



MECHANICAL SPECIFICATIONS

Project Title:

IPAC – DX geothermal system with CO2

Philippe Simard ing. (#OIQ :126081, Québec)

Issued for tender

June 23rd, 2021



1. INFORMATION ON THE PROJECT

- 1.1. Project title: IPAC – DX geothermal system with CO₂
- 1.2. Project location : 1615, Lionel-Boulet, Varennes (Qc) J3X 1S6
- 1.3. Main NRCan Project Officer (Technical Authority) : [\(To be completed at contract award\)](#)

2. SCOPE OF WORK

Installation of a 5 direct expansion boreholes geothermal field, as illustrated in the civil engineering drawings, and in accordance with the instructions in sections 6, 7, 8 and 9, including, but not limited to:

- 2.1. Trenches excavation
- 2.2. Drilling of the borefield;
- 2.3. Supply and installation in the boreholes, of U-tubes in stainless steel, including elbows and U fittings;
- 2.4. Extension of the U-tubes, through the trenches, all the way to the mechanical room
 1. The tubes will be capped at the mechanical room level. The final connexion with the heat pump will be completed later by another contractor
- 2.5. Supply and injection of a pre-mixed grout with a thermal conductivity higher than 1W/m.K;
- 2.6. Pressure and vacuum testing ;
- 2.7. Backfilling and compaction of the trenches;
- 2.8. Obtaining from the competent authorities the necessary permits and authorizations to carry out the work.

Note : The works supervision will be performed by the technical authority. To be defined at the kick-off meeting.

3. APPLICABLE STANDARDS

The following list indicates the standards applicable to the project but is not limited to :

- 3.1. Standard ANSI/CSA/IGSHPA C448 SERIES-16, *Design and installation of ground source heat pump systems for commercial and residential buildings.*
- 3.2. CSA B52-05(R2009), B52 Package, Mechanical Refrigeration Code.
- 3.3. ASME B31.5-10, Refrigeration Piping and Heat Transfer Components.
- 3.4. ASME B36.19 Stainless Steel Pipe.
- 3.5. ASME B31.3, Process Piping, Chapter IX High Pressure Piping (Chapter IX).
- 3.6. ASTM A269 / A269M - 15a, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- 3.7. ASTM A511 / A511M – 16, Standard Specification for Seamless Stainless Steel Mechanical Tubing and Hollow Bar
- 3.8. ANSI/ASME B31.1-2007, Power Piping.
- 3.9. ANSI/ASME B31.3-2006, Process Piping.
- 3.10. ANSI/ASME, Boiler and Pressure Vessel Code-2007 :
 1. BPVC 2007 Section I: Power Boilers.
 2. BPVC 2007 Section V: Non Destructive Examination.
 3. BPVC 2007 Section IX: Welding and Brazing Qualifications.
- 3.11. AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.



- 3.12. AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
- 3.13. AWS W1-2000, Welding Inspection Handbook.
- 3.14. CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- 3.15. CSA B51-03 (R2007), Boiler, Pressure Vessel and Pressure Piping Code.
- 3.16. CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
- 3.17. CSA W178.1-2008, Certification of Welding Inspection Organizations.
- 3.18. CSA W178.2-2008, Certification of Welding Inspectors.
- 3.19. Environment Quality Act
- 3.20. Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- 3.21. An Act Respecting Occupational Health and Safety, R.S.Q., c.S-2.1 (current edition) - Updated 2005.
- 3.22. Safety Code for the construction industry, S-2.1, r.4.
- 3.23. Canadian Standards Association (CSA).
- 3.24. Workplace Hazardous Materials Information System (WHMIS, SIMDUT)/ Health Canada
 1. Safety data sheets (SDSs)
 2. Material safety data sheets (MSDSs)

4. SHOP DRAWINGS

Submit the shop drawings for approval to Main NRCan Project Officer (Technical Authority) for all materials, including the following elements: Material for the tubes, including welding method, backfill material, and insulation material.

5. MATERIALS

All materials must be compliant with the CSA C448 standard.

5.1. TUBING

1. High-quality, fully annealed (Type 304, 304/304L, 316, 316/316L) (seamless or welded and drawn) stainless steel hydraulic tubing, ASTM A269 and A213, or equivalent. Hardness not to exceed 90 HRB or 200 HV. Tubing to be free of scratches, suitable for bending and flaring.
2. Tubes of 1/2" OD wall thickness of 0.035";

5.2. TUBE SPACERS IN THE BOREHOLES

The spacers should not obstruct the grout injection pipe. The material of the spacers must offer resistance to galvanic corrosion or have a trim that offers that resistance.

5.3. TUBE SUPPORT IN THE TRENCHES

Rail mounted tube support system with trim. Collar in stainless steel 316 or better. Polypropylene based thermoplastic elastomer trim offering resistance to galvanic corrosion or better. Stainless steel 303 or better mounting rail. The system should have an operating temperature range of -40 °C to 120 °C or better.

5.4. GROUT

High conductivity sand and bentonite mixed grout: the thermal conductivity must be higher than 1 W/m.K (0.578 BTU/ hr. pi. °F). The thermal conductivity of the grout used must be demonstrated (recipe from the grout manufacturer, test certificate, etc.) and approved by the Main NRCan Project Officer (Technical



Authority)

5.5. INSULATION

Refer to the civil engineering drawings. 2 in. thick rigid insulation panels for underground use. Thermal resistance of R-10 and a resistance to compression of 60 PSI

- 5.6. SLEEVES: New material only and must meet either ASTM A-53 Grade B, ASTM A-589 Grade B or ASTM A-409 standard requirements.

5.7. BACKFILL MATERIEL

Refer to the civil engineering drawings.

6. EXECUTION

All work must be completed in accordance with the CSA C448 Standard.

6.1. Generalities

1. The location of the trenches and boreholes is shown in the civil engineering drawings
2. Note that an existing trench (Trench B) with 2 existing boreholes (F1 and F2) for a standing column well system have already been dug and backfilled. Trench B shall be redug down until the depth markers. The contractor will be responsible of any damage caused by the herein described work, on the existing trench and boreholes and will pay for any necessary repairs.
3. In each borehole, one (1) stainless steel U-tubes is installed as illustrated in figure 1
4. The boreholes configuration and piping arrangement are illustrated in figure 1 and in the civil engineering drawings.

6.2. Drilling

1. Drill 5 boreholes of 4 in. diameter, of a maximum effective depth of 300 feet (does not include the trench's depth) as illustrated in figure 1;
2. Plan for the underground water management in compliance with the provincial and municipal regulation in force; the water table level at the site can be found in a geotechnical report that is provided;
3. Soils and rocks extracted from boreholes must be disposed of in compliance with the provincial and municipal regulations in force.

6.3. Welds

1. Welds must be performed by an employee holding a high pressure welder qualification. The welder's competency card must be accepted by the Main NRCan Project Officer.
2. All welds must be done with socket fittings or using an orbital welding machine.
3. Tube preparation: The tubes must be properly prepared for welding. In particular, but not limited to, they must be free of scratches, deburred inside and out, and cut at right angles.

6.4. U-fittings (U-bend) for stainless steel tubes in the boreholes

1. The contractor can decide to bend the tubes on site (or in the factory) in order to have a continuous tube (without any joint) inside the borehole
2. Welds must be minimized in boreholes and trenches; In boreholes, one (1) welded joint is allowed at the junction with the U only (see figure 1);
3. Welds for stainless steel piping must prevent leaks and ensure long-term (25 years) corrosion resistance.



6.5. Tube spacers in the boreholes

1. Provide the spacers for the tubes and install them at every 10 ft over the entire length of the borehole. The spacers must maintain the tubes at a minimum distance of 2.25 in from each other. The spacers must be securely attached to the tubes so that they remain in place once the tubes are in the boreholes

6.6. Tube support in the trenches

1. Provide the pipe supports and install them every 3 m (10 ft.) on the entire length of horizontal piping at the bottom of the trenches.
2. Provide pipe supports and install them every 1 m (3 ft.) on the entire length of vertical piping.

6.7. Grout injection

The injection of the grout is done from the bottom up.

6.8. Sleeves

Install steel sleeves in the boreholes in accordance with the Environment Quality Act

6.9. Excavation and trench details

1. Refer to the civil engineering drawings
2. The soil must be graded above the underground components and over a distance of 1 m around the system in a way that prevents water pooling and water runoff towards the components

6.10. Extension of the tubes to the mechanical room

1. The extension of the borehole tubes to the mechanical room is done with tubes of 1/2" OD (wall thickness of 0.035") installed in the trenches A, B and C as shown in the civil engineering drawings.
2. Horizontal tubing for the boreholes 3 and 4 is installed in trench C, as shown in the civil engineering drawings
3. Horizontal tubing for the boreholes 5, 6 and 7 is installed in trench A, as shown in the civil engineering drawings
4. The details for the installation of the horizontal tubing from the boreholes 3 to 7 in trench B, going to the mechanical room, are shown in the civil engineering drawings.
5. The tubes must be welded while welding must be minimized. All welds must be done with socket fittings or using an orbital welding machine
6. The tubes must come out of the ground at the edge of the mechanical room (as shown on the civil engineering drawings) and have a sufficient length to allow for the final connection to the heat pump
7. The final connections between the geothermal piping and the heat pump in the mechanical room will be done in another contract and is not part of this scope of work.

6.11. Pressure and vacuum testing

1. Perform pressure and vacuum tests in compliance with CSA C448 and B-52 standards on each U-tubes:
 1. All tubes must be capped with plastic caps during transport and during work. Caps should only be removed when absolutely necessary. The contractor must take all precautions to prevent the introduction of moisture and debris into the tubes.
 2. Grout injection: a preliminary leak test of 2 hours must be carried out before making the welds inaccessible. The test involves pressurizing each circuit to a 13,000 kPa gauge and then isolating the tubes from the pressure source. The tubes must keep the pressure for a period



of 2 hours. All piping can be tested at the same time. U-tubes in wells can be manufactured and tested at the factory. It is then not necessary to perform a 2 hour leak test before the grout is injected. In the case where the U-tubes in the wells do not have welds, the grout can be injected without performing a leak test.

3. Once the installation of the vertical tubes is completed, proceed with a triple vacuum test:

Note 1: The technical authority from NRCAN must be present at the beginning of this procedure

Note 2: A temporary manifold can be used in order to test all tubes at the same time.

- a) Evacuate the system three (3) times: Bring the vacuum pressure down to 14 Pa (100 microns) absolute and hold for twenty-four (24) hours, for purge of air, moisture and other contaminants. Use a two-stage vacuum pump filled with new oil. Oil must be changed regularly during the vacuum test. A digital pressure gauge must be used.
 - b) Break vacuum with dry nitrogen, then bring it up to 13000 kPa, and maintain for 2 hours. Add nitrogen as needed to correct pressure loss due to mechanical and thermal expansion. The test is completed once the pressure is kept constant for at least 24 hours.
 - c) Repair as needed and repeat tests.
 - d) After testing and repairing leaks, the system must be filled with dry nitrogen up to a pressure of 200 kPa, and the tubes and pipes must be sealed with service valves or welded/brazed caps.
 - e) Submit test results to Main NRCAN Project Officer (Technical Authority).
4. Backfilling of the trenches: Once the results are accepted, the final backfilling of the trenches can be done. The contractor is responsible for any additional work necessary to repair a leak identified after grouting and backfilling, and should take all possible care to deliver a clean, dry and leak free installation.

6.12. Pipes identification

1. Each pipe must be identified at the point where it exits the ground near the mechanical room to facilitate final connection with the heat pump.
2. The identification must include the borehole number and the direction of flow (supply or return).

6.13. Insulation

1. Rigid insulation with a thickness of 2 " must be installed according to the civil engineering drawings.

7. HEALTH AND SAFETY

7.1. Safety assessment

1. Perform site specific safety hazard assessment related to project.
2. The Contractor has to plan and organize the Works so as to favor the elimination at the source of the dangers or the collective protection and so reduce to the least the use of personal protective equipments.
3. An equipment, a tool or a means of protection which cannot be settled or used without compromising the Health and Safety of the workers, the public and the users / occupants of places is considered for being inadequate for the Work to be made.

7.2. Meetings

1. Schedule and administer Health and Safety meeting with Main NRCAN Project Officer (Technical Authority) prior the beginning of the Works, and insure its management.

7.3. General requirements

- Appropriate action planning at all stages of the project is required, and must be submitted to



the Main NRCan project officer (Technical Authority) for approval.

- Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work.
- The Main NRCan project officer (Technical Authority) must approve the Health and Safety Plan
- The contractor must apply the plan and continue to implement, maintain, and enforce plan until final demobilization from site. The Main NRCan project officer (Technical Authority) may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.
- The contractor shall clearly define the work zone and ensure its safety. The contractor will install steel fences of a minimum height of 1.75m with openings of a maximum of 16 cm. The work site must be entirely fenced and the access door must be locked when the contractor is not on site. Fences must be removed maximum 1 week after the work is completed.

7.4. Responsibility

1. Be responsible for health and safety of persons on site, safety of property on site or close to site, including, but not limited: the trees, the mechanical room (container), the parking surface, the buried cables and tubing, standpipe; and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
2. Contractor shall be the Principal Contractor as described in the Quebec Act Respecting Health and Safety code for the Construction for only their scope and areas of work as defined and described this project specification.
3. Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site- specific Health and Safety Plan.

7.5. Compliance requirements

Comply with R.S.Q., c. S-2.1, an Act respecting Health and Safety, and c. S-2.1, r.4 Safety Code for the Construction Industry.

7.6 Unforeseen hazards

- When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise the Main NRCan project officer (Technical Authority) verbally and in writing and follow procedures in accordance with Acts and Regulations of the Province of Quebec having jurisdiction and advise Main NRCan Project Officer (Technical Authority).

7.7. Posting of documents

1. Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of the Province of Quebec having jurisdiction, and in consultation with the main NRCan project officer
2. Take all the necessary measures to assure an effective communication of the information regarding health and regarding safety on the construction site. From their arrival to the construction site, all the workers must be informed about the peculiarities of the program of prevention, about their obligations and about their rights. The Entrepreneur has to insist on the right(law) of the workers to refuse to execute a work if they believe that this work can compromise their health, their safety, their physical integrity or those of the other persons present on the construction site. He has to keep on the construction site and update a register with the transmitted information and the signature of all the workers who received this information.
3. The information and the following documents must be posted in an easily accessible place for the workers:
 - Notice of Project of the construction site;
 - Identification of the project manager;
 - Corporate policy regarding SST;



- Program of specific prevention in the construction site;
- Emergency Plan;
- Identification sheets of all the controlled products used in the construction site;
- Reports of the meetings of the site committee of construction;
- Names of the representatives to the site committee of construction;
- Name of the first-aid workers;
- Reports of intervention and correction emitted by the CNESST.

7.8. Correction in case of non-compliance

1. Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by the main NRCan project officer
2. Provide the Main NRCan project officer (Technical Authority) with written report of action taken to correct noncompliance of health and safety issues identified.
3. the Main NRCan project officer (Technical Authority) may stop Work if non-compliance of health and safety regulations is not corrected.

7.9. Work stoppage

Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

7.10. COVID-19 related policy

The contractor must provide his policy in regards to COVID-19 for approval by the Main NRCan project officer (Technical Authority) at the kick-off meeting.

8. CONSTRUCTION WASTE MANAGEMENT FOLLOWING THE WORK

Criteria of waste management:

1. The Contractor makes a commitment to make a responsible management for waste of construction / demolition in all the stages of the works until their elimination.
2. The Contractor is responsible for taking into account criteria of the environmental protection, applicable laws in the way he is going to arrange waste.
3. The Contractor has to favor the actions of management of the residual materials according to the following order: the reduction to the source, the re-use, the recycling, the valuation and the elimination (3RV-E)
4. The Contractor has to make sure that the recyclable, recoverable materials, valuable and the waste of construction is sorted out well to the source and that they are forwarded to a sorting office of the residual materials shape and to use the burying as a last resort.
5. The Contractor makes sure to prevent the contamination of the scrap materials intended to be got back and recycled, according to the acceptance conditions of the appointed installations.
6. The Contractor makes any time sure to protect well the materials of the bad weather so that they do not become waste.
7. The transport by a verified carrier and the delivery of the not recoverable waste following the works towards an installation of authorized elimination stays the responsibility of the Contractor.
8. All the residual materials of construction which must be evacuated / eliminated



become property of the Contractor.

9. WORK SCHEDULE AND CONDITIONS - SITE PARTICULARITIES

- Meetings

A kick-off meeting will be planned by the main NRCAN project officer. Worksite meetings will be discussed during the kick-off meeting. The contractor shall provide meeting notes within 2 days following the meeting.

- Plans and specifications

Original plans and specifications and any modification request will be provided only to the contractor in PDF format.

- Work schedule and site and parking access

The working hours are Monday to Friday from 7:00AM to 3:30PM. The site is not accessible outside of these hours. The general contractor must always be present on site during work. No sub-contractor will be allowed on site without the presence of the general contractor.

All vehicle that are not on the construction site must be parked in the employee parking. The visitor parking must not be used.

The heavy machinery must be unloaded on the grassy area when possible. The grassy area is right next to the construction site and will be identified at the kick-off meeting. If necessary, heavy machinery will be unloaded in the parking, next to the grassy area.

- Energy

The contractor shall provide all energy source for the execution of the work.

- Hot work :

Information to be clarified at the kick-off meeting

- Delivery and storage of construction material

Reception of material must be done by the contractor during working hours. No delivery will be accepted by NRCAN. Materials must delivered and stored on the construction site.

9.7 Sanitary installations

A chemical sanitary installation must be provided and installed by the contractor. The contractor must remove the sanitary installation one (1) week after the work is completed.

9.8 Cigarette, alcohol et drugs

All drugs are strictly prohibited on NRCAN's property. Cigarette is allowed at 9m from the building.

9.9 Breaks

Breaks will be taken outside NRCAN's building. Picnic tables and other installations will not be accessible. Break site must be left clean and without any trash.

10. ADDITIONNAL DOCUMENTATION

- Geotechnical Report
- Civil Engineering Drawings

11. Drawing/plan:

- Figure 1:

