
Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 – Common Work Results for HVAC

1.2 REFERENCES

- .1 ASHRAE – American Society of Heating, Refrigerating and Air-conditioning Engineers.
- .2 ASTM D2683-04 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- .3 ASTM D3261-03 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- .4 Coalition canadienne de l'énergie géothermique.
- .5 CSA série C448, Conception et installation des systèmes d'énergie du sol.
- .6 IGSHPA – International Ground Source Heat Pump Association.

1.3 DOCUMENTS/ÉCHANTILLONS À SOUMETTRE POUR APPROBATION/INFORMATION

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures
- .2 Product Data
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Canada and member of the OIQ
 - .2 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .7 Manufacturers Reports
 - .1 Manufacturer's Field Reports: submit manufacturer's written reports

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heat exchangers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Where materials or products are specified by their trademark, consult the Instructions to Bidders document for the procedures to follow regarding the request for approval for materials or product replacement.
- .2 Extra Stock Materials:
 - .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide a list of extra stock materials recommended by each manufacturer, a list of suppliers where you can purchase them, and a list of special tools for adjusting, repairing and replacement of these parts and adding them to the operating and maintenance manual.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address
- .3 Storage and Handling
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat exchangers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PIPES, FITTINGS, AND ACCESSORIES FOR UNDERGROUND NETWORKS

- .1 Piping and fittings made of high density polyethylene (HDPE) resin PE 3408 or 3608, with 345564 or 345434 cell classification according to ASTM D3350, CSA B137.1 and CSA C448 standards, with stamps required by these standards.

Products that are marked as adequate for use with drinking water are prohibited (as to avoid confusion on construction site).

 - .1 Products must be compatible with heat transfer fluid.
- .2 Fusion sealed joints and fittings, according to ASTM D2657 and CSA C448 standards, and according to piping manufacturer requirements.
 - .1 Products intended to be fused together must be made with the same resin and

- have the same cell classification.
- .2 Accepted fusion methods are:
 - .1 Fusion fitting,
 - .2 Fusion butt-weld and
 - .3 Electrofusion
- .3 Threaded couplings between HDPE and indoor metal piping are prohibited.
- .4 Vertical network:
 - .1 Pipes and fittings class SDR11, schedule 160.
 - .2 Factory pre-assembled U sections, with sufficient length to be inserted to the bottom of wells, pressurized with air or nitrogen at a pressure of 10 psig or greater.
 - .3 Pipe separators to push tubes against borehole walls.
 - .1 Acceptable products: GBT Geoclip, Omega EZ-Snaps or or a replacement product approved by addendum in accordance with the Instructions to Bidders.

2.2 SEALING GROUT

- .1 High thermal conductivity grout, made of a mixture of silicate sand, water and bentonite, as specified by the grout manufacturer. Mixture ratio must be specified by the manufacturer in order to have the expected thermal conductivity.
- .2 Grout conductivity must be at least 1,73 W/mK (1,0 BTU/hr pi °F).
- .3 Grout permeability to water must be lower than 1×10^{-7} cm/s.

2.3 SEALING PELLETS

- .1 Preformed pellets compatible with grout material, of appropriate size for application.
- .2 High expansion capacity in contact with soft water, no heat of hydration, forming a flexible and half-solid seal. Water permeability of expanded pellets must be lower than 1×10^{-7} cm/s.
- .3 Use: by Engineer's authorization only, to seal a water vein harmful to grout injection.

2.4 LINING AND ACCESSORIES

- .1 Metal casing to install into well down to rock in order to seal against surface water infiltration and avoid overburdened rock slides.
- .2 Well covers provided with two cable grommet holes to bolt to liner

2.5 FLUIDE CALOPORTEUR / HEAT TRANSFER FLUID

- .1 Distilled (demineralized) water and anti-freeze solution, measured by volume, with application specific additives recommended by manufacturer (eg, corrosion inhibitor and biocide).
- .2 Make sure anti-freeze solution is premixed before injection into network

- .3 Flash point must not be less than 30 °C (86 °F).
- .4 No use of additives that are mutagenic, teratogenic, carcinogenic or that can bioaccumulate in humans or laboratory animals.
- .5 40% by volume solution of propylene glycol, freezing point of -22 °C (-8 °F).
 - .1 Acceptable products : Dow Chemical Dowfrost, Viessmann Tyfocor-HTL, Mangor or a replacement product approved by addendum in accordance with Instruction to Bidders.

Part 3 Execution

3.1 ON-SITE STORAGE OF PIPES AND FITTINGS

- .1 Pipes stored on site must be stored according to CSA B137.1 standard, tagged for intended use and provided with temporary plugs.
- .2 Pipe fittings stored on site must be tagged for intended use and stored in their original packaging or in airtight bags.

