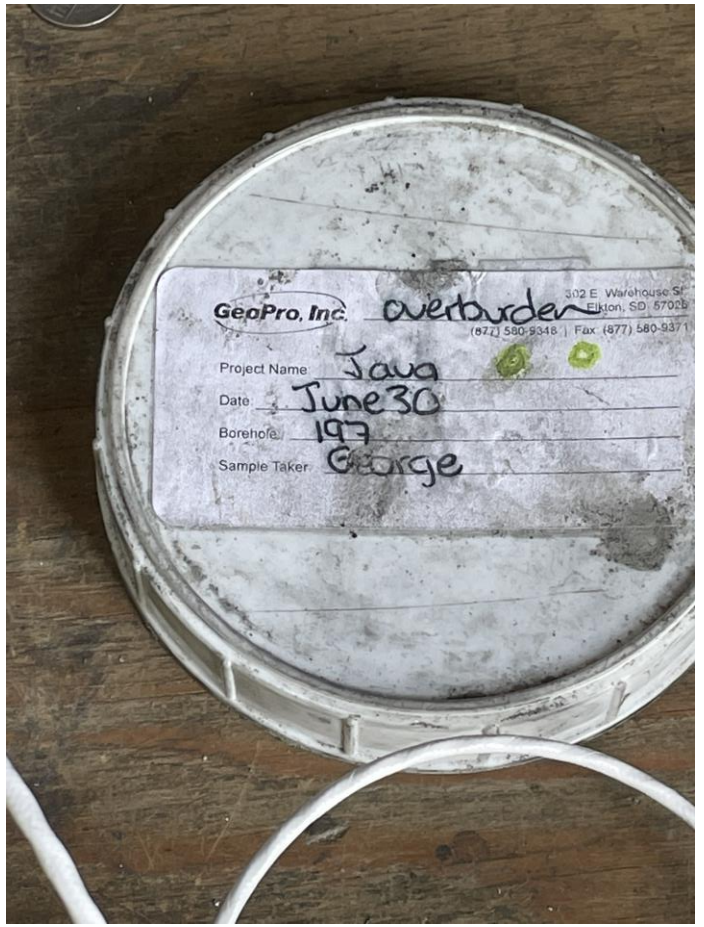
| | Company Name | |
|---|---|---|
| Comm Agent: | FST | x |
| CM: | Lend Lease | x |
| Contractor: | Brightcore | x |
| 3rd Party | AEL | x |

8) Pass/Fail: Pass

Comments: 17.5psi Δ@ 125 gpm

# Grout Testing

- Verification of specified products and ensures quality control
- Grout testing can happen via sampling containers that get shipped back to the manufacturer or via a portable testing device on site
- Know what to do with the information before it's received back



