ATTACHMENT A

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Pasadena Ice Skating Center - Evaluation Report

For:

Pasadena Center Operating Company (PCOC), California

Pasadena Convention Center
300 E. Green Street
Pasadena, CA 91101-2399

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By:

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Section 1: Project Information

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Type of Facility:	Ice Arena	

Section 2: Executive Summary

In efforts to evaluate an aging facility and be proactive in sustaining and improving the community's access to ice skating activities, the PCOC has directed Stevens Engineers to perform an evaluation of the mechanical systems inside the Ice Skating Center.

The Pasadena Exhibition Hall or Ballroom was constructed in 1931 as part of a larger community facility. In 1976 the space was transformed from event center with a surface of hardwood to an ice rink with assistance the Ice Capades. The transformation of the building included covering the existing skylight system, shutting down the existing heating and ventilating systems, installing a low emissivity ceiling material, installing new ventilation and dehumidification equipment, new office space, a skate rental shop, restrooms, locker rooms, skate shop and other ancillary spaces. The ice system was also installed at this time which included a direct refrigerated, sand based, ice rink floor, a direct refrigeration system, a snow melt pit and wood framed dasher board system. The current ice rink is undersized by industry standards and the overall condition and quality of the amenities and support spaces are below standard which creates a competitive disadvantage for the operation.

Existing Ice System
There have been very few, if any, improvements to the inside of the building over the past 34 years. A significant investment of reportedly $100,000 was made toward upgrading and/or replacing parts of the refrigeration equipment. These improvements included installing a used cooling tower system and replacing one of the two compressor units. The mechanical systems in the facility have exceeded their typical life expectancy of 25 years.

The existing direct expansion ice system has reportedly experienced a few small leaks in past years. It's likely that additional leaks have been avoided because the ice sheet operates continuously and hasn't been taken down in over 10 years. The existing refrigeration system is in need of repairs. Based on the age and condition of the existing ice rink floor, we would not recommend a shut-down and re-start of the existing system. In order to accomplish replacement of the dasher board system and structural repairs, the ice rink floor should be replaced. The insulation systems have deteriorated allowing frost to build up on the piping, vessels and equipment making inspections and maintenance difficult. The majority of the controls and equipment appear to be original.

Direct refrigeration systems are being phased out of the ice rink industry, due to the large quantity of refrigerant they use and circulate in the rink floor or arena. The existing system uses R-22 refrigerant currently scheduled to be phased out by 2020 because of high global warming potential. It may be possible to get another 5 years of life from this system depending how fast the steel rink tubing deteriorates. However, at this age, the system is unreliable and a catastrophic release of refrigerant is more likely as the system ages. The existing dasher board system is in poor condition, poorly supported and needs replacement. A new ice system including refrigeration system, ice rink floor and dasher board system would cost an estimated $1,307,500. Based on our observations, there could be significant additional cost impacts related to code compliance upgrades for life safety and ADA, environmental remediation, and the necessary aesthetic repairs and improvements to create an ice rink that meets the minimum operating standards.

Existing Mechanical Systems
The Ice Skating Center's HVAC system appears to be marginally adequate at best to meet current code regulations. We understand the facility has experienced problems with dehumidifying the air, at times, which was likely caused by the age or design of the system. Humid air can lead to building deterioration, poor ice quality, high energy use, mold build-up and health concerns. Improvements to these systems would cost an estimated $558,600.

Therefore, the total estimated cost for mechanical improvements to the existing Ice Skating Center is $1,866,100.

Existing Building
The evaluation of the historical building's envelope and structural components were beyond the scope of this study. However, for comparison purposes, it is important to understand the costs associated with renovating the existing building to current industry standards. The estimated cost to renovate the interior of the building including walls, lighting, supports spaces, flooring, improve accessibility, etc. is $1,892,000. Determining the cost to renovate the historical building's exterior, skylights, roof, windows, doors, structure, etc. requires a much more extensive study.

The total estimated cost to renovate the existing building's ice system, mechanical systems and interior is $3,758,100.

New Ice Arena
The existing tensile structure building has good potential for being developed into an ice arena facility. It is recommended that the building be expanded, a minimum of 20 feet, to provide adequate room for a full sized regulation sized ice rink (85' x 200'). All of the desired programming for the building fits within the footprint of the existing building.

It is highly recommended that a new ice system be installed for this building to maximize energy efficiency, improve safety and operation and maintenance of the system. New ice equipment and resurfacer rooms could be located on the south side of the existing building. A packaged, commercial grade, refrigeration system may be desired if this is a temporary solution or short term solution. Equipment leasing may also be an option.

