Title Page

Pine City Civic Center
Facility Evaluation
Pine City, MN
November 2013

HTG architects

Stevens

Gausman & Moore
Mechanical and Electrical Engineers

The Pine City Civic Center
Pine City, MN
FACILITY EVALUATION

HTG Project #131171 in conjunction with Stevens Engineers in Hudson, WI and Gausman & Moore in St. Paul, MN

HTG Architects
Eden Prairie, MN
November 2013

Pine City Civic Center looking northwest

Facility Evaluation

Pine City Civic Center
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Pine City, MN
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Pine City Civic Center
Pine City, MN
By HTG Architects
Eden Prairie, MN
September 2013

The following report was prepared by HTG Architects, in conjunction with Stevens Engineers (refrigeration engineers) Hudson, WI and Gausman and Moore Associates (mechanical and electrical engineers) St Paul, MN. The report is based on conversations with the arena staff and observations of the existing conditions found at the Pine City Civic Center located at 1225 Main Street in Pine City, MN. HTG Architects and their engineering partners were retained to tour the facility, review any existing documents and/or drawings. Then, in this written document, we have recorded our findings, comments and recommendations on items that could be done architecturally, mechanically, electrically and refrigeration wise that would be beneficial in assisting the facility to extend its existing ice skating season by at least one month on both ends of its current season. These recommendations are based the following events:

1. HTG's initial site tour and meeting with Ted Kraft and committee members on June 21, 2013.
2. Subsequent Visual tour of facility by Design Team Members and site meeting with Ted Kraft and committee members on September 13, 2013.
3. Conversations between team members and members of the arena committee between September 13, 2013 and the issue date of the report.

HTG Architects has completed a number of ice arena projects with Gausman Moore and Stevens Engineers, which is why they were invited to share their comments on the existing facility's systems. Our firms have a long history of working together on Ice Arena Development in the Central United States. The staff at HTG Architects has a combined experience of over 30+ years in the development and design of community based ice arenas. Gausman Moore Associates and Stevens Engineers were invited by HTG to join them on the Visual Tours of Pine City Civic Center for the specific purpose of preparing the following notes on systems renovations for the extension of the ice skating season.

By definition, "Visual Tour" means we did not dismantle, cut, drill holes, climb ladders to dismantle, walk across roofs, poke, prod or take any samples for future examinations. As noted, we did have access to some existing construction documents and met with the arenas staff and committee members to obtain information. Once we accumulated notes, photos and copies of documents from the tour and meetings we relied upon our arena experience from other opportunities of similar type construction, general conditions and similar age. Using those experiences, we came to our conclusions and recommendations herein. We point out that before you decide to go forward with any of this reports' recommendations you should contact both your local Fire Marshall and Building Inspector.

ARCHITECTURAL:

Existing Base Building Construction:

HTG's observations and research of existing construction documents, tours, and conversations with members of the arena committee, confirmed the arena base building is commonly referred to as a pre-engineered metal fabricated building. The structural steel frame is a rigid steel frame resting on spread concrete foundations. The integrated steel columns and roof beams are bolted together and support perpendicular steel "C" channels that support a metal roof decking. The insulation used throughout this type of building consists of 3 ½" batt insulation placed into thickened elongated plastic bags that are then form fitted between vertical steel "C" channels screwed into the main wall structure. The Ceiling spaces are insulated in a similar manner with form fitted bags of insulation placed between parallel steel "C" channel roof purlins supported by the rigid framed roof girders. During our tour, we observed the insulation in both the walls and the ceiling was showing its age by the numerous holes that have been punched through the plastic covering by errant hockey pucks. The puncture holes allow arena moisture to enter into the bags and this starts to compromise the insulations ability to function.

Existing Exterior Walls:

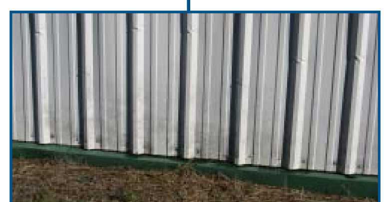
The exterior wall finish on this arena is sheets of factory painted galvanized metal panels. The wall panels are secured to the factory primed steel framework by screws with rubber grommets. The screws however transmit exterior cold and hot temperatures through their shanks into the frame work of the arena building. This type of temperature transfer causes moisture to condense on the screw shanks within the insulation causing the insulation to become wet. Over time wet insulation losses its insulation value and triggers the beginning of oxidation in the steel walls structure and the structural steel frames. At a certain point, wet batt insulation will start to lose its thermal capacity causing the refrigeration and dehumidification systems to work harder to maintain the ice sheet. When both of those systems start to work harder to maintain the atmospheres within the building, utility bills start to increase. We did not probe into the insulation with any electronic instruments for reading the moisture content, but we did simply insert our hands into some of the holes allowing us to feel the temp difference from the back side of the exterior metal paneling and the inside face of the steel structure. Moisture was felt in some places.

Ridge Frame buildings have no capacity to store cold energy; they merely stop the transfer of heat. It does create a thermal stop but the refrigeration system is constantly working to maintain the indoor temperatures until the outside temperature drops below the freezing temperature. At this point, the interior temperature is easier to maintain and the refrigeration system is more efficient. To extend the skating season into the warmer months, the refrigeration system will need to work longer and harder (costs rise) and the quality of ice could be compromised. Unless a practical way to insulate the building is used that can increase the "R" value in the wall/ceiling and reduce the moisture saturation factor.

Currently when the refrigeration system sensor(s) signal the compressors to stop, the temperature in this type of building will soon start to rise. When batt insulation starts to become saturated, the time line for the building to start to warm up will become shorter and shorter. Less time to heat up will cause the refrigeration system to cycle more often increasing the operational costs.


A.


B.


C.

Failure in this type of wall system can also be caused by other factors known as "catastrophic failure" of the protective metal skin. This can be seen in the south wall just west of the existing gas meter. (Refer to photo "A and B"). A concave fracture can also be seen, most likely caused by heavy snow cascading off the roof and stacking up against the wall. Further evidence of the theory is that the gas meter has had a shed roof added over it to protect it from the same snow. Referring to photo "C", one can start to see where the concaving effect of the snow has also started to create an opening at the base of the wall panel which allows moisture to seep in at the bottom of the wall. There are also horizontal cracks starting to show up in the metal siding at the screw locations in this concaved area. These cracks will start to show rust and deteriorate into larger holes that will subject the batt insulation to further moisture infiltration causing further loss in its insulation value.