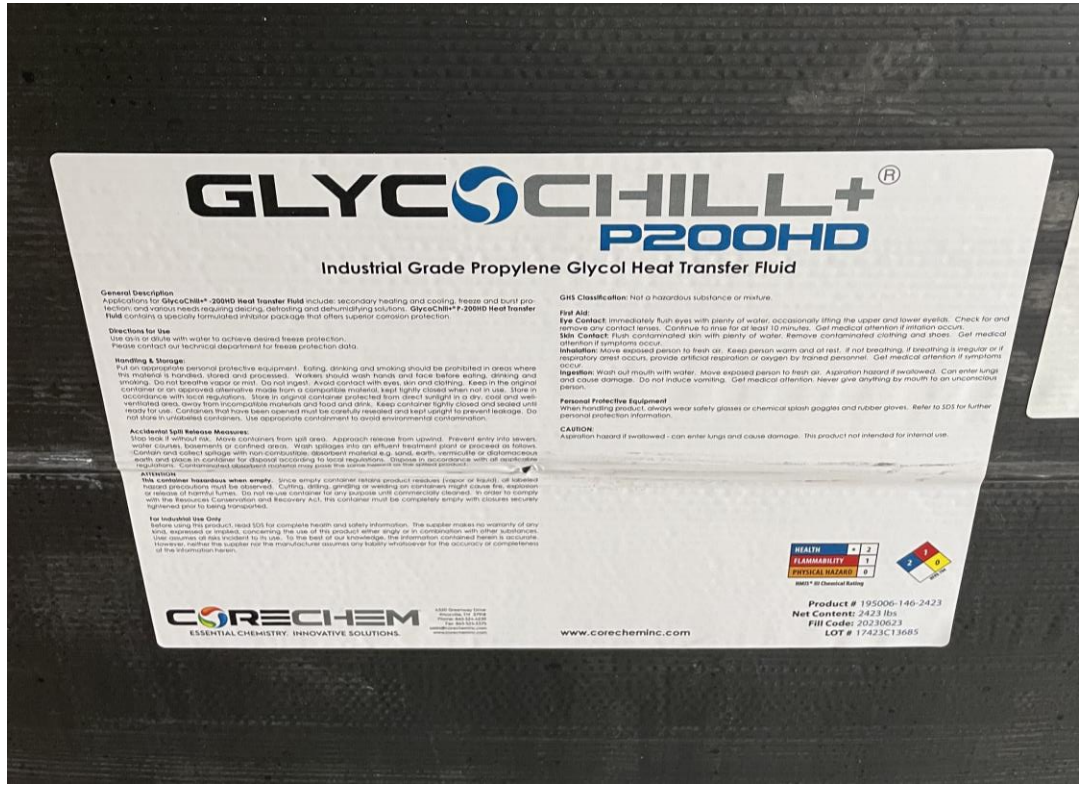

# Flushing and Filling of the System

| | |
|---|---|
|  |  |
| Pump used for flushing piping | Fluid reservoir for flushing pipes |

# Filtration Equipment

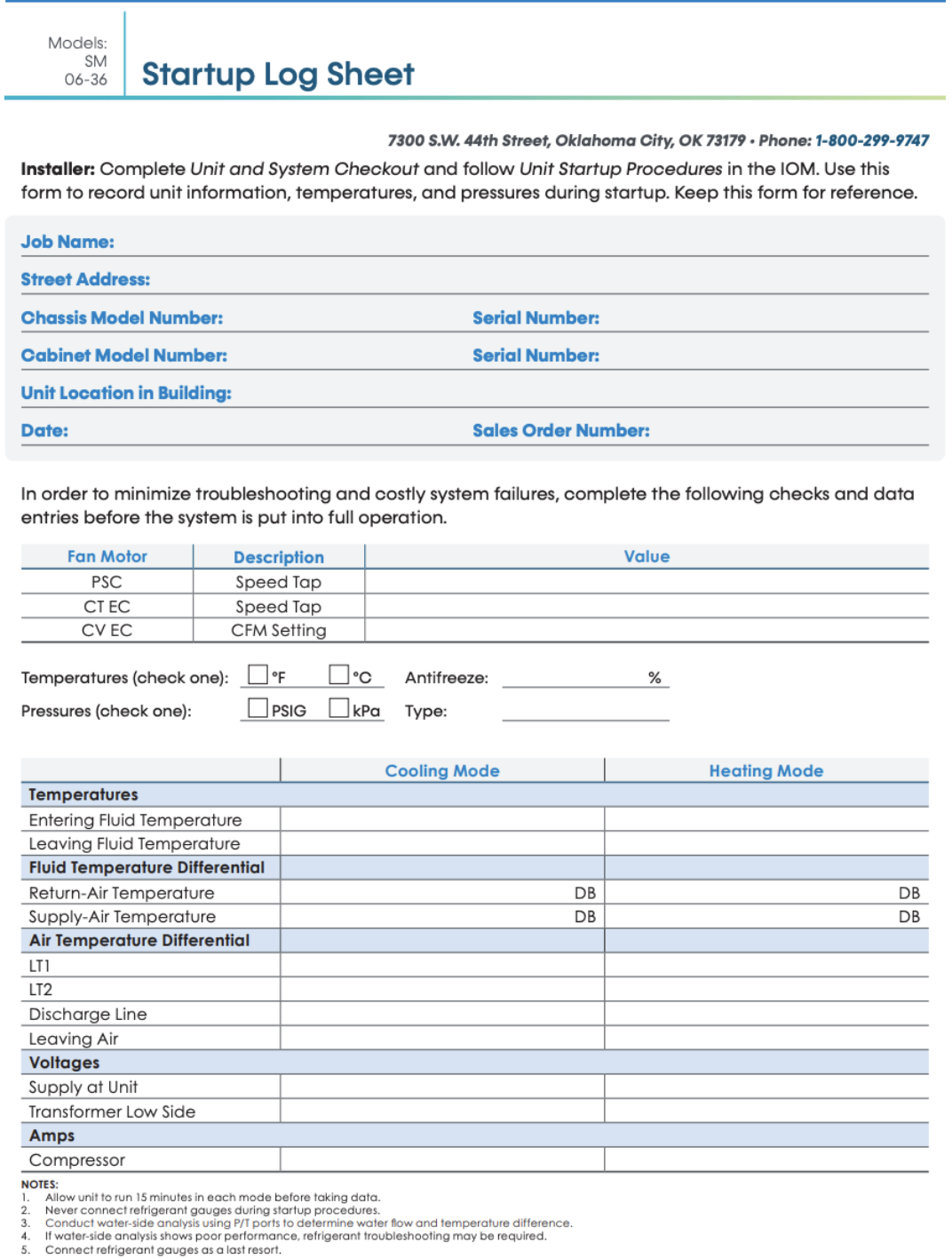

# Glycol Installation

- Confirm water quality aligns with manufactures specifications and the project specifications
  - Disinfectant of the water
  - What water treatment is required?
- How will the glycol level be tested at the end?
- Inhibitor and Testing
  - Most glycol manufactures offer annual testing



# Heat Pump Commissioning

- Manufacturer start up forms are filled out first
  - Either the contractor or the manufacture's rep typically fills out the startup forms
  - Air flow is checked and set as per drawings and approved submittals
  - Overall unit performance is checked for noise, temperatures, dehumidification
- Commissioning agents then choose a random sample of units to check and verify that they were installed correctly
- Commissioning checks to make sure the correct unit is installed in each apartment



Models:
SM
06-36

## Startup Log Sheet

*7300 S.W. 44th Street, Oklahoma City, OK 73179 • Phone: 1-800-299-9747*

**Installer:** Complete *Unit and System Checkout* and follow *Unit Startup Procedures* in the IOM. Use this form to record unit information, temperatures, and pressures during startup. Keep this form for reference.

**Job Name:**

**Street Address:**

**Chassis Model Number:** **Serial Number:**

**Cabinet Model Number:** **Serial Number:**

**Unit Location in Building:**

**Date:** **Sales Order Number:**

In order to minimize troubleshooting and costly system failures, complete the following checks and data entries before the system is put into full operation.

| Fan Motor | Description | Value |
|---|---|---|
| PSC | Speed Tap | |
| CT EC | Speed Tap | |
| CV EC | CFM Setting | |

Temperatures (check one): ☐ °F ☐ °C Antifreeze: % 

Pressures (check one): ☐ PSIG ☐ kPa Type:

| | Cooling Mode | Heating Mode |
|---|---|---|
| **Temperatures** | | |
| Entering Fluid Temperature | | |
| Leaving Fluid Temperature | | |
| **Fluid Temperature Differential** | | |
| Return-Air Temperature | DB | DB |
| Supply-Air Temperature | DB | DB |
| **Air Temperature Differential** | | |
| LT1 | | |
| LT2 | | |
| Discharge Line | | |
| Leaving Air | | |
| **Voltages** | | |
| Supply at Unit | | |
| Transformer Low Side | | |
| **Amps** | | |
| Compressor | | |

NOTES:
1. Allow unit to run 15 minutes in each mode before taking data.
2. Never connect refrigerant gauges during startup procedures.
3. Conduct water-side analysis using P/T ports to determine water flow and temperature difference.
4. If water-side analysis shows poor performance, refrigerant troubleshooting may be required.
5. Connect refrigerant gauges as a last resort.

# Heat Pump Commissioning

- Check that condensate drains are functioning
- Check zone valves to ensure that the units are only getting flow when the thermostat calls
  - Confirm zone valve type (normally open vs normally closed vs modulating) and correct logic and sequencing
- Check the filters to make sure they're installed correctly

# Pump Commissioning

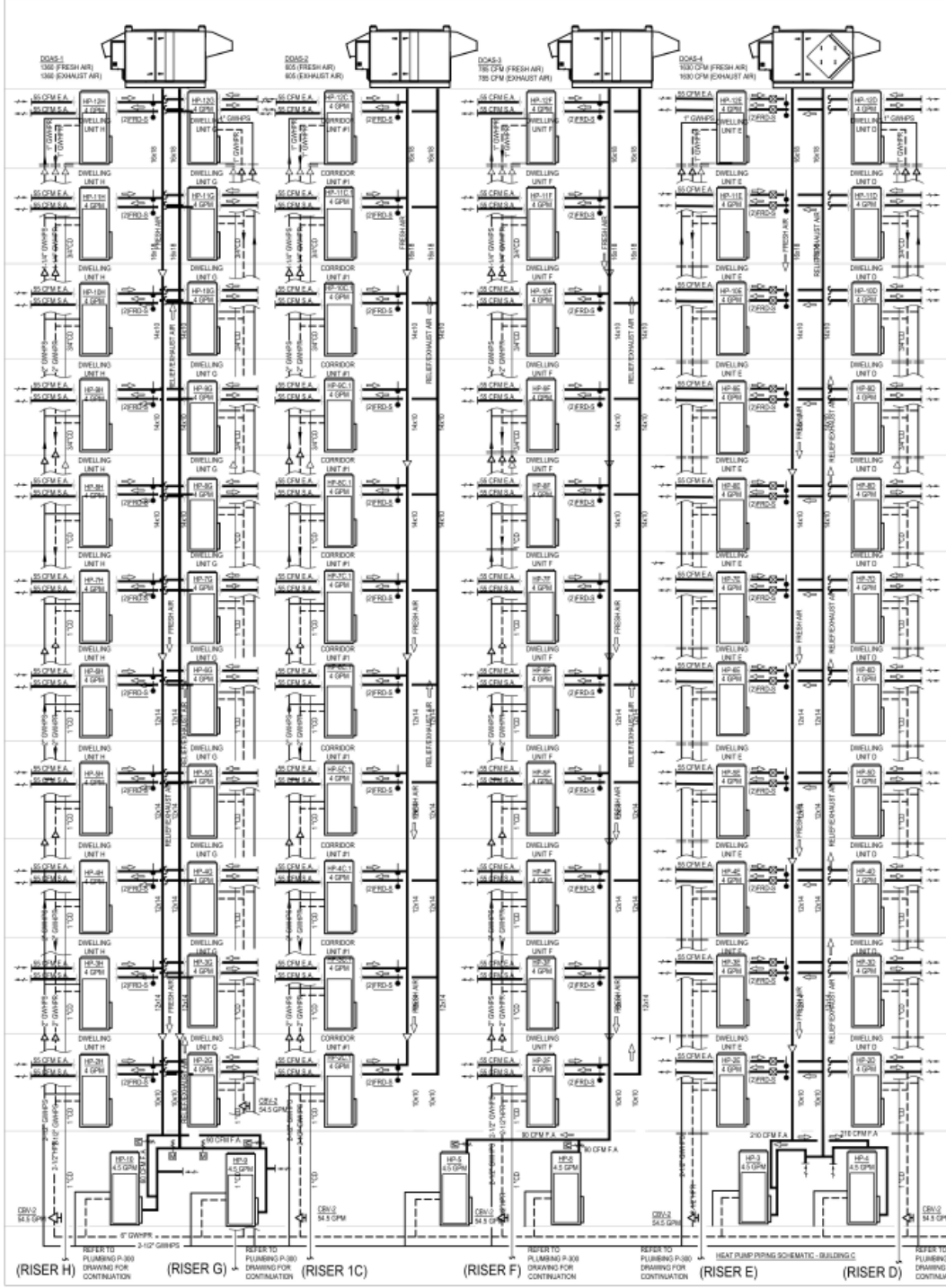
- Ensure that the pumps are following the correct curve and modulating based on design intent
  - Possible control modes
    - Sensorless
    - Differential Pressure
    - Temperate Differential
    - Lead/Lag
    - Parallel Pumping
  - Confirm the strainers are cleaned
  - Confirm the water side balancing has been completed

