ASHRAE TECHNOLOGY AWARDS APPLICATION FORM (Page 1)

APPLICATION MUST BE COMPLETE TO BE CONSIDERED FOR JUDGING

(Required for Society-Level Competition)

28

(For ASHRAE Staff Use Only)

I. Identification (0 Points)

Name of building or project: [redacted] Ice Arena Addition and Renovation

II. Category (Check one and indicate New or Existing, if applicable)

- ○ Commercial Buildings — ○ New or ○ Existing
- Institutional Buildings:
  - ○ Educational Facilities — ○ New or ○ Existing
  - ○ Other Institutional — ○ New or ○ Existing
- ○ Health Care Facilities — ○ New or ○ Existing
- ○ Industrial Facilities or Processes — ○ New or ○ Existing
- ◉ Public Assembly — ○ New or ◉ Existing
- ○ Residential (Single and Multi-Family) — ○ New or ○ Existing

III. Project Description (0 Points)

1. Type of building or process: Ice Arena including ice refrigeration system.
2. Size – gross floor area of building (ft. sq. or m. sq.): 28,000 ft. sq.
3. Function of major areas (such as offices, retail, food services, laboratories, guest/patient rooms, laundry, operating rooms, warehouse/storage, computer rooms, parking, manufacturing, process, etc., or industrial process description:

   Recreational indoor ice arena that hosts public skating and competitive events.

4. Project study period: 03/2011 (Begin date (mm/yyyy)) to 09/2012 (End date (mm/yyyy))
5. Project Occupancy and Operation Period: 09/2012 (Begin date (mm/yyyy)) to 03/2014 (End date (mm/yyyy))

Introduction

The [redacted] ce Arena is owned and operated by the [redacted] The arena provides opportunities for indoor skating on a year round basis. Throughout the year, the rink hosts hockey practices, adult hockey leagues, figure skating, youth hockey practice, special skating events and seasonal celebrations. The Ice Arena is home to the School District of [redacted] High School Hockey program and the [redacted] of the North American Hockey League.

The project included the renovation of the existing 26,000 square foot Ice Arena with the addition of 2,000 square feet that included new locker rooms, an ice resurfacing melt pit and resurfacing equipment storage area. The administration area including offices, skate rental and warming areas were not directly a part of this project. The arena has a seating area with a capacity of approximately 1,200 people.

Figure 1: Installation of Ice Slab Chilled Glycol Water Piping.

The net 26,000 square foot ice arena includes one 200 foot by 85 foot regulation ice sheet. The original ice refrigeration system was installed in 1964 and was a direct refrigeration system that used R-22 refrigerant circulated in piping imbedded in the rink floor. The existing system was at the end of its useful life and was in need of replacement to reduce the overall operating cost of the ice arena. The replacement of the ice system included the removal of the original concrete cold slab, refrigerant piping system, chiller, cooling tower and water treatment systems.

The building renovations included the installation of a new ice sheet, re-roofing of the entire facility, re-lighting of the ice sheet, and the replacement of hollow metal doors. New system improvements include a new pond loop geothermal refrigeration system *(Appendix A, B, and C),* new hot water heating system and the installation of a new fire protection system for the existing building.

Energy Efficiency

The new ice refrigeration system incorporates a pond loop geothermal system to handle the high refrigeration needs of the arena. The system uses the [redacted] owned [redacted] Pond, located adjacent to the building, as thermal storage to pull and reject heat to the ice sheet refrigeration system. The ice refrigeration system is made up of three water source heat pumps with a cooling capacity of 50 tons each. The pond is utilized as a renewable energy source through the combining of a series of HDPE pipe loops that are sunk to the bottom of the pond approximately 18 feet deep. The water source heat pumps supply 30% glycol solution at 17 ºF to the ice rink. The heat pumps are designed to operate with a cooling efficiency of approximately 11.0 energy efficiency ratio (EER) and a heating efficiency coefficient of performance between 3.4 and 3.8. The geothermal source side of the system maintains an average temperature of 70ºF at peak summer loads. A more traditional ammonia ice plant reciprocating compressor will operate with a coefficient of performance in the range of 1.2 to 1.6.

Figure 2: Water Source Heat Pumps.