To extend the skating season means the arena and its refrigeration system will need to maintain ice conditions when the outside temperatures in September can still be as high as the mid 70's low 80's. At which point the possibility of condensation with in the batt insulated walls and ceiling will become even greater.

Alternate Base Building Wall Insulation Systems:

Preparations needed to add new wall insulation:

We recommend the existing batt insulation system be removed in its entirety. Then an inspection of the metal wall panels inside face should be made for damage and rust. Replace those metal wall panels that have been badly damaged, remove minor rust from the remaining panels. Then recommend the panels with damage be sealed at the repaired panel areas per manufactures recommendations.

Wall Insulation Option One:

Consider filling the empty wall cavity with a minimum R value between R18 and R26 of a closed cell foamed insulation application. Foam insulation is impervious to water and should be checked to make sure the type used is "UV" resistant. The walls will still have no thermal storage capacity but will efficiently stop the thermal transfer of heat, moisture, and UV rays at the face of the outside wall. The interior surface of the insulated wall will need to be covered to protect it from forcible damage read further below.

Wall Coverings: If the spray insulation is selected for the walls on the project the spay foam insulation will not stand up to the hostel interior activities of flying hockey pucks, swinging hockey sticks, and just normal people picking at it. The following are suggested covering faces over the sprayed insulation.

Wall Covering Option One:
Lay up a 6" masonry block wall in front of the foam from the floor to the bottom of the roof beams.
Once you paint it you will have five elements currently lacking in the original structure.

1. Continuous wall of insulation isolating a majority of outside heat sources.
2. Masonry wall provides a source of thermal storage on the cold side of the wall.
3. Hard protective surface protects foamed insulation.
4. The addition of acoustical blocks into the block pattern wall will provide some acoustical control in the arena.
5. You have the option to add color and graphics to the inside of the arena.

Wall Covering Option Two:
Install ¾" sheets of exterior grade sheathing over the foam using existing metal purlins for attachment points sheathing then painted. Sheathing will add protection and some acoustical properties.

Wall Covering Option Three:
Install 1/1/2" Sheets of Tectum I* roof sheathing over the foam adding addition insulation value as well as protection and acoustical noise reduction. The Tectum would be connected to the existing metal purlins of the building shell. * Consult Tectum representative that the product will be used in an arena situation.

Wall Covering Option Four:
Sheets of perforated corrugated galvanized metal panels could be installed over foam connected to the existing metal purlins of the building shell. The perforated holes in the panels would provide some noise reduction.

Wall Covering Option Five:
Cover the foamed wall surface with a ½" x ½" expanded galvanized metal mesh attached to the existing metal purlins of the building for protection. The same time exposing the foam insulation in this protected manner that would provide additional sound attenuation.

All of these options can be bid out by the appropriate sub contractors with a simple Square Footage take off of product needed plus the labor to install.

Wall Insulation Option Two:

Once the batt insulation has been removed and the exterior metal wall panels repaired the cavity space could be filled with solid core insulated panels similar to the product manufactures by EPS Building systems www.epsbuildings.com. These foamed insulated panels are custom made to fit the cavity space in the wall and are protected on both faces with an exterior sheathing suitable for painting. The Panels are built with thermal broken connections to stop heat transfer.

Wall Insulation Option Three:

A number of prefabricated metal building manufacturers now offer an insulated metal panel product. These panels come in varying thickness depending on the R value required. Many large freezer buildings are made with these panels. Researching this product could provide a metal faced sandwiched rigid insulation panel that is detailed to provide a thermal broken continuous wall protected on both the inside and exterior side with a prefinished metal panel. Their connection devices use the same horizontal structure that supports the original metal siding currently on the building. Investigating this option with your local metal building representatives would be a possible solution that would perform as well as these others.

Existing Roof Insulation:

The roof insulation is the same batt insulation that is on the walls. There is no protective covering applied over the roof insulation that hangs over ice portion of the arena other than the plastic bag it came in. There are numerous holes poked though those plastic bags by errant hockey pucks exposing the batt insulation to humidity.

Roof insulation Option:

This report recommends the removal of the bagged insulation, inspect the metal roofing, replace damaged sheets and replace the insulation with the same type of foamed insulation recommended for the walls. Once in place, then cover the foam with a ½" x ½" expanded galvanized mesh. The foam decreases utility costs and by using the mesh for protects the foam adds much needed acoustical properties inside the arena. If the foam insulation used is UV resistant it has the properties to reflect the UV rays that penetrate the roof structure. If the spray insulation is not UV resistant then we recommend the following:

Ultra Violet Sun Ray Protection:

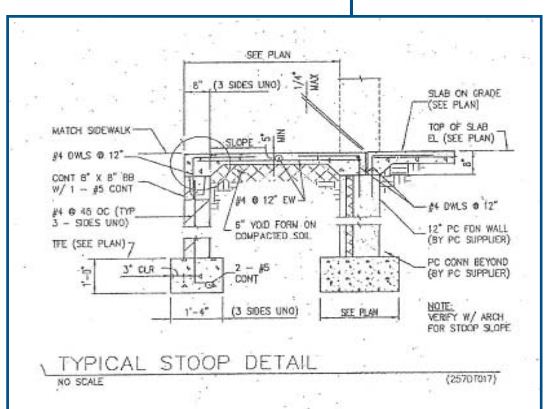
The UV rays from the sun will penetrate through this type of building's metal roofing and any insulation not UV resistant. The rays will strike the surface of the ice. Much like on humans who will get sun burned if not protected the hydrogen and oxygen molecules in the ice will get excited causing them to move and create heat. The sensor(s) in the ice floor monitor the raise in temperature and tell the compressors to turn on to keep the ice at a constant temperature.

To prevent this natural occurrence from happening if the spray foam is not "UV" resistant we recommend the introduction of a "low emissivity ceiling" product over the ice surface to reflect the UV rays back out through the roof. The addition of a "low e" ceiling in this building will have an obvious effect on the arena through the reduction of compressor run time. The ceiling may be hung down just below the existing fire sprinkler lines and above the existing lighting. Samples of "low e" ceiling were given to owner.

The fire protection sprinkler heads may need to be rotated to extend down through the "low e" ceiling material. We recommend you consult your local Fire Marshall about the installation of the ceiling and modifications that may need to be done to the existing fire sprinkler heads for above and below the low "e" ceiling. Contacting your local Fire Marshall is important in any case to discuss this process and address his comments and concerns.