The cost estimate to transform this facility into a new ice arena is $2,552,200. Included in this cost is the build out for the new rooms (e.g. team rooms, concessions, office space, etc.) within the structure which are required for an ice rink that meets minimum industry standards and can be competitive in the marketplace.

Section 3: Introduction

Purpose

In efforts to evaluate an aging facility and be proactive in sustaining and improving the community's access to ice skating activities, the City has directed Stevens Engineers to perform an evaluation of the mechanical systems inside the existing Ice Skating Center. The Ice Skating Center is located in the historical Pasadena Exhibition Hall or Ballroom.

The primary objectives of this evaluation are as follows:

- Evaluate the condition of the existing ice and mechanical systems.
- Identify areas of concern.
- Recommend repairs and/or improvements that will increase the reliability and performance of the systems and extend the life expectancy by a minimum 5 years.
- Evaluate the feasibility of transforming the existing tensile building structure, located adjacent to the Ice Skating Center, into an ice arena.
- Estimate the cost of performing the recommended repairs and/or improvements.

It is recommended that the findings presented in this report be used to improve the operations and maintenance of the facility and to assist in planning and budgeting for the recommended improvements.

The following information was used in performing this evaluation and to generate this report:

- A site visit was conducted on January 7, 2010 to observe the operation of the ice and mechanical systems in the Ice Skating Center. During the site visit there were ice skating activities taking place on the ice rink. The ambient temperature was 60 to 65F.
- Original building drawings dated 1925.
- Building modification drawings dated 1968 for air conditioning improvements.
- Ice Capades drawings dated 1976 with limited ice system and HVAC information.
- Discussions with Ice Skating Center management and staff.
- No refrigeration system logs were available for review.

The evaluation of the historical building's envelope and structural components were beyond the scope of this study. A building code analysis was also not included in the scope of this study.

General Building Description

The Pasadena Exhibition Hall or Ballroom was constructed in 1931 as part of a larger community facility and is now registered as a historical building. In 1976 the space was transformed from an event center, with a hardwood surface, to an ice rink with assistance from the Ice Capades. The transformation of the building included: covering the existing skylight system; shutting down the existing heating and ventilating systems; installing a low emissivity ceiling material; installing new ventilation and dehumidification equipment; and constructing new office space, a skate rental shop, restrooms, locker rooms, skate shop and other ancillary spaces. The ice system was also installed at this time which included: a direct refrigerated, sand based, ice rink floor; a direct refrigeration system; a snow melt pit; and wood framed dasher board system.

The mechanical systems in the facility have exceeded their typical life expectancy of 25 years.

Mode of Operation

The Ice Skating Center is used for public skating, figure skating, free style sessions, broomball, learn to skate programs and youth and adult level hockey programs. In the past ten years the ice rink has been in continuous operation with no downtime for maintenance or repairs.

History of Facility Improvements

There have been very few, if any, improvements to the inside of the building over the past 34 years. The only major improvements that have been completed since the facility was renovated into an ice rink were the replacement of part of the refrigeration system including the installation of a used cooling tower system and the replacement of one of the two compressor units. The cost of the these repairs were reportedly approximately $100,000.

Cost Estimates

The proposed cost estimates presented throughout this report were developed by estimating the probable construction costs based on similar types of construction projects and work performed and bid in 2005-2009 and updated for 2010 costs unless otherwise noted. The estimated costs include all materials and labor for a complete installation unless otherwise noted. Costs will vary depending on the time of year the projects are bid and the current economic climate.

In addition to the probable construction costs of the proposed work, other associated project costs are included to provide a total estimate cost for the project. The Estimate, Design and Construction Contingency line item in each cost table is included during the concept or preliminary phase of design projects because the exact scope of the project has not yet been determined. This percentage is typically reduced from 10% to 5% during the final design phase of the project. The Engineering, Legal and Administrative line item in each cost table is provided to cover all work performed by the design team and all legal and administrative work required by the Owner for projects of this type.

Section 4: Ice System Evaluation

General

The existing ice system is classified as a "direct" refrigeration type ice system and was installed in 1976. In a "direct" refrigeration ice system, the R-22 refrigerant is circulated not only in the refrigeration system but also in the ice rink floor. This is in contrast to an "indirect" refrigeration system that circulates a secondary fluid, such as ethylene glycol or calcium chloride through the ice rink floor while the primary refrigerant remains contained in the ice equipment or mechanical room.

The direct refrigerated ice system was very popular and frequently installed during the 1970's and 80's and is the most efficient ice system serving ice rink facilities today. However, numerous concerns with the standard system design, current code regulations, and new environmental regulations have prompted facilities to convert, or change, to an indirect system. Those concerns include the following:

- Reliability. Most direct refrigerated ice systems still in use today have exceeded their useful life of 25 years. The existing ice system is over 34 years old. As the system ages, reliability and lost revenue become a concern.

- Safety. A direct system circulates refrigerant through the ice rink floor where spectators and skaters are located. As direct refrigeration systems age, the steel ice rink floor piping starts to corrode and eventually fails, leading to refrigerant leaks and exposures spectators and skaters to refrigerant fumes.. The rink floor is usually the first area to fail in this type of system.

- Environmental. R-22 refrigerant is used in the existing ice system at the Ice Skating Center and has been has been the most popular refrigerant used in ice rink applications over the past 20 years. However. with the signing of the Montreal Protocol, the United States Environmental Protection Agency implemented its 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. Chlorofluorocarbons (CFCs), such as R-12, were scheduled for phase out by the year 2000 and Hydrochlorofluorocarbons (HCFCs), such as R-22, in 2010 for the production and importation in new equipment and 2020 for installing in existing equipment. This ruling targets refrigerants that delete the ozone as measured by their ozone depletion potential (ODP).

  There is now pressure to consider phasing out refrigerants that contribute to global warming as measured by their global warming potential (GWP), mainly HFCs like those used in blended refrigerants such as R-507 and R-404A. 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. Carrier, a leading refrigeration equipment manufacturer, stated that R-404A "...has a very high direct GWP.....and probably will not play a significant part as a long term replacement for R-22"

  Other leading global companies, such as Coke Cola, are leading the charge to ban HFCs and use natural refrigerants such as CO2, hydrocarbons and ammonia. As we approach the phase out date for R-22, refrigerant manufacturers are developing new refrigerant blends. We are in a transition period and only time will tell what other refrigerant options will be available to the ice rink industry.

- Cost. A single direct ice rink system can require up to 6,000 pounds of R-22 refrigerant compared to an average of 700 pounds for an indirect type system. With the phase out of R-22 refrigerant nearing, concerns over R-22 cost and its availability are increasing. For example, if a leak occurred in the system, a 6,000 pound refrigerant charge would cost approximately $42,000 to replace at today's cost of approximately $7 per pound.

For purposes of this report, the "ice system" includes the following four sections:

- Refrigeration System
- Ice Rink Floor System
- Waste Heat Recovery System
- Dasher Board System

Refrigeration System

General Description

The existing refrigeration system was engineered by McCormack Engineering and has a model number of IRCRM – 150 R280, Serial No. 76M338-01 and manufactured on August 13, 1976. The system is over 34 years old and has exceeded its typical life expectancy of 25 years.

The system has reportedly experienced a few small leaks in the past several years. The locations of the leaks were not identified. It is likely that further or more substantial leaks have been avoided because the ice sheet operates continuously and hasn't been taken down in over 10 years.

Overall, the refrigeration system is in poor condition with the exception of the new compressor. The system is poorly insulated allowing frost to build up on the piping, vessels and equipment making inspections and maintenance difficult. There is oil and fluids on the floor of the ice equipment room indicating the system is either currently leaking and/or has been leaking the recent past. The majority of the controls and equipment appear to be original.

The existing direct refrigeration system includes: two reciprocating compressors, two liquid pumps that circulate the refrigerant through the ice rink floor, one low pressure receiver and one storage receiver, two evaporative type condensers with water pumps and chemical treatment system, and controls. Each system is described in more detail in the following paragraphs.

Compressors

The existing refrigeration system uses two reciprocating type compressors. The manufacturer and capacity of the compressors could not be determined. Each motor is rated at 75 horsepower, 96 FLA, 540 LRA, 192 Total Amps. Compressor 1, and its motor, where recently replaced. Compressor 2 appears to be original.

A direct system typically operates at design conditions of 15 F suction temperature (38 psi suction pressure) and 100 F condensing temperature (196 psi discharge pressure). During our site visit, the system was operating close to these typical conditions with suction and discharge pressures of approximately 35 psi and 210 psi, respectively. Both compressors were operating.

Low Pressure Receiver

The low pressure receiver is the large pressure vessel on the refrigeration system that stores the liquid refrigerant. The receiver is poorly insulated and could not be inspected because of frost build-up on its surface. There is another storage vessel on the system that has some visible corrosion, especially on the underside of the vessel. However, the extent of the corrosion could not be determined.

Liquid Pumps
The two liquid pumps in the system pump liquid refrigerant through the ice rink floor. The pumps appear to be original and are poorly insulated and corroded on the surface.

Cooling Tower System
The original cooling tower system was abandoned in place and replaced with two smaller, used condensing units. The role of the condenser is to remove the heat from the refrigerant, cooling it back down as it returns to the refrigeration system. This system uses both water and air to accomplish this task. If an adequate amount of heat cannot be removed, the compressors need to work harder and therefore, use more energy.

The condenser system water is treated through a chemical treatment system. Chemical treatment of the water is generally necessary to help prevent scaling inside the condenser unit, prolonging the life of the unit and minimizing maintenance.

Monitoring Devices
There is a lack of monitoring devices, such as temperature gauges, pressure gauges, etc. on this system. The lack of these devices makes it difficult to monitor the performance of the ice system and to troubleshoot problems.

Waste Heat Recovery Systems
These systems capture heat that is generated during the refrigeration process and use it in various places throughout the facility such as melting snow or ice shavings in the snow melt pit, dehumidification, subfloor heating, space heating, etc. This is essentially "free heat". This system is not capturing and reusing any waste heat from the refrigeration system. The ice shavings in the snow melt pit are being melted by domestic hot water.

At one time the system used hot gas from the refrigeration system to help dehumidify the arena. This was reportedly discontinued as utility costs increased.

Ice Rink Floor

General Description
The ice rink floor was constructed on top of the existing Exhibition Hall wood flooring system. The 1976 drawings show the construction of the existing ice rink floor consists of a 2 inch thick layer of insulation, a vapor barrier and a 4 inch thick layer of sand in which the steel rink tubing is embedded. The rink floor is approximately 90 feet wide by 150 feet long with a 28 foot radius. This is smaller than the standard ice rink of 85 feet wide x 200 feet long.

Performance and Condition
There were no performance (e.g. ice quality, etc.) problems reported with the ice sheet at the time of the site visit. The quality of the ice surface appeared to be uniform. The condition of the ice rink floor could not be inspected because the ice sheet was in place.

The condition of the hardwood floor could only be inspected from the underside in the basement. Wood flooring beneath an ice rink floor can be problematic for obvious reasons. The existing wood flooring appeared to be in fair condition with only localized rotting of the wood planks. Keeping the ice sheet in place continuously over the years has likely reduced the severity of the deterioration in the wood. However, once the ice is removed or melted for repairs, replacement, or other reasons, damage to the aging wood floor and to the wood floor beams will accelerate. The weakened areas of

the floor and underlying structure will need to be repaired before a new dasher board system can be installed.

Arena Space Conditions
The space conditions of the arena (e.g. temperature, relative humidity, ventilation, etc.) play a major role in how hard the ice system has to work to maintain the desired level of ice quality. See the Mechanical System Evaluation section of this report for more discussion on the arena space conditions.

Dasher Board System

General
The existing dasher board system was installed with the development of the Ice Skating Center in 1976 and is constructed of wood framing, a thin polyethylene cap rail and polyethylene facing and kick plate. The spectator shielding is acrylic and not tempered glass. Protective netting is installed on both ends of the ice rink.

Overall, the 34 year old dasher board system is in fair to poor condition and should be replaced. Where the wood framing could be inspected, it appeared to be in poor condition with extra bracing and ties installed as needed over the years. The system is anchored to a wood curb that surrounds the perimeter of the rink floor. The wood curb is anchored to the wood flooring system. The anchor bolts, for the wood curbing, can be inspected on the underside of the flooring system and appear to be in fair condition. It is evident that water dripping through the anchor holes is a problem. It is also evident that the anchoring system is inadequate, or has deteriorated, causing the dasher board system to lean out away from the rink floor in many locations.

The failure rate of wood dasher board systems typically increase with age as the wood cracks and rots from temperature fluctuations and high moisture levels found in ice arena facilities. Safety concerns increase with age as the structural integrity of the wood system is compromised and panel gaps and misalignments become more prevalent. The deterioration and misalignment of the dasher board panels can cause playability issues as well.

The useful life of wood dasher board systems depend on the maintenance, timeliness of the repairs and the amount of moisture in the ice arena, and therefore, can be difficult to determine. Wood dasher board systems are not commonly found in arenas today, and are no