3.2 WELL DRILLING

- .1 Well drilling must be performed according to accredited and accepted method for the soil type, borehole diameter and depth to reach. Hydrostatic pressure of water table and water inflows can also be critical factors.
- .2 Depth to reach is calculated in relation with the rock level with a minimal 5 feet distance to absorb the sedimentation and partial screes.
- .3 The Contractor must proceed with depth measurement of the well before pipes installation and grout injection, in order to confirm the actual depth. He must submit a drilling record to the Engineer. A long-form report must be given after each week.
- .4 The Contractor must, at his expense, continue the drilling or add wells if the depth is not satisfactory to the Engineer
- .5 The Contractor must drill wells without deviation from the vertical.
- .6 The Contractor must verify with Info-Excavation (or other relevant authorities) if there are underground lines before to drill.
- .7 Collect and remove drilling mud and water to avoid accumulation and floods on owner's property. Do not throw waste on public neighboring land, except if an approval has been previously obtained and given to the Engineer
- .8 Install the required liner in the bore-hole. Adjust the liner at the level of horizontal connections or remove the liner when piping installation in the well and grout injection are done
- .9 At any time, trim the top of the liner to prevent damage on piping or use wells covers or other protection methods for pipes in the borehole, approved by the Engineer.

3.3 INSTALLATION OF UNDERGROUND PIPING - GENERAL

- .1 Install piping according to specifications in this section and CSA C448 standard
- .2 Prevent introduction of foreign matter into the unconnected openings.
- .3 Trim pipe ends and remove the slag and foreign matters prior to assembly
- .4 Fusion duration must be timed
- .5 Installation must be done using a minimum of joints
- .6 Each well must be connected separately to headers.
- .7 Threaded connections between HDPE piping and metal networks are prohibited. Use compression seals preferably
- .8 Provide a water seal around the piping wherever piping cross an exterior wall, a foundation wall or floor below ground level
- .9 Aboveground piping must be mounted, stabilized and sustained in order to allow movement due to thermal expansion, vibration and settlement. Protect against wear and mechanical shocks. Install away from door openings, panels and covers.
- .10 When piping is laid under pavement to enter the building, install piping under pavement in a sleeve.

3.4 INSTALLATION OF VERTICAL UNDERGROUND PIPING

- .1 Installation of piping in the boreholes must be performed only after having the written approval of borehole depth by the Engineer.
- .2 Before insertion into boreholes, tag every 3 m (10 ft) piping in order to know the actual installation depth of the U-loop
- .3 Install spring spacers every 3 m (10 ft) deep.
- .4 When a loop installation is completed, probe each pipe with a weight to be sure it is not crushed or deformed. Use a weight a little bit smaller diameter than the internal diameter of the pipes
- .5 Piping installation of the first borehole must be witnessed by the Engineer
- .6 Submit to the Engineer a report showing U-loops installation depth and probe results

3.5 HYDROSTATIC TRIALS

- .1 Perform hydrostatic trials conforming to C448 standard. Submit a test report to the Engineer
- .2 For each loop and test, the report must include following data in order to allow a true analysis of the results:
 - .1 Time of day, outside air temperature, sunlighting and barometric pressure.
 - .2 Test duration, time interval between each test and test results.
 - .3 Sketch of installation during test and position of measuring devices.
- .3 The Engineer must be informed of testing schedule in order to attend as needed

- .4 Proceed to tests 1) before insertion into boreholes, 2) during installation into boreholes, and 3) before grout injection:
 - .1 Fill the loop with water or heat transfer fluid and pressurize with air to 690 kPa (100 psig).
 - .2 Maintain constant pressure for at least 15 consecutive minutes before work. Pressurize several times if needed to prevent mechanical and thermal pipe expansion.
 - .3 Maintain constant pressure for at least one (1) hour after grout injection. Pressurize if needed.
- .5 Perform tests during horizontal strokes installation and before their backfilling (individually for each connection to ground drain, and for each connection to building drain).
 - .1 Fill the network with water or heat transfer fluid and pressurize with air to 690 kPa (100 psig).
 - .2 Maintain constant pressure for at least two (2) hours before work. Pressurize several times if needed to prevent mechanical and thermal pipe expansion. Meanwhile, inspect piping and look for any evidence of leakage.
 - .3 Maintain constant pressure for at least 12 hours after completion work without noticing pressure drop over 3%. Pressurize if needed.
- .6 Perform tests described in section 3.7.5 one more time after installation is done, flushing and final backfilling.
- .7 Take care to avoid distorting the results due to sun exposure or excessive temperature variations, and consider piping deformation.
- .8 In case of leakage, isolate the network, locate the leak and fix it immediately. Then repeat filling and draining work for this network

