Operations and Maintenance Strategy for the Flagg Loop, A Geothermal Network in Framingham, MA

This report describes the operations and maintenance (O&M) strategy for geothermal networks as developed for the Flagg Loop in Framingham, MA. This report is a product from the Budget Period 1 (BP1) "Planning and Design" of the Community Geothermal Heating and Cooling (CGHC) grant awarded by the Department of Energy (DOE) to HEET. The partner organizations of this project are: Eversource Energy- the Deployment Partner; the City of Framingham - the Municipal Partner, Salas O'Brien - the Design Partner, and HEET, the main recipient. HEET is a non-profit with a mission to drive systems change through an ethical and efficient thermal energy transition.

For the Flagg Loop, the existing maintenance plan from the operational Concord Loop will be updated to include the new equipment and assets of the expanded system. A maintenance plan outline is provided in Appendix A.

Ground Source Heat Pumps

The proposed maintenance strategy for ground-source heat pumps will stem from equipment manufacturer's recommendations and is comprehensive and strategically designed to ensure long-term system reliability, efficiency, and performance. A detailed maintenance schedule will be established, focusing on routine and preventive maintenance activities that will mitigate the risk of system failures and extend the lifespan of the equipment. Learnings from the ongoing Concord Loop will be leveraged to optimize the maintenance schedule for units on the Flagg Loop. Key activities will include regular inspections of all system components, such as compressors, heat exchangers, pumps, and piping. These inspections will assess the condition of the equipment, looking for any signs of wear, corrosion, or mechanical fatigue that could compromise system performance.

The maintenance plan also incorporates systematic fluid checks to ensure that the heat transfer fluids are at appropriate levels and maintain their thermal conductivity. This includes monitoring for signs of contamination or degradation, which could reduce the system's efficiency or lead to mechanical damage.

Ground loop water temperatures will be monitored. An essential element of maintaining ground-source heat pumps is the continuous monitoring of ground loop water supply temperatures. This monitoring will record both seasonal variations and year-over-year performance metrics. Monitoring data will be collected and analyzed to identify any deviations from expected performance, which could indicate issues such as ground loop imbalance, equipment inefficiencies, or the need for supplemental heating or cooling solutions.

The maintenance plan will also outline protocols for responding to such deviations, including the steps for conducting detailed diagnostics, making necessary adjustments, and implementing corrective measures. Furthermore, the plan will address the need for regular descaling and antifreeze replenishment, as these activities are critical for maintaining the heat exchange efficiency of the system. Descaling will be scheduled based on water quality and usage patterns, while antifreeze levels will be checked and replenished as necessary to prevent freezing in the loop.

Adjunct, Supplemental, and Redundancy Systems

In addition to the primary heat pump systems, the maintenance plan also addresses the needs of adjunct, supplemental, and redundancy systems that support overall system operation. These systems play a critical role in ensuring the reliability and efficiency of the geothermal network, particularly in scenarios where the primary systems may be operating at capacity or during maintenance periods.

The maintenance plan outlines a schedule for regular testing and inspection of these auxiliary systems, ensuring that they are ready to perform when needed. Backup systems in particular will be tested periodically under simulated operational conditions to confirm their readiness and ability to seamlessly take over in the event of a primary system failure. This includes routine checks of system pressures, flow rates, and operational statuses, with a focus on identifying and addressing any issues that could impair performance.

For central loop infrastructure, including pumps and distribution piping, the maintenance plan includes assessments of run-time and electricity consumption. Monitoring these metrics is essential for optimizing operational efficiency and cost-effectiveness. If energy consumption is found to be higher than expected, it may indicate inefficiencies in the system that require further investigation and correction.

Additionally, the plan incorporates regular assessments of the central loop's flow rates, ensuring that water flow (measured in gallons per minute, or GPM) remains balanced and consistent. Any detected imbalances or leaks will be promptly addressed to prevent potential system failures or performance losses.

Existing Infrastructure

A critical component of the maintenance plan involves the evaluation of existing infrastructure that will remain in use after the implementation of the networked geothermal system. This infrastructure may include existing pumps, piping, control systems, and other key components that are still functional and compatible with the new system. The maintenance plan provides a detailed account of these components, specifying their roles in the system and the maintenance activities required to ensure their continued reliability and efficiency. For infrastructure that will remain in routine operation, the plan includes a maintenance schedule that outlines the frequency of inspections, the conditions under which the equipment will operate, and any specific maintenance activities required to keep the equipment in optimal condition. This may include routine cleaning, lubrication, pressure testing, and component replacements.

The electric boiler included in the Concord Loop will play a critical role in providing supplemental heating when needed, ensuring consistent thermal energy output and reliability for all connected buildings. Regular maintenance and monitoring will be performed to optimize the boiler's efficiency and ensure smooth integration with the existing geothermal system.

Additionally, the plan incorporates continuous monitoring of critical parameters such as water flow rates, pressure levels, and temperature readings to detect any signs of system degradation or inefficiencies. For infrastructure that will be kept on standby, the maintenance plan specifies the conditions under which the equipment will be activated, as well as the steps required to ensure that it remains in a ready state. This may involve periodic testing, calibration, and maintenance activities designed to prevent deterioration or obsolescence. The plan also

includes protocols for reactivating standby equipment, ensuring that it can be brought online quickly and efficiently when needed.

Finally, the maintenance plan also addresses the decommissioning and demolition of existing infrastructure that will be replaced by the new geothermal system. A clear timeline and rationale for the removal of outdated or inefficient components, such as old pumps, boilers, or piping systems will be provided. The plan also includes a detailed demolition strategy outlining the steps for safely dismantling and removing these components, as well as the procedures for disposing or recycling materials in an environmentally responsible manner.

Ownership and Maintenance Responsibilities

Thermal Production: It is the expectation that the maintenance plan will define the ownership and maintenance responsibilities for the thermal production equipment, including ground-source and water-source heat pumps, boilers, and other thermal generation components to lie with the local thermal utility (Eversource) who is responsible for the project development and the initial networked geothermal project at Framingham to which this project is physically connected. The local thermal utility will be responsible for the day-to-day operation and long-term maintenance of these systems, as well as the protocols for ensuring their continued efficiency and reliability. The plan includes best practices for maintaining the wellfield and other thermal production assets sustainably and cost-effectively.

Distribution Piping: It is the expectation that ownership and maintenance of the distribution piping, which is responsible for transporting heated or cooled fluids throughout the community, is also defined in the maintenance plan and will lie with the local thermal utility (Eversource) upon Massachusetts Department of Public Utilities approval for this project. This network is a critical component of the geothermal system, and its maintenance is essential for ensuring consistent and efficient energy distribution. The plan includes protocols for monitoring the distribution piping, with a focus on detecting and addressing issues such as leaks, blockages, or corrosion. Regular inspections and pressure tests will be conducted to assess the integrity of the piping, and any necessary repairs or replacements should be carried out promptly to prevent disruptions to the system. Additionally, the plan incorporates the monitoring of make-up water/glycol over time, tracking the typical volume and cost requirements for maintaining the system's fluid levels and ensuring its continued operation.

Other Assets of the Community-Style Heat Pump System: The maintenance plan also addresses the ownership and maintenance of other significant assets within the community-style heat pump system, such as control systems, monitoring equipment, and auxiliary components. It is expected that the ownership and maintenance of these assets will also lie with the local thermal utility (Eversource) upon approval of the project by the Massachusetts Department of Public Utilities. These assets play a crucial role in the overall functionality and efficiency of the system, and their maintenance is essential for ensuring long-term reliability. Regular water quality tests will be conducted as part of the maintenance plan to monitor the condition of the system and prevent issues such as scale buildup, which can reduce system efficiency and lead to mechanical failures. The plan also includes protocols for calibrating and maintaining control systems and monitoring equipment, ensuring that they continue to provide accurate and reliable data for system management.

Ownership Transition and Expectations: The maintenance plan also outlines the expectations for transitioning ownership and responsibilities from the project developers to the

community or another designated entity. It is not expected that there will be an ownership transition away from the local thermal utility over the useful life of the project.

Appendix A: Operations and Maintenance Outline

VOLUME A: OPERATIONS MANUAL

1. ADMINISTRATIVE PROCEDURES
    1. Overall manual purpose, scope and review requirements.
    2. Damage prevention program statement (participation in Dig-Safe)
        a. Damage Reporting
    3. Public awareness program (Future)
        a. Including demarcation of responsibility for equipment
    4. General repair procedure statement
    5. O&M recordkeeping procedures.
    6. Data collection plan
    7. Regulatory Reporting Requirements
    8. Security procedures
    9. Training plan
    10. Reference to As-Builts/Wiring Diagrams/Project Records
2. GEOTHERMAL OPERATING PROCEDURES
    1. O&M Safety (Trench, Confined Space, LOTO, Chemicals & SDS)
    2. List of each system and separate section for each piece of equipment not part of a system?
        a. Overall system startup & shutdown
    3. Seasonal Operation or Operation outside of normal limits
    4. AOC response
    5. Post- AOC response
    6. Investigation of failures and incidents
    7. Leak Detection
    8. Valve inspections
    9. Equipment inspections
    10. Facility Inspection & Accessibility
    11. Filling Procedure
    12. Draining Procedure
    13. Glycol Testing Procedure
3. FORMS

This section will contain any forms required to be filled out by operators when conducting or implementing any of the procedures listed above

VOLUME B: EMERGENCY MANUAL

1. Event response procedure (Process flow from Resident Call to Operator Response)
2. Local public safety liaison procedure
3. Fire procedure
4. Natural disaster procedure (Flood, Earthquake, Storms)
5. (Gas Leak not relevant)
6. Leak response procedure
7. Equipment failure procedure
8. Power failure procedure
9. Water Outage
10. Chemical Spill
11. List of Emergency Contacts

VOLUME C: MAINTENANCE MANUAL

1. MAINTENANCE PROCEDURES
    1. Maintenance schedule
    2. Preventative maintenance procedures
    3. Troubleshooting Guide and Equipment repair
    4. Performance Data Evaluation (Future)
    5. Spare/Active equipment switching
2. EQUIPMENT MANUALS
    1. All equipment to be listed, including equipment list w/ tag #s
3. SPARE PARTS
    1. Spare parts list
    2. Spare replacement schedule
4. SERVICE CONTRACTS (if any)
5. WARRANTIES – provide signed copies (or reference to where they can be found)
6. DRAWINGS – as built drawings