# Mechanical Water and Piping

- Anti-Freeze / Glycol
  - Ensure glycol is installed as per specifications and system design
  - Manufacture requirements were followed for system disinfectant and water quality
  - Inhibitors are installed to limit biofowling and corrosion of steel pipe
- Pipes are insulated as per code

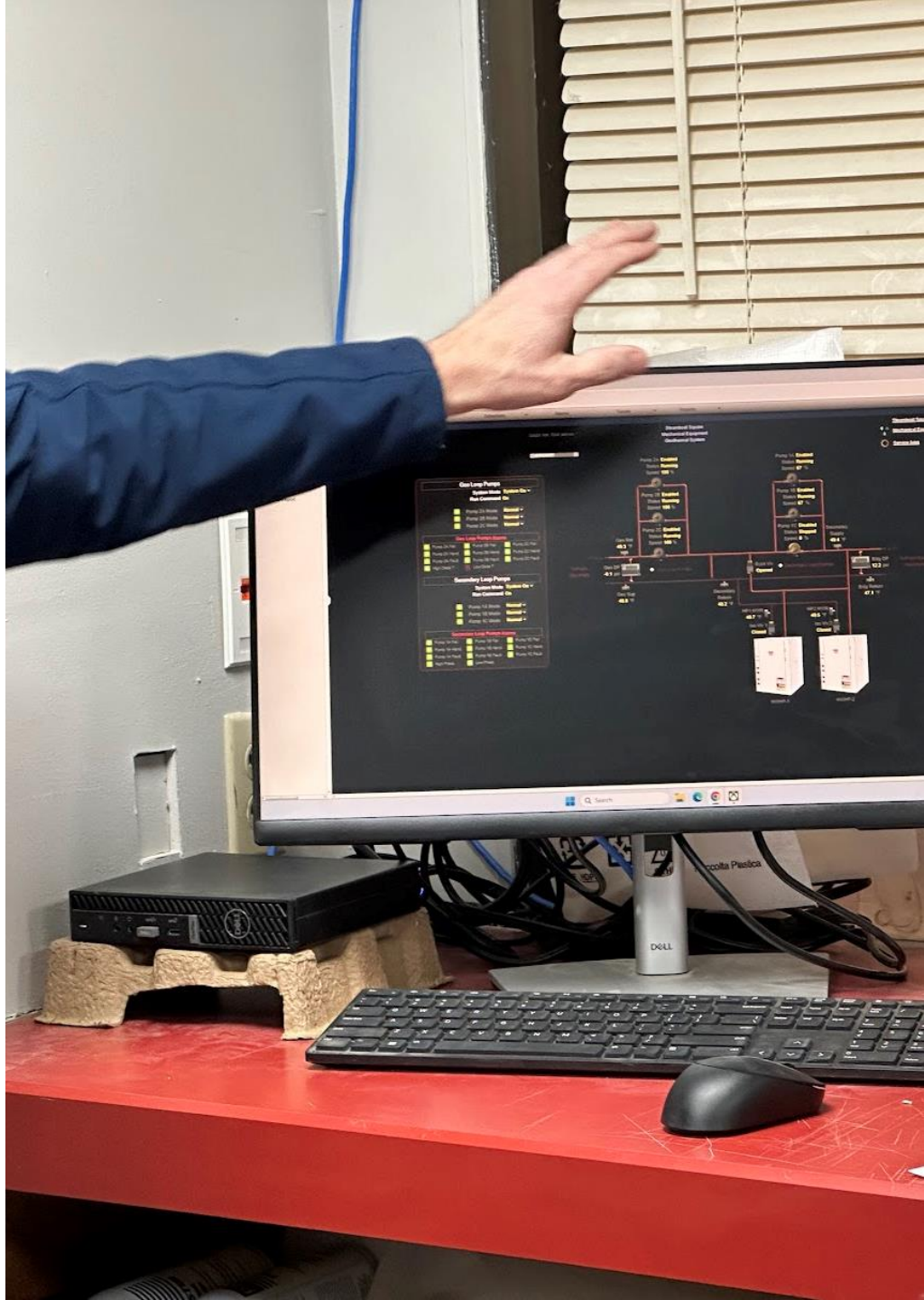
# Simulate a load

- How to simulate a load in the building
  - Run heat or air conditioning with the windows open
  - Run an electric heater
  - Run domestic hot water systems to lower the borefield temperatures
  - Run the system with only partial loops active to simulates a cold or hot loop situation to make sure the load balancing equipment energizes