3.6 GROUT INJECTION

- .1 Borehole filling must be completely done with grout having a mixture viscosity suitable for pumping into the filling pipe (according to its diameter).
- .2 Injection must be performed by positive displacement pumping by using a hopper pipe which is going down into the borehole during vertical piping insertion. Grouting must be done after intensive liquid circulation in order to drain any obstruction.
- .3 Grouting must start at the bottom to facilitate the ejection of accumulated water in the borehole
- .4 Injection is done by two strokes. The first stroke must completely fill the borehole. The second stroke is done two (2) to four (4) hours later to fill from the top any grout settlement or subsidence
- .5 The grout is mixed on site, immediately before its injection
- .6 An analysis of injected grout characteristics must be done individually for each borehole by the grout manufacturer representative. A sample report must be sent to the Engineer.

- .7 When the grouting is done, make sure that two (2) sides of the U-tube are not crushed by using a plumb line with an immersion close to lower pipe diameter
- .8 Sealing pellets
 - .1 Use sealing pellets only with the approval of the Engineer.
 - .2 Sealing pellets are used to neutralize water veins encountered during drilling and which can affect the grout catch and injection.

3.7 FILLING AND FLUSHING

- .1 Remplir les circuits de façon à purger l'air et les débris à l'aide d'un système d'injection opérant en boucle fermée et permettant la circulation du fluide dans toutes les sections à purger.
 - .1 Purger à une vitesse de fluide d'au moins 0,6 m/sec (2 pi/sec) et jusqu'à 15 minutes après la fin de l'éjection de l'air et des débris. Le débit correspondant est tel qu'indiqué au tableau.
 - .2 S'assurer du débit utilisé à l'aide d'un débitmètre ou d'une autre mesure directe ou indirect acceptable.
 - .3 Isoler des sections les unes des autres au besoin pour réduire le débit de pompage requis.
- .2 Fill networks in order to flush air and debris using an injection closed loop system allowing the fluid circulation into every section to drain.
 - .1 Flush fluid with a minimum speed of 0,6 m/sec (2ft/sec) and until 15 minutes after the end of air and detritus injection. The associated flow is as shown in Table.
 - .2 Make sure the flow is suitable by using a flowmeter or any other direct or indirect acceptable measuring.
 - .3 Isolate sections from each other as needed to reduce the required pumping flow.

Class (series) and pipe diameter, mm (in)	Water flow, l/s (US gpm)
SDR 11 (series 160), 19 (¾)	0.3 (4)
SDR 11 (series 160), 25 (1)	0.4 (6)
SDR 11 (series 160), 32 (1¼)	0.6 (9)
SDR 11 (series 160), 38 (1½)	0.8 (12)
SDR 13.5 (series 125), 25 (1)	1.2 (19)
SDR 13.5 (series 125), 32 (1¼)	0.7 (10)
SDR 13.5 (series 125), 38 (1½)	0.9 (13)
SDR 13.5 (series 125), 50 (2)	1.3 (20)
SDR 17 (series 100), 50 (2)	1.4 (22)
SDR 17 (series 100), 75 (3)	3.0 (47)
SDR 17 (series 100), 100 (4)	4.9 (77)

- .3 Flush and fill piping separately for each loop, each group connected to the same header and independent from internal piping.
- .4 Use water for initial filling and specified heat transfer fluid for final filling.
- .5 During initial filling, it is prohibited to fill internal building network before draining of underground network is done to avoid clogging of exchangers, coils and equipment.
- .6 Provide the Engineer an inspection report of water-antifreeze mixture when final filling is done.

3.8 HYDRODYNAMIC TRIALS

- .1 Perform hydrodynamic trials according to specifications below. Provide the Engineer a tests report
- .2 During filling and draining, record the pressure drop and circulated flow for each step (each network, each drain and the entire network). Record fluid temperature.
- .3 When the final filling with water-antifreeze mixture is done, circulate the heat transfer fluid. Record the flow, the pressure drop and the fluid temperature.

3.9 IDENTIFICATION

- .1 Show on floor plan the position of each borehole and each horizontal strokes run. This work must be done by a qualified land surveyor.
- .2 Identify the work of this section in accordance to the Section 20 05 53. The identification must enable to associate buried section with each visible pipe segment in the thermal power plant or in the underground room (for example, by an identification code between pipes and plans of survey).

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.11 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat exchanger installation.

END OF SECTION