Arena Exiting Door Landings:

Although not a contributing factor to the operations of the arena during our observation tours it came to our attention there are two sets of exit doors from the arena that open out onto grassed landings. The State Building Code requires all exit doors opening to the out side shall have concert landings supported by frost footing. There's no code requirement for sidewalks leading from the landing. Concrete landings are easier to maintain in the winter to insure that the exit doors will not be blocked by snow and Ice and that the landing do not heave from frost stopping the doors from opening in an emergency. We have provided a typical section detail through a landings construction. A pair of 3' exist doors require a landing approximately 8' x 5'.



Arena's Existing Lighting:

The lighting over the ice is being provided by the preferred fluorescent light fixtures. Refer to Gausman Moore's Electrical Section of this report.

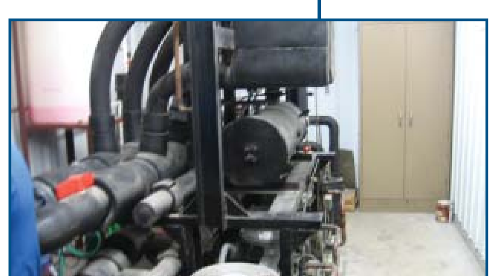
Arena's Existing Exhaust System:

The arena has an existing exhaust system in place. The operations of this system were discussed in length. Basically the arena has two larger operable intake lovers mounted high in the west wall of the arena. On the East wall of the arena equally mounted high in the wall are two small exhaust fans. The system is used during and immediately following the resurfacing of the ice. The exhaust fans are turned on the louvers open and unconditioned out side the air is drawn into the arena pulled across the arena and exhausted out the east side in an effort to dissipate the CO fumes from the fossil fueled resurfacer's exhaust. Refer to Gausman Moore's Mechanical Section of this report Section.

Arena's Existing Dehumidification System:

The arena has an existing gas fired desiccant dehumidification system in place. It is located on a concrete pad outside the back of the arena. Refer to Gausman Moore's Mechanical Section of this report Section. Our conversations on the site lead us to believe the value and the exact operations of the dehumidification system may not have been explained to the group by the company that originally installed the equipment. The design team discussed how important the dehumidification system will be in a successful extension of the season. Gausman and Moore volunteered to contract the equipment manufacture to make arrangements to have a factory trained representative come to Pine City and provide a training secession for the arena group.

Arena's Existing Refrigeration System/Refrigeration Room:



The arenas existing refrigeration system was explained as a modified system that is normally used to run a supermarkets freezers. Refer to Stevens Engineers' Refrigeration Section of this report. We understand it is a modified used piece of equipment when purchased with four compressors, only one of them new with a rating of 70-80 tons. The flow rates of the pumps are good, the units capacity is not sufficient however to maintain a longer season. The group confirmed this by saying they have tried several times to make ice in September only to get frost but that was it. A preliminary size of 90 tons was discussed.

Comments were made regarding the size of the current refrigeration room and it will most likely be large enough. However, the type of refrigerate selected to be used in any new or renovated refrigeration system may result in modification needed to the existing refrigeration rooms construction. As an example, should an ammonia base refrigerate be selected, the room will need to be renovated in the following manner to comply with current Codes:

1. The room's construction type will need to be confirmed as a 1 HR system and any modification needed will have to be included in any remodeling.
2. The door leading to the refrigeration room can not open onto any part of the arena unless it is part of a designed air lock vestibule. We recommend a new door be added that opens directly to the exterior and the current door be blocked up
3. A new isolated ventilation and alarm system will need to be designed and installed in the refrigeration room.
4. An eye wash sink will need to be added to the room improvements as well.

During the site visit we were informed a sub-soil heating pipe system was installed at the same time the original refrigeration system. It was however never hooked up because the arena's season was not intended at that time to extend in the warmer month. With the advent of an extended season the sub soil heating system will need to tested for leaks and then put into operation to prevent permafrost migration below the ice sheet. Additional floor space will be required in the facility for the sub floor heating pumps and reservoir tank for the glycol solution.

Arena Existing Refrigeration Concrete Floor System:

The ice was out during the tour of the facility. HTG's visual review of the existing refrigerated concrete floor showed it to be very good condition. Refer to Stevens Engineers' Refrigeration Section of this report. We observed that the headers are external of the ice sheet and are on both ends of the rink. They were placed in trenches with removable covers for maintenance purposes. Because the headers are not curved to match the radius of the ends on the rinks there are four areas on the arena floor outside of the boards that are refrigerated and can become dangerous if moisture is present in the building. Recommend that some type of raised platform be set over these to maintain a non slippery surface.

Existing Re-Surfacer Room:

The existing re-surfacer room is very narrow and short with a shallow open floor trench drain that, according to the staff members, is not used to dump snow. The re-surfacer is currently driven outside and the arena snow is dumped on grade. The re-surfacer is then driven back into the room where, we assume, the tires are washed down to keep pollutants off the ice surface. Washing down the tires adds humidity to the room. The re-surfacer room has two over head doors. One that opens on to the arena, the other opens to the exterior. We were informed that the exterior door is not opened during the season until the interior door is closed. Existing weather seals on the OH doors should be inspected and replaced as necessary and if there are no weather seals in place, they should be installed.

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We understand the current practice is to leave the exterior door open when dumping snow outside on grade. During the seasonal extension months this practice will allow the room to fill with humid air that will or could be transmitted directly out into the arena area when the interior door is opened. This will cause the warmer humid air to condense when it evacuates into the arena and possibly cause an icy condition on the adjacent floor and condensation on the end dasher board surface. This condition currently doesn't happen that often because within the current season, the outside air is cold and dry.

