**PART 1 – GENERAL**

* 1. **SUMMARY**
1. Section Includes: Underground piping systems for heating, ventilating and air conditioning systems. Systems include, but are not limited to, the following:
	1. Chilled Water Piping System.
	2. Heating Hot Water Piping System.
	3. Condenser Water Piping System.
2. Related Requirements:
	1. Division 01: General Requirements.
	2. Section 23 0500: Common Work Results for HVAC.
	3. Section 23 0513: Basic HVAC Materials and Methods.
	4. Section 23 0553: HVAC Identification.
	5. Section 23 0700: Insulation for HVAC Piping.
	6. Section 23 2013: Above Ground HVAC Piping.
	7. Section 31 2323: Excavation and Fill for Utilities.
	8. **REFERENCES**
3. American Society of Testing and Materials (ASTM) International:
4. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
5. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
6. ASTM D1895 - Standard Test Methods for Apparent Density, Bulk Factor, and Pourability of Plastic Materials.
7. ASTM D2657 - Heat Fusion for Polypropylene Pipe & Fittings.
8. ASTM D2774-12 - Underground Installation of thermoplastic Pressure Piping.
9. ASTM F1290-19 - Electrofusion for Polypropylene Pipe & Fittings.
10. ASTM F1668-16 - Construction Procedures for Buried Plastic Pipe.
11. ASTM F2389 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems.
12. National Science Foundation (NSF) and American National Standards Institute (ANSI):
13. NSF/ANSI 14 – Plastic Piping System Components and Related Materials.
14. Canadian Standards Association (CSA):
15. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
	1. **DEFINITIONS**
16. ANSI: American National Standards Institute.
17. ASTM: American Society for Testing and Materials.
18. CSA: Canadian Standards Association.
19. IOR: Inspector of Record.
20. NSF: National Science Foundation.
21. OAR: OWNER's Authorized Representative.
22. PP: Polypropylene.
23. PP-RCT: Polypropylene Random Copolymer with modified crystallinity and Temperature resistance.
24. SDR: Standard Dimensions Ratio.
25. OWNER: Los Angeles Unified School District.
	1. **SUBMITTALS**
26. Provide submittals in accordance with Division 01, Sections 23 0500, and 23 0513.
27. Provide Shop Drawings with dimensioned piping layout and details of expansion loops, elbows, anchor points, building or manhole entry points and other pertinent information required to verify layout, intent and type of materials are in accordance with this Section. Prefabricated pipe units shall be dimensioned and numbered to fit actual Work with field verified conditions prior to start of factory fabrication.
28. The CONTRACTOR shall indicate location and depth of all installed fittings, in addition to the as-built drawing content required in accordance with Section 01 7700.
	1. **QUALITY ASSURANCE**
	2. Refer to Sections 23 0500 and 23 0513.
	3. The Pipe and fittings manufacturer’s representative shall provide the installing CONTRACTOR with on-site training and certification in the fusion welding methods, the operation of fusion machines, the proper handling of pipe and fittings on site, and the inspection of pipe and fittings for quality control.
	4. The CONTRACTOR shall provide the OAR with documentation of the Welders certifications.
	5. The CONTRACTOR shall inspect delivered pipe and fittings, shall ensure that piping and associated jacketing is not damaged and shall verify that pipe and fittings are properly stored. The CONTRACTOR shall repair and/or replace damaged materials.
	6. As part of the manufacturer’s on-site training and certification process, the Contractors preparation and installation of several field joints shall be observed and approved by the pipe manufacturer’s authorized representative and the IOR.
	7. Plastic piping material shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
	8. Only those fittings recommended by the manufacturer for use on their piping material shall be used and must comply with manufacturer’s specifications.
	9. Special engineered plastic piping material products shall be certified by NSF International as complying with NSF 14.
	10. **PRODUCT HANDLING**
	11. Comply with the requirements of Section 23 0513.
	12. Verify that materials delivered to the site are undamaged.
	13. Deliver piping in factory applied UV protective plastic bags. UV protective plastic bags end caps. End caps shall remain in place until piping is installed to prevent entrance of dirt, debris and moisture.
	14. Deliver fittings in plastic bags to prevent entrance of dirt, debris, and packaged in cartons to protect them from UV exposure.
	15. Handle and store materials on site in accordance to manufacturer recommendations.
	16. Protect stored piping from moisture and dirt by elevating above grade.
	17. **COORDINATION**
	18. Coordinate installation and related procedures with provisions of Section 23 0500.
	19. **WARRANTY**
29. Manufacturer shall warrant pipe and fitting to be free of defects in materials or manufacturing for a minimum period of ten years starting at substantial completion.
30. Warranty shall be in effect only upon submission by the contractor to the manufacturer valid pressure/leak test documentation indicating that the system was tested and passed the manufacturer’s pressure/leak test.
31. CONTRACTOR shall remedy defects due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of three years from substantial completion.
32. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.