# Controls

- Building Management System Controls
  - Verify the sequences are correct
    - Run tests to ensure the system is functioning as designed
  - Are systems in hand or fault modes?
  - Is fault monitoring enabled?
  - Consider a BTU meter to allow for diagnostics at a later point, in the event of an issue.



# Domestic Hot Water

- Domestic Hot Water can be 50% of the HVAC energy on a new building
- Hot water recirculation can be up to 45% of the total DHW energy
- Hot water storage temperatures are as per submittals
  - Consider the performance curve of the heat pumps to determine the ideal storage temperatures
  - R744 (C02) heat pumps become more efficient with the higher lift
  - R410, R134a, R32, R454B heat pumps become less efficient with the higher lift

# Domestic Hot Water

- Confirm mixing valve temperatures
- Confirm recirculation lines are correct
- Confirm the flow rates are correct and not over pumping
- Heat Pumps – Things to Check
  - Can the units maintain the setpoint temperatures?
  - Simulate a load and make sure the heat pump modules are set up to recover fast enough for the building

# Operator Training

- Does the building operator know how to operate the system?
- In the event of an issue do they know how to handle it/ who to call?
- Does the building have extra filters on site?
- Has the operator been trained in the BMS/control system?

# Example of Fault Notifications

Alarm: Tarrytown Senior Living - DPT Low Pressure Alarm - Alarm External Inbox ×

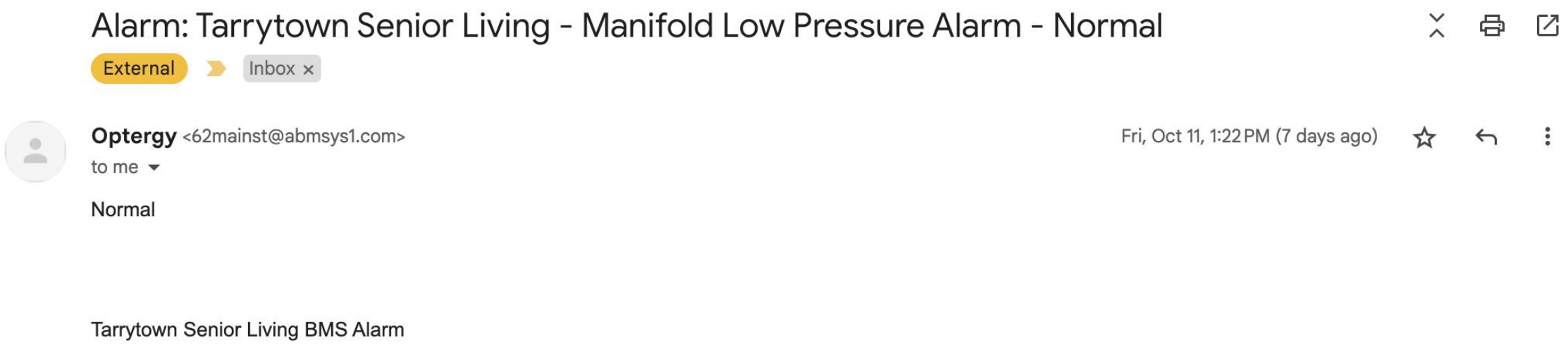
**Optergy** <62mainst@abmsys1.com> Wed, Oct 16, 3:21 PM (2 days ago)

to me

Alarm

Tarrytown Senior Living BMS Alarm

# Example of Fault Notifications



# Questions

- Can a commissioning agent confirm every aspect of a borefield by observation?
  - Why or Why not?
- What is the most overlooked aspect of geothermal system commissioning?
- What is an acceptable deviation of pressure drop when flow testing?
- How long does it take to commission a geothermal system?

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