The system was designed to reclaim as much heat from the water source heat pumps and use it to heat water for the ice sheet underfloor heating system, the snow melt pit, and the ice resurfacing water preheat system (Appendix A, B and C). The underfloor heating system distributes tempered water to a bed of sand located beneath the concrete ice slab and keeps the subfloor above freezing (34 ºF to 38 ºF) to prevent the ice slab from cracking or upheaving. A snow melt pit was added to the arena to allow the ice resurfacing equipment a place to unload ice without having to drive outside the facility and exposing the arena to ambient conditions. The snow melt pit is equipped with radiant piping located in the walls and floors of the pit. The snow melt pit is designed to maintain a sump temperature range of 42 ºF to 45 ºF and be capable of melting a full ice resurfacing load within one hour.

The existing building hot water heating system was redesigned with a low temperature, condensing hot water boiler designed to provide 120 ºF heating hot water to the office areas and to provide auxiliary heat to the locker rooms. The new low temperature system is designed to operate with return water temperatures between 90 ºF F and 100 ºF, and will operate with a combustion efficiency of approximately 94% where the previous cast iron boilers were operating with a total thermal efficiency closer to 75%. The new and existing locker rooms were retrofitted with a new energy recovery ventilator to supply the code mandated ventilation air to the locker rooms. The energy recovery ventilator is equipped with a total energy recovery wheel that preconditions the ventilation air prior to heating or cooling the airstream. The energy wheel operates with an effectiveness of 0.65, with a capacity of 72 MBtu in design summer conditions (89 ºF DB, 77 ºF WB) and 115 Mbtu in design winter conditions (-10 ºF DB). The energy recovered from the wheel reduces the load on the gas fired heat exchanger and the DX cooling unit of the rooftop unit serving the locker rooms.

Table 1: Energy Usage Comparison

Energy Usage Summary:		
Year	**Natural Gas Usage (Therms)**	**Electrical Energy Usage (kWh)**
2010	37,251	696,000
2013	24,784	734,600
Change (%)	33.5%	-5.5%

The upgrades and improvements to the building energy systems resulted in an annual natural gas energy savings of 33.5% from 2010 to 2013 (Refer to Table 1). The electrical energy usage increased by 5.5% from 2010 to 2013. The increased electrical usage is from two sources. The first source is the 2,000 square foot addition to the arena and the subsequent lighting, and air conditioning cost that is directly related to the locker rooms in the addition. The second source of electrical energy usage was the increased lighting to the ice sheet required by the [redacted] and the NAHL. The new lighting over the ice sheet increased the installed wattage by 13,550 watts or 47,425 kWh based on 3,500 average annual operating hours. The overall facility energy usage intensity (EUI) was reduced from 234.6 kbtu/ft2/yr in 2010 to 178 kbtu/ft2/yr in 2013; a reduction of 24.1%.

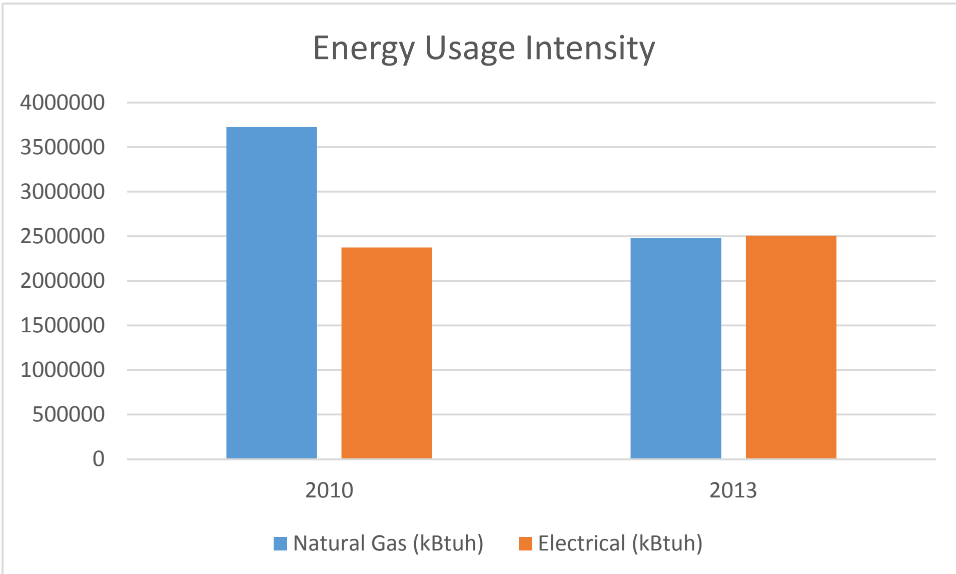


Chart 1: Energy Usage Intensity Comparison.

Indoor Air Quality and Thermal Comfort

The indoor air quality of the existing and new locker rooms was improved through the implementation of a new packaged rooftop energy recovery unit (ERV). The ERV provides 0.5 cubic feet per minute (CFM) of fresh air along with an equal amount of exhaust, meeting the ASHRAE 62.1-2007 standard for minimum exhaust rates. The ERV is equipped with a mechanical dehumidification cycle that allows the unit to control space humidity levels, and increase occupant comfort in the locker rooms. The ventilation for the existing offices, auxiliary spaces and the rink area were not modified under this project.

The new pond loop geothermal system eliminates the need for water treatment chemicals at the facility needed for a cooling tower of a conventional ice rink refrigeration system. The removal of the chemical treatment reduces the potential of fumes in the building and eliminates the exhaust systems required for providing adequate ventilation.

Innovation

The concept of using a pond loop geothermal system with a water source heat pump is a common application in North America. The use of a pond loop geothermal system as it relates to an ice sheet refrigeration system is more unique as the system takes advantage of the ponds ability to maintain relatively constant temperatures. The geothermal system is a highly efficient renewable energy technology that uses the energy stored in the pond for both heating and cooling. The uniqueness of using a geothermal system as an ice plant refrigeration system is that the system will reject heat to the pond throughout the year, and depends on the large mass of the pond to dissipate that heat to the atmosphere. The system design eliminates the risk of developing an imbalance in temperatures that could arise in a traditional vertical or horizontal bore field. The imbalance in loads requires that traditional vertical and horizontal geothermal bore field systems be oversized to handle the capacity of the ice plant system and makes it uneconomical to install. The [redacted] Pond is a 12 acre lake with a consistent depth of 15 feet. The large volume of the pond diminishes the impact of the rejected heat from the water source heat pumps and allows for constant condenser water temperatures. The primary benefits of the geothermal system include: Reduction of natural gas usage and emissions, lower annual energy usage costs, lower annual maintenance costs compared to a traditional ammonia refrigeration plant, and improved system life expectancy.

Figure 3: Installation of Pond Loop Condenser Water Piping.

The condenser water system is designed to use heat rejected from the heat pumps and transfer that energy to other systems such as Zamboni water preheat, ice melt pit and under slab heating systems.

The snow melt pit consists of 8" concrete walls with 1,300 feet of 3/4" hot water piping spaced 6" on center in both pit walls and floor slab. The pit uses the heat rejected off the heat pumps to provide hot water that flows through the continuous loop of high density polyethylene pipe, heating the concrete walls and floor of the pit. This system will melt a full resurfacing equipment load of ice within 1 hour.

Operation and Maintenance

The use of a geothermal system reduces the overall operating cost of a traditional ice plant by eliminating the need for an evaporative cooling tower. A traditional cooling tower requires the use of a significant amount of water to condition the condenser loop of the refrigeration system. Water treatment is also an important aspect of maintaining the cooling tower to prevent the formation of scale and bacteria growth. The cost of water and water treatment is reduced or eliminated with a pond loop geothermal system and the elimination of the cooling tower.

The system was designed to use a 30% glycol brine solution in lieu of a direct refrigerant system that was existing in the building. The indirect system reduces the amount of refrigerant in the system that will reduce the replacement cost and the potential for refrigerant leaks.

The water source heat pump utilizes scroll compressors typical to the HVAC industry and that can be serviced by local HVAC technicians already serving the building. The water source heat pumps eliminate the need for the [redacted] to enter into an additional contract with a local refrigeration contractor.

Cost Effectiveness

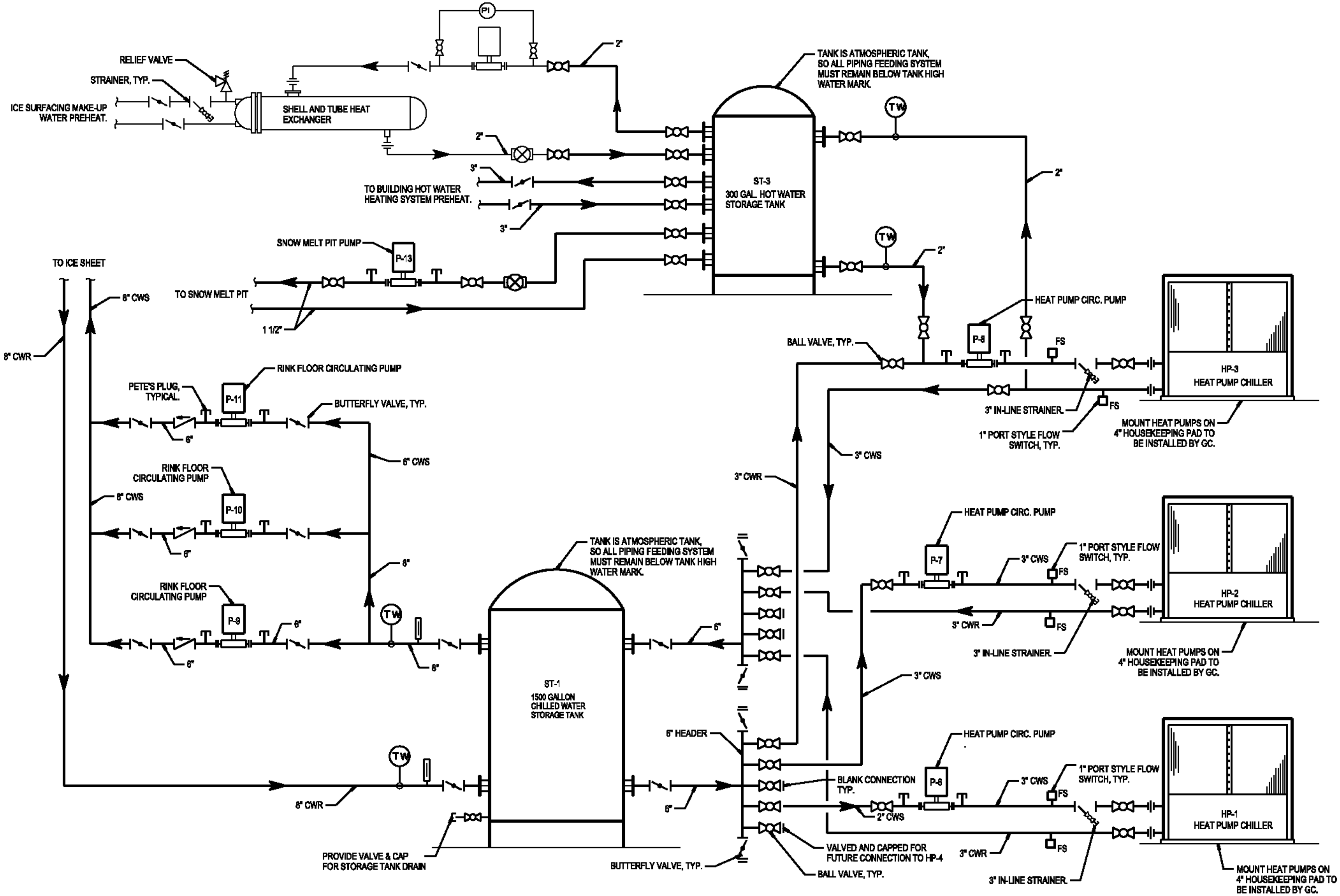
The implementation of the geothermal pond loop system cost the [redacted] an additional $119,100 upfront compared to a conventional ammonia ice refrigeration system at the time of bidding. The cost savings to the [redacted] was expected to be seen in yearly maintenance, annual energy usage and water usage savings. The total annual energy savings was calculated based on existing energy usage data and maintenance contracts and was estimated to be approximately $15,625. The resulting simple payback of the pond loop geothermal system is 7.6 years.

Environmental Impact:

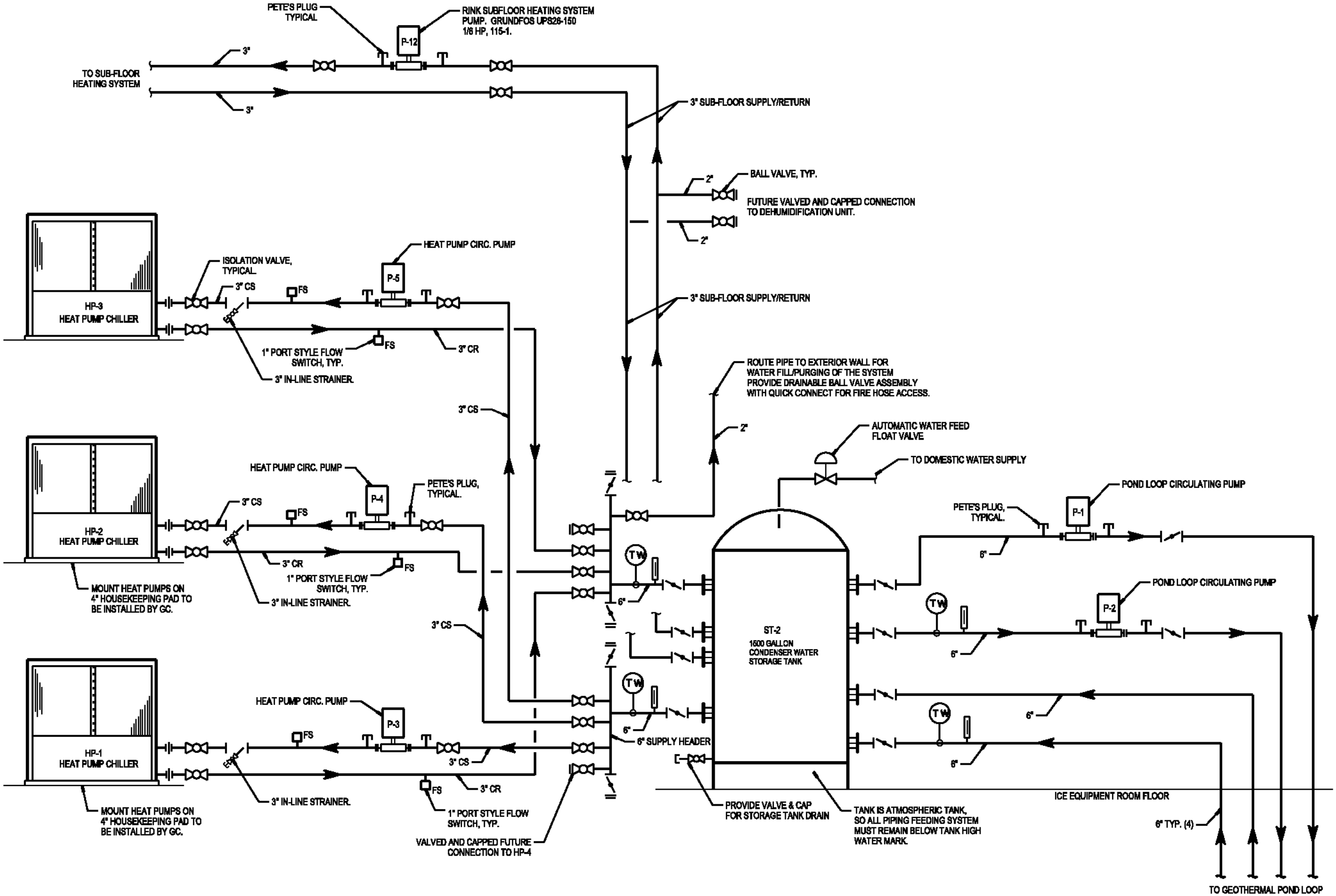
The water source heat pumps use R-410A refrigerant which does not contain bromine or chlorine and is considered a non-ozone depleting refrigerant. The geothermal heat pump system transfers energy to and from the pond without burning fossil fuels. The EPA recognizes geothermal heat exchange as an effective way of reducing carbon monoxide, carbon dioxide and other greenhouse gases. The original scope of the project was to replace the existing ice refrigeration system with an ammonia based refrigeration system. The use of ammonia is considered a high health hazard and requires a more advanced refrigerant monitoring system.

The geothermal heat pump systems ability to recover heat rejected from the ice making system reduces the heating load on the building hot water heating system and the domestic hot water heating system. The reduced load lowers the run time of the condensing boilers and reduces carbon emissions. The increased combustion efficiency of the new condensing boilers will also reduce the overall carbon emissions produced by the building hot water heating system.

The elimination of a cooling tower associated with a traditional refrigeration system eliminates the need for water treatment and eliminates or reduces the risk of chemicals being introduced to the environment, sanitary and storm water systems.



APPENDIX A - GEOTHERMAL SYSTEM - CHILLED GLYCOL WATER SCHEMATIC



APPENDIX B - GEOTHERMAL SYSTEM - CONDENSER WATER SCHEMATIC

Appendix C - Geothermal Pond Loop Ice Making System Layout