**PART 2 – PRODUCTS**

* 1. **UNDERGROUND CHILLED WATER, CONDENSER WATER AND HEATING HOT WATER PIPE AND FITTINGS MATERIALS**
1. Pipes and Fittings shall be pre-insulated, pre-fabricated type, manufactured from a PP-RCT resin meeting the short-term properties and long-term strength requirements of ASTM F2389 or CSA B137.11. The pipes and fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
2. All pipes shall have a fiberglass reinforced PP-RCT core and with PP-RCT material on the inside and the outside of the pipe wall made in a single extrusion process resulting in a single homogenous pipe wall. All pipes shall comply with the rated pressure requirements of ASTM F2389 or CSA B137.11. All fittings shall be molded type fittings.
3. Approved Products for pipes and fittings:
	* + 1. Heating Hot Water pipes and fittings:
	1. PP-RCT, Blue Pipe Multi-layer Faser composite, SDR 7.4 manufactured by Aquatherm.
	2. PP-RCT, Asahitec Climatec, SDR 7.4 manufactured by Asahi-America.
	3. PP-RCT, Niron Clima, SDR 7.3 manufactured by Nupi-Americas.Equal products.
		* 1. Chilled Water and Condenser Water pipes and fittings:
4. PP-RCT, Blue Pipe Multi-layer Faser composite, SDR 11 manufactured by Aquatherm.
5. PP-RCT, Niron Clima, SDR 11 manufactured by Niron.
6. PP-RCT, Asahitec Climatec, SDR 11 manufactured by Asahi-America.
7. Equal products.
8. Insulation:
	* + 1. Pre-insulated Pipe and fittings: Pre-insulated pipe shall be a complete system of factory pre-insulated polypropylene PP-RCT piping for the specified service.
9. Insulation shall be polyurethane foam either spray applied or injected with one shot into the annular space between carrier pipe and jacket with a minimum thickness of one inch.
10. Insulation shall be rigid, 90-95% closed cell polyurethane with a 2.0 to 3.0 pounds per cubic foot density and coefficient of thermal conductivity (K- Factor) of 0.14 to 0.16 maximum and shall conform to ASTM C-591.
11. Jacketing material shall be extruded, black, high density polyethylene (HDPE), having a minimum wall thickness of 100 mils (0.1-inch) for jacket sizes less than or equal to 12”, and 125 mils (0.25-inch) for jacket sizes larger than 12” to 24”. Or a white UV protected Polypropylene (PP-R) jacket, having a minimum jacket wall thickness meeting schedule 40 pipe dimensions.
	* + 1. Granular Loose Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.
12. Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F and shall conform to ASTM C177.
13. Application Temperature Range: 35 to 800 deg F.
14. Dry Density: 40 to 42 lb/cu. ft. and shall conform to ASTM D1895.
15. Strength: 12,000 lb/sq. ft.
16. Manufacturer: Gilsulate International, Inc.
17. Flanged joints shall be used at the transition from the underground pipe to the aboveground metallic piping as required.
18. Verify expansion loop requirement with piping manufacturer. Provide aboveground expansion loops prior to flanged transitioning of the underground Heating Hot Water PP-CRT to the aboveground piping as required by PP-RCT piping manufacturer.
19. Thrust Blocks: Suitably sized concrete thrust blocks shall be installed at changes in direction, both vertical and horizontal, changes in pipe size, dead ends, and valves.
20. Valves: Refer to Section 23 0513: Basic HVAC Materials and Methods. Provide valve stem extension and valve boxes.

**PART 3 – EXECUTION**

* 1. **INSTALLATION - GENERAL**
1. Refer to Section 23 0513: Basic HVAC Materials and Methods.
2. Refer to Section 23 2013: HVAC Piping.
3. Refer to Section 31 2323: Excavation and Fill for Utilities.
4. Only trained and certified installers can assemble PP-RCT pipe and fittings. Install in accordance with manufacturer's assembly and installation instructions.
5. Preparation and installation of all field joints shall be observed and approved by the IOR.
6. The CONTRACTOR shall routinely monitor that handling, storage and installation practices are being performed in accordance with manufacturer's recommendations
7. Buried PP-RCT piping shall be fully bedded on sand, with a minimum 6‑inch‑deep layer on the leveled trench bottom, allowing for the necessary depth for couplings to maintain contact of the pipe on the sand for its entire length. Sand and gravel containing a significant proportion of silt and clay shall be compacted by hand, by mechanical tamper. Provide a 12” or larger thermal barrier between heating hot and chilled water piping or provide a minimum distance of 3 times the pipe diameters between the heating hot and chilled water piping. Underground installations shall conform to ASTM D2774-12 and ASTM F1668-16 for Buried Installation of Plastic Pressure Pipe, Section 312300 of this specification, and shall comply with the piping manufacturer’s installation instructions.
8. Inspections and Tests:
	1. Welding Inspection: In accordance with Section 23 0513.
	2. Pressure Testing: In accordance with Section 23 0513 and following:
9. While still accessible all piping shall be pressure/leak tested to the manufacturer’s standards.
10. Hydrostatic pressure test at 200 psi or 1.5 times the design pressure whichever is greater, and for an air test shall be 200 psi or 1.1 times the design pressure whichever is greater. Maintain test pressure for at least 48 hours, observed by the Project Inspector, to prove tightness without leaks. Tests shall be carried out using water, or a mixture of compressed air and water. The test pressure shall be as indicated in the pressure leak testing procedures required by the manufacturer.
11. Any leaks or defects detected shall be repaired at the contractor’s expense by removing the leaking part and replacing with new parts welded per the pipe manufacturer’s installation and repair guidelines.
	1. Video Recording of Underground Installation:
12. Prior to backfill, the CONTRACTOR shall video record the entire extent of the underground piping installation. The video recording shall also note depths, and locations of fittings.
13. The video recording shall be developed on a 12 cm, DVD disk, or Flash Drive. Provide three copies of the recording to the Project Inspector for approval by the ARHITECT, prior to backfill.
14. Provide one copy of the recording within the underground piping “as-built” drawing submittal package.
	1. **INSTALLATION**
		1. Piping applications:
			1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination layout drawings.
			2. Installers shall be trained and certified by the manufacturer or the manufacturer’s representative to install the pipe according to the manufacturer’s guidelines.
			3. Installation shall be accomplished with the proper tools for installing piping following manufacturer’s instructions.
			4. Install underground piping level and plumb.
		2. Fusion welding of joints:
			1. Install fittings and joints using butt-fusion, socket fusion, or electrofusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer’s specifications, product standards, ASTM F1290, and ASTM D2657 standards.
			2. Use electrofusion for repairs of existing piping only or when other fusion methods are not practical.
			3. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
			4. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389, ASTM F1290, ASTM D2657, and the pipe and fitting manufacturer’s specifications.
			5. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer’s specifications.
		3. Tracer wire pipe locator:
			1. An electrically conductive wire shall be installed with the piping to facilitate locating it with an electronic pipe locator as specified in Section 23 0553 HVAC Identification.
	2. **CLEANING AND INSPECTION**
		1. Clean water distribution piping following procedures of the manufacturer. Pipe systems shall be flushed with cold water after finishing the installation. Flush the system until the water runs clear of debris and dirt.
		2. Inspect and test piping systems following procedures of the IOR and as specified by the piping system manufacturer. See paragraph 3.01 G of this specification section.
	3. **CLEANUP**
		1. Remove rubbish, debris and waste materials and legally dispose off the Project site.
	4. **PROTECTION**
		1. Protect the Work of this Section until Substantial Completion.

END OF SECTION