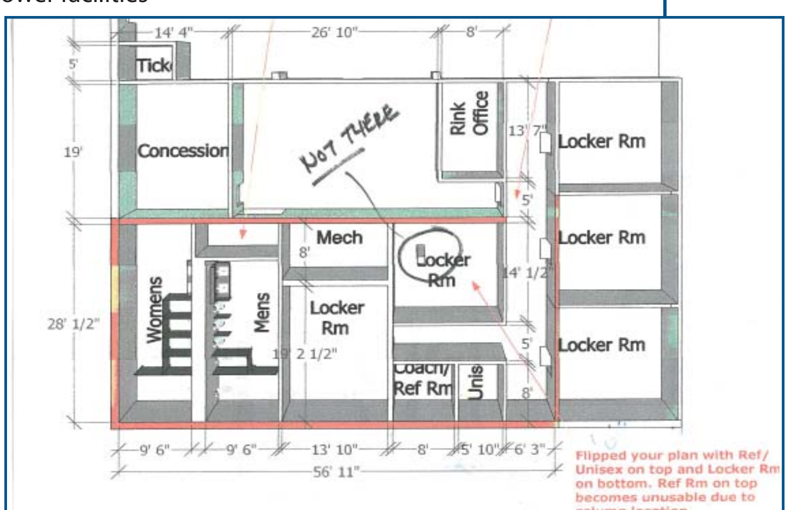
At the request of a committee member, attached to this report is a concept design option for the redesign of the existing Locker Rooms/Public Restrooms/Concession Areas. revision/addition to the resurfacer room adding a snow melt pit to eliminate the need to dump snow outdoors.

We have provided in this report a possible re-design option of the existing Locker Rooms/Public Restrooms/ Concession Area. The re-design option includes a proposed revision to the re-surfacer room which adds a snow melt pit eliminating the need to dump snow outdoors on grade. Should the refrigeration room require an enlargement/revision (Refer to Stevens Engineers report section) then a design could be done to accommodate for both areas.

Programmed Designed Space:

Although our proposal does not include final design drawings it does include time for us to provide a simple to scale hand drawn recommendation on how your non ice areas could be redesigned to be more efficient. We have included our thoughts for the existing concrete block building on how it could be better laid out to serve the arena. We note we were advised the column referenced on the PCCC Committee drawing does not exist. We also based our concept sketch on the following program statement: (see image on next page)

1. Four Team locker Rooms with two locked out restrooms.
2. One Referees Locker Room with toilet/shower facilities
3. One Janitor/Storage/Mechanical Room
4. One Arena Managers Office
5. Men and Women Public Restrooms
6. Warming Hut/Concessions
7. New Vestibule Entrance
8. New Ticket Stand
9. New Team Entrance



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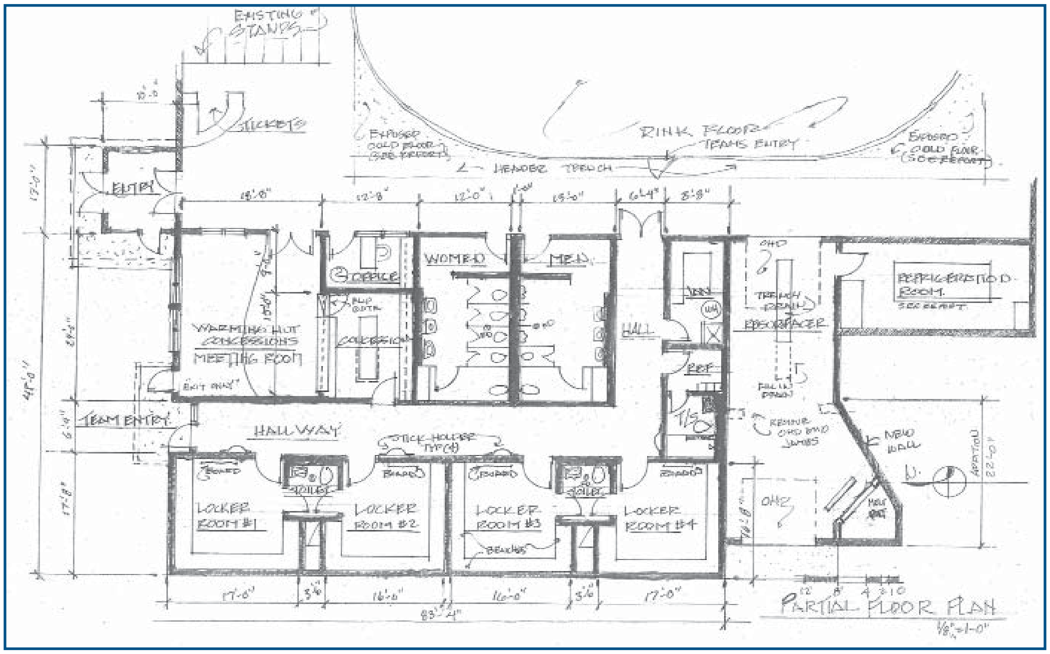

Construction Costs

Preliminary cost estimates for the suggested building renovation options to extend the skating will all come down to no new construction only cost per square foot plus labor to replace existing conditions. In our meetings with the committee members, it appeared to us there were sufficient construction trades represented who we believe would have direct access through their networks to obtain better material and labor costs than our office could. To that end, we have provided a cost estimate for your reference.

Preliminary SF cost estimates for modifications to the Existing Pine City Civic Center

The following estimated costs for modifications to the existing Pine City Civic Center are based on the following model:

A footprint of approximately 220' x 110' with an average wall height of 23' for a total wall area of approximately 12,000 SF and a total roof area of approximately 27,000 SF. These approximations are for the arena building only. These estimates include labor costs that can be reduced through in-kind donations.

Suggested remodeling to the locker rooms and re-surfacer room is a separate SF estimate.

Wall and Ceiling Insulation removal and disposal		$10,000/$15,000*
Wall Insulation Options:		
Based on estimate of 11,300 SF		
Option One: Closed Cell Spray Foam:		$22,600/$25,000*
1. 6" Concrete Block wall covering		$67,800/$70,000
2. ¾" Exterior Plywood covering		$24,000/$28,000
3. 1 ½" Tectum Panels covering		$55,000/$60,000
4. Perforated Corrugated Metal Panels covering		$28,000/$32,000
5. Expanded Metal Mesh covering		$20,000/$30,000
Option Two: Manufactured Wall System		not available without drawings
Option Three: Prefabricated Metal Wall Panels		not available without drawings
Roof Insulation: Closed Cell Spray Foam:		$52,000/$54,000*
Low E ceiling system (26,400 SF)	energie innovations inc.	$30,000/$35,000
Remodel to the locker room area and expansion of ice resurfacer room (approximately 4,200 SF)		
Demolition		$20,000/$25,000*
New construction		$350,000/375,000*

* Assumes in-kind labor and trades from Association Members

END

Pine City – Ice System Evaluation
10.9.13
Stevens Project No. 900.13.190

ICE SYSTEM:

General
Stevens' toured the facility along with the design team and operating staff of the facility on September 13, 2013 and has the following observations and comments. During our site visit there was no ice on the rink floor and the refrigeration system was not operating. No operating logs were available for review. The ice season currently operates between mid October to the first of March.

The Pine City Civic Center has a single ice sheet that is served by an indirect R-22 and glycol, refrigeration system. An indirect ice system uses two refrigerants or fluids. In this case, the primary refrigerant is R-22, which is only located inside the ice equipment room; and the secondary refrigerant is a solution of glycol which is circulated in the refrigeration system and in the ice rink floor. The glycol is used to remove the "heat" from the ice rink floor and transfer that "heat" or energy to the R-22 refrigerant. The R-22 refrigerant then releases the "heat" to the atmosphere allowing the refrigerant to cool down and start the process over. The reference to "indirect" comes from this secondary heat exchange between the R-22 refrigerant and the glycol.

Refrigeration System
The existing refrigeration system was constructed with "commercial grade" refrigeration equipment, similar of what is found in supermarket type applications. The equipment includes semi-hermetic compressors, a direct expansion chiller, air cooled condenser, pumps, etc. This type of system is commonly used in ice rink applications mainly because of its lower upfront costs. The main disadvantages of this type of system in comparison to an "industrial grade system" include; lower operating efficiency, shorter life span (15-20 years vs. 25-35 years for an industrial grade system), and limited performance. The system was installed in 2000 and nearing its expected life. The system is very well maintained and is currently in fair condition.

Compressors: The existing semi-hermetic compressors were manufactured by Copeland. There are a total of four (4) compressors. Three compressors are model 4DA3-2000-TSK 235, 20 HP and one model 4DR3-300E-TSK-800, 30 HP. One of the compressors was recently replaced but it was uncertain which one.

The total capacity of the compressor system is approximately 75-80 tons, determined by compressor manufacturer data. The typical required minimum capacity for a year round ice arena is 90 tons so the existing system is close to the required capacity. The performance of the refrigeration system is greatly dependant on the space conditions inside the ice arena. The facility generally operates on one to two compressors during normal winter operation and all four compressors during start-up through mid November.

For definition purposes one ton of refrigeration is equal to the daily delivery of one ton (2,000 lbs) of ice. Or, in more scientific terms, one ton of refrigeration is equal to the power required to cool 1oF for every 10 minutes or the power required to melt one short ton (2,000 lbs) of ice at 0oC in 24 hours. One ton equals 12,000 BTU/hour = approximately 3517 Watts.

Chiller: The chiller system consists of 3 plate and frame type units that were obtained used from a milk barn operation. Size and capacity of unit could not be determined. The chiller system plays a key role in the capacity of the refrigeration system. For example, even though the compressors have a capacity of approximately 75 tons, the chiller system may not be capable of providing that same capacity and, therefore, would be limiting the capacity of the overall system.

Rink Pump System: There is one circulation pump for the system. The system was not operating so the flow rate of the system could not be verified. The proper flow rate is important to maximize heat transfer in the rink floor and meet capacity demands for the refrigeration system. It is recommended that a second pump be installed for back up purposes.

Air Cooled Condenser System: The existing air cooled condenser units were purchased used and installed in 2000. They are reportedly in good working condition. There have been no history of problems with high head pressures, etc. The large unit is manufactured by Liebert in Deerborn, Ohio Model CST480CA, serial #96040402, 4 fans with 0.75 horsepower each. The smaller unit is the same manufacturer Model C12-2 or 5000-4, serial #LR49625, three fans, motor information was not legible.

Insulation Systems: The existing insulation systems on the refrigeration package and piping systems are constructed with flexible type (vs. rigid extruded Styrofoam) insulation and are in fair condition. This type of material is easily compromised and not very durable. There are some locations that should be repaired to maintain a completely sealed system. The condition of the piping systems could not be inspected without compromising the integrity of the insulation systems.

Waste Heat Recovery System: There are currently no systems that recover waste heat from the refrigeration system. Traditional uses for this heat include snow melt pit heating and subfloor system heating. The facility is currently dumping ice shavings from the resurfacing process outside. A refrigeration system like this can generate around 800,000 to 1,200,000 BTUs of waste heat from the refrigeration process. This heat is currently being wasted through the air cooled condenser.

In general, an ice arena facility can operate 6 to 8 months continuously before frost begins to build up in the soils beneath the ice rink floor. The length of safe operation is dependent on factors such as soil condition, ground water elevation, etc. It is recommended that if the facility extends its ice season beyond 6 months that a heat reclaim system be installed for serving the existing subfloor heating system that is currently located beneath the ice rink floor. The cost to add the subfloor heating equipment is approximately $15,000.

Refrigerant: The existing refrigeration system is using R-22 refrigerant. R-22 has been the most popular refrigerant used in ice rink applications in recent history. However, with the signing of the Montreal Protocol, the United States Environmental Protection Agency (EPA) implemented the final rule of Section 604 of the Clean Air Act in July 1992, limiting the production and consumption of a set of chemicals known to deplete the stratospheric ozone layer as measured by their ozone depleting potential (ODP). R-22, which also has a high global warming potential (GWP), is one of these targeted chemicals.

Regulations on R-22 started taking effect in 2010 and will continue to significantly reduce the allowances to produce and import R-22 through 2020 when production and importation in the U.S. will be halted all together. The U.S. EPA has proposed to significantly reduce allowances by 11-17% per year between 2012 and 2014.

In addition to the current regulations on refrigerants that affect the ozone, there is now pressure to consider phasing-out refrigerants that contribute to global warming, as measured by their global warming potential (GWP). This affects mainly hydrofluorocarbons (HFCs) like those used in blended refrigerants such as R-507A and R-404A. Europe has been on the leading edge of this change. The European Parliament passed legislation called the "F Gas Directive" that became effective in 2007, that requires very strict inspection of systems for leakage, rigorous record keeping, and mandatory training and certification on systems using HFCs.

Currently, the ice rink industry is caught in a transition period for refrigerants as new environmental regulations are implemented. Careful consideration and evaluation of the current refrigerant options should be made. The replacement refrigerants for HCFC refrigerants (i.e. R-22, etc.) are fairly new with a limited history and performance data in this application. The almost certain future regulations of HFC refrigerants (i.e. R-507, R407C, R404, etc.), which are used in many of the R-22 replacement refrigerants, should be considered.

Large global companies, such as Coca Cola, are leading the charge to ban HFCs and use natural refrigerants such as CO2, hydrocarbons and ammonia. Between 1999 and 2013, thirty two or more ice skating facilities in Europe have switched over to using CO2 based ice systems. The first CO2-based ice system in North America, and the first direct CO2-based system in the world, opened in 2011 in Quebec, Canada with at least six more opening by the fall of 2013.

The increasing environmental regulations are certainly impacting the price of R-22. As the industry experienced in March of 2012 when the price suddenly jumped overnight from $7 per pound to $13 per pound. The cost is currently $14 per pound but peaked at $22 per pound earlier this year. Replacement or "drop-in" refrigerants for R-22 are currently on the market and becoming more available at a cost of approximately $15 to $18 per pound. Ammonia and CO2 are currently $1.50 per pound.

Other factors such as location, efficiency, environment, system charge, composition (pure vs. blended refrigerants), and safety, should be considered when comparing primary refrigerants.

Reporting Refrigerant Leaks: There are requirements for governments, local authorities and facilities to report hazardous and toxic chemicals. For accidental releases of refrigerant a report must be filed under the Emergency Planning and Community Right-To-Know Act (EPCRA). For an ice system, the reporting trigger leak for CFC (e.g. R-12) or HCFC (e.g. R-22) type refrigerant is 35 percent annually. The Environmental Protection Agency, under the Clean Air Act (Section 608), also requires a report for the release of HCFC type refrigerants.

There are government regulations for repairing leaks in a refrigeration system. If during the course of a 12-month period, an appliance is leaking refrigerants beyond the trigger rate, the owner must take action to repair it. In general, the owner needs to make suitable repairs to the appliance within 30 days of finding out about the leak. Or, make plans to retrofit or retire the appliance within 30 days, and act on the plan within a year of the plan date.

It is recommended that plans for replacing the existing R-22 refrigerant be made. The cost to replace the existing refrigerant and make the necessary modifications to the compressors is estimated to be $10,000 to $15,000. There is a revised Mighty Ducks Bill moving through the Minnesota Legislature that will fund up to $50,000 for replacing R-22 refrigerant and up to $200,000 for replacing the entire system. The legislation failed by one vote in 2013. It will be up again for a vote in the spring of 2014.

Life Safety Systems: There did not appear to be a refrigerant leak detection system in the refrigeration room which is required by current code regulations. There was also no emergency stop device outside the refrigeration room door as required to stop the operation of the refrigeration system. The room does have mechanical type ventilation although it was unclear how the system was controlled. Estimated costs for life safety improvements range from $2,000 to $7,000.

Refrigeration System Replacement: The existing compressors have enough capacity to at minimum; extend the operating season several months. In particular if the existing building envelope and ceiling insulation are modified by one of the recommended options and the dehumidification system is modified or replaced. However, it was not possible to determine the capacity of the existing chiller system and, therefore, the total capacity of the system could not be determined. Observations and logging of temperatures and pressures during operation may provide additional information that could be used to more accurately determine the capacity of the system. It is not recommended that the existing system be expanded for additional capacity mainly due to the quality of and age of the existing equipment. At minimum, an expansion of the system would likely require replacing the chiller system and re-piping the system.

A new commercial grade refrigeration package is estimated to cost $200,000 installed. The existing room is limited in size (276 square feet) and may need to be expanded to accommodate a new system.

Ice Rink Floor
The existing concrete ice rink floor was installed in 2000. Drawings of the system were not available but the floor is reportedly standard NHL size of 200' x 85' and constructed with 5" of concrete, 1" polyethylene rink piping spaced at 4" on center clamped to PVC headers and return bends, reinforcement, 3" of rigid floor insulation and a subfloor heating system. The headers and return bends are exposed on each end of the rink floor for good access. The floor appears to be well constructed and could have a 25+ year life expectancy especially since the return bends and headers are exposed. The PVC pipe will likely fail earlier than the rest of the system. There are no reported ice quality or other problems with the rink floor.

Dasher Board System
The existing dasher board system is fairly new, manufactured and installed in 2005 by Becker Arena Products, and is in good shape. There are no recommendations for improvements or repairs to this system at this time.

Operation and Maintenance

The following are several recommendations that the facility may want to consider, if they are not being performed already, to assist with maintaining, monitoring, operating and troubleshooting the ice system.

• Maintain Daily Log Book: Daily observation and monitoring of the ice system is important in maintaining proper operation and in trouble shooting future problems. Maintaining a daily log of the system operational parameters is required. It is recommended that the mechanical refrigeration system be inspected a minimum of four (4) times per day while in operation. System readings may not be valid if no compressors are in operation. System monitoring requires a physical examination of the system's vital signs, and operating levels. Monitor the air temperature and relative humidity inside and outside the arena on a daily basis. All readings should be entered into the log book, each time a reading is taken.

The vital signs should be checked with previous log readings, and the system operating parameters for the proper operating range. All readings not meeting the proper operating range should be immediately investigated for cause.

• Calibrate Monitoring Devices. Calibrate temperature and pressure gauges annually to assist in monitoring and troubleshooting the system. Add gauges in the system where additional information is beneficial in monitoring and troubleshooting. Replace existing gauges that are not functioning properly.

• Monitor and Test Glycol Solution. Test and monitor glycol solution. The glycol solution is critical in protecting the ice system's steel and copper piping and equipment, therefore, extending the life of the systems.

• Monitor and Test R-22 Refrigerant: The refrigerant in the system should not require routine testing unless there are suspected problems with the system.

All test results and measurements should be compared to recommended values provided by the refrigerant suppliers, equipment manufacturers or system designers for the specific applications. A full understanding of the test results and measurements is necessary to correctly assess and evaluate the operation of the system.

• Closely Monitor Ice Thickness: The ice thickness on the rink floor was not verified. Maintaining an ice thickness between 1 inch and 1.5 inches will lead to fewer operating hours on the compressor packages, thus saving energy and maintenance. It will also provide a better surface and faster freezing times, leading to more control.

• Develop an Operation and Maintenance Manual. Develop an operation and maintenance manual for the ice system. Proper operation and maintenance will prolong the usefulness and maximize the efficiency of the ice system. It is recommended that an operation and maintenance manual be developed to assist the current and future staff of the facility in the safe operations and maintenance of the ice system. It will also assist in training new staff members on the operation of the system, monitoring the existing system, trouble shooting future problems, and planning and budgeting for repairs.

The manual should include the following:

• Narrative including: general system description; type of system; description of equipment; capacity of system; description of controls; start up and shut down procedures; recommended maintenance on the system; recommended testing program for the glycol solution with recommended standard parameters; and recommend operational procedures for the system including rink pump operation, emergency plan and contacts;
• Operations chart for logging daily system checks;
• Schematic drawing of brine system with valve numbering and description;
• Schematic drawing of refrigeration system piping with valve numbering and descriptions;

• Equipment information including: copies of all original shop drawings; parts lists for manufactured equipment; warranties; manufacturer's instructions for maintenance and operation for each piece of equipment; spare parts lists; manufacturer's wiring diagrams for electrically powered equipment; trouble shooting information;
• Test Records for brine; refrigerant and pressure tests on systems; and
• Certification of inspections by regulatory agencies.

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Gausman
&Moore
Mechanical and Electrical Engineers

Pine City Arena - Mechanical Evaluation

One key issue essential for extending arena operation earlier and later into the season is to effectively control the humidity within the arena. Moisture enters the arena in three primary ways – during the ice making and resurfacing process, from the occupants within the building, and from the moisture contained in the outdoor air. During most of the season, the outdoor air is dry enough to absorb the moisture from resurfacing and the occupants. During the warmer months, however, the outdoor air can contain a significant amount of moisture, and if the outdoor air dew point is above the temperature within the arena, this moisture will condense on the relatively cold inside surfaces unless the air is treated prior to entering the arena to lower its dew point.

Dehumidification System

There is an existing gas-fired desiccant dehumidification unit installed on grade on the west side of the arena. It is a Concepts and Designs, Incorporated (CDI) Model DH-130 which is capable of moving 3,000 cfm through the unit. It appears that there may be 3 modes of operation available based on the literature supplied – an unoccupied mode which circulates 3,000 cfm of the arena air through the dehumidifier and back to the arena, a low occupancy mode which brings in 600 cfm of outdoor air and recirculates 2,400 cfm from the arena, and an high ventilation indoor air quality (IAQ) mode which brings in 3,000 cfm of outdoor air with no recirculation. It appears that the unit operates by a humidistat located in the arena mounted on the west wall.

The dehumidifier contains a silica gel desiccant material, which is bonded to a slowly rotating wheel, which absorbs moisture like a sponge as the air passes over its surface. As the desiccant becomes saturated, the wheel rotates to the reactivation area where a gas-fired heater warms air which is then passed over the silica gel. The silica gel releases the moisture into the hot air stream and the wheel is then ready to repeat the cycle and rotates back into the supply air stream. The desiccant dehumidification process reduces moisture in the air stream and also warms the air temperature in this process, so operation of the dehumidification unit will also assist in raising the temperature in the arena.

It is the goal of the organization to extend the operation earlier and later in the year and have the ability to host skating or hockey events and tournaments which could occur during the extended season. The existing unit, however, is not capable of the ventilation and dehumidification required for an arena extending its operation earlier and later into the year and anticipating significant occupancy for games and possible tournament play. The unit's air flow capacity of 3,000 cfm of outdoor air in the high ventilation IAQ mode is below the code minimum level required for the ice surface, which is about 5,000 cfm. The unit also does not take into consideration the added ventilation required by the occupants within the space. It appears that the peak occupancy based on the available seating within the arena is about 700 occupants. Ventilation for peak occupancy requires an additional 5,400 cfm of outdoor air. Average occupancies can be considered because of the variability and short term peak occupancy duration typically encountered in arena operations. This results in a desiccant dehumidification unit in the 8,000 cfm range. The unit should also contain an integral exhaust fan to accommodate the relief/exhaust required when the unit is operating at maximum outdoor air ventilation. Variable frequency drives controlling fan speed would be utilized to allow a reduction in air flow when there is low occupancy and indoor air quality conditions permit. Low temperature desiccant dehumidification units also exist which work with the lower temperatures available from a heat pump refrigeration system, utilizing this energy to reactivate the desiccant wheel instead of using natural gas burner reactivation. These units are more complex and utilize additional piping and controls to achieve the energy savings.

The approximate budget cost for a gas-fired desiccant dehumidification unit in the 8,000 cfm ventilation air flow range is about $75,000. low temperature desiccant units have costs in the range of about $135,000. There would also be additional expense for new duct distribution to accommodate the additional air flow, as well as, installation and other electrical connection and control system costs.

Currently, it appears that carbon monoxide (CO) is monitored for maximum ventilation control on the existing dehumidifier. Carbon dioxide (CO2) can also be monitored as an indicator of indoor air quality based on the number of occupants in the arena, which can then control the new dehumidification unit to adjust fan speed and reduce the outdoor air flow, saving energy during operation. During the warmer extended season, most of the time the dehumidification unit can operate in an unoccupied mode cycling to maintain the arena humidity at the proper level. When the resurfacer is in operation and contaminants are being released, the dehumidification unit would be indexed to the ventilation level required to dilute and exhaust those contaminants. When occupied, the ventilation controls would adjust the outdoor ventilation as necessary to serve the level of occupancy within the space.

In the meantime, we would recommend that the manufacturer's representative and their service representative visit the arena and provide a training session to review the existing unit's operation with the arena operators to ensure that there is a complete understanding of the current available modes of operation and when each mode should be activated. They would also be able to review the condition of the unit and ensure that it is working properly. We can assist in contacting the representative if desired, although perhaps it would be most practical for the rep and the rink operators to coordinate the time and date of the visit and training. The manufacturer's representative for the CDI unit is:

Schwab-Vollhaber-Lubratt, 4600 Churchill Street, St. Paul, MN 55126
Tel: 651-481-8000 Fax: 651-481-8621

Consideration should be made to controlling the dehumidification unit using a dew point sensor instead of a humidistat. A dew point sensor more closely controls the moisture within the arena. A humidistat will allow the dew point to fluctuate as it controls to a particular relative humidity level. While the relative humidity may remain the same, the moisture level within the arena can rise and fall depending on the arena's temperature. This operation can also be reviewed with the manufacturer's representative.

Exhaust System

The existing arena exhaust system consists of two (2) propeller-type exhaust fans located high in the space at the east end of the arena. There was not any documentation available which indicates the exhaust air flow amount. These fans are manually operated during ice resurfacing by the rink operators. In conjunction with the operation of the exhaust fans, two (2) motorized outdoor air dampers installed high at the west end of the arena open and provide cross ventilation within the arena. Visually, these exhaust fans appear limited in air flow capacity and do not comply with the quantity required by current codes for ice surface and occupant ventilation as discussed earlier. However, the building operators indicate that these exhaust fans do maintain indoor air quality within the arena during the resurfacer operation based on routine CO monitoring of the indoor air.

Without regard to extending the operating season, we recommend that these fans be replaced with two fans sized to exhaust 5,000 cfm each. One fan can be operated when resurfacing the rink when there are no occupants, and both can be operated as necessary when there is resurfacing when occupied,. Fans with variable speed drive control can be manually adjusted depending on the level of occupancy or with electronic controls. Corresponding changes would have to be made at the outdoor air intakes on the west wall of the arena to accommodate the increased outdoor air amount.

Operation of the exhaust fans is necessary to remove contaminants generated by the resurfacer and for the occupants. However, operation of these exhaust fans is only appropriate during the current season of operation. During the typical season when the outdoor air dew point is low, it is appropriate to operate the exhaust fans to ventilate and dehumidify the arena, as the outdoor air entering the building through the motorized dampers in the west wall is low in humidity. Operation in the winter can ventilate and reduce the humidity being generated within the arena by ice resurfacing and the spectators. This method of ventilation can lead to comfort issues because of the cold air being drawn in during the winter. However, during early and late season arena operation, the humidity within the outdoor air is too high and the dew point is above the arena temperature. Introducing untreated outdoor air through the intake dampers in the west wall in the early and late extended season will cause moisture problems, increased refrigeration system load, and fog within the arena, as the cold surfaces and ice will condense the moisture out of the air. As discussed earlier, significant humidity exists in the outdoor air during the desired extended season of operation and the air should be treated by the desiccant dehumidification unit prior to entering the arena.

For consideration, a duct extension could be added to each intake location and turned down near the top of the glass. While historically the rink operators testing has indicated that the indoor air quality is being maintained at acceptable levels, introducing the outdoor air at a lower elevation may promote even greater cross ventilation within the space.

Also, we recommend that the resurfacer performance be regularly checked and tuned to minimize contaminants being introduced in the arena.

Envelope Penetrations: A tight building enclosure is a necessity for proper early and late extended season operation. It is critical that all penetrations be sealed. Even small openings can introduce moisture which can damage building materials and increase the energy use of the refrigeration system. There are two areas of concern noticed during our visual observation.

One area is the motorized outdoor air intake dampers. When standing in the arena, there were visible gaps in the damper blades even though the dampers were indexed to the fully closed position, and this is typical of both dampers. We recommend that these louvers be replaced with insulated dampers with gasket blade and edge seals so that the gaps are eliminated. The damper operators and linkage should be adjusted to make sure that the dampers are able to fully close. This condition may also exist at the exhaust fan discharge dampers, but this was not readily observable. If it does, the comment above applies at this location as well.

The other is the ice resurfacer entrance. Of first concern is the difficulty of maintaining a proper weather strip seal with these doors, especially the exterior door. In addition, there is no indoor pit for discharge of the ice shavings. The exterior garage door must be opened for an extended period of time to allow the resurfacer to leave the arena, discharge the shavings outside, and return. Even coordinating closing the interior garage door before the outer door is opened still can allow significant moisture to enter and condense on the cold surfaces within the resurfacer room. Also, a great deal of moisture can enter the arena itself and condense on interior arena surfaces. This may be unavoidable based on the current operation and layout of the resurfacer room. It will be very important that the dehumidifier is operated during these extended season times to take care of the moisture introduced through the garage door openings.

There may be additional gaps and openings which were not observed. Similar effects occur from any opening which uncontrolled moisture can enter the arena. Sealing of these penetrations is also recommended.

Spectator Heating System

The heating system within the arena consists of two (2) zones of gas-fired radiant heaters arranged in a U-tube manner. These heaters are installed near the seating area and the reflectors are directed for spectator comfort. These types of heaters warm the spectators without directly raising the surrounding air temperature. They are operated manually by the arena operators as necessary when desired for the spectators.

These heaters can be operated during the extended season for occupant comfort in the same manner as during colder times of the year if desired. Any heat added to the inside of the building results in surfaces being at a higher temperature than the dew point of the space. These surfaces then resist condensing of moisture. Ensure that reflectors remain directed towards the spectators and not towards the ice as these heaters will degrade the ice condition in areas which receive the direct radiant energy from the heated tube.

END of Mechanical

Pine City Arena – Electrical Evaluation

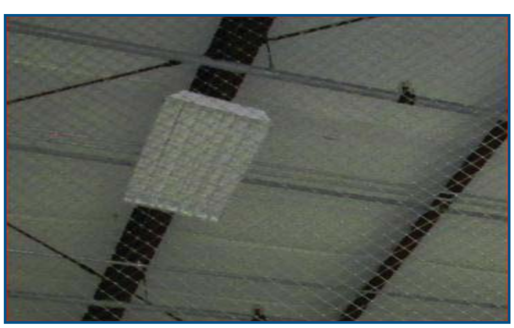
Electrical Distribution System

The electrical distribution system is an existing 480/277 volt, three phase 800 amp service which is served from a 300kVA utility owned transformer. This transformer serves a number of disconnect switches which follow the National Electrical Code's 6-disconnect rule.

The disconnect switches feed lighting and motor/equipment panelboards as well as transformers to transform the voltage to 208/120 volts which feed smaller motors and receptacle loads. The highest demand load (kW) recorded by the utility company (East Central Energy) in the previous 3 years is 111.2 kW. This equates to approximately 170 amps at a 0.8 power factor which is considerably less than the capacity of the distribution system and the utility transformer serving the distribution system. The electric distribution system appears to have capacity to upgrade the dehumidification and refrigeration system if it is required to extend play earlier and later in the season.

Lighting System

The arena lighting system consists of 6 lamp T-8 high-bay fixtures. This style of light fixture lends itself well to the task of lighting an ice arena, in light output, illumination of the rink, and in controllability as the fixture requires multiple ballasts to power the light fixture and allows additional switching capability. In addition, no considerable start up time is required to bring the light fixtures to full output. The existing rink lighting is switched manually with multiple zones to provide high and low light levels as needed.



Additional lighting control could be added to ensure lights are automatically turned off, although a facility manager currently turns the lights off after the facility is done being used for the day.

Interior lighting located elsewhere in the building is also via T-8 light fixtures which are still considered by most, the most energy efficient and cost effective way of lighting.

Exterior lighting, which is High Intensity Discharge (HID) may be exchanged for LED style fixtures which provide a better light while also reducing the energy used. LED lighting fixtures also have a long life of over 70,000 hours decreasing the maintenance costs of the exterior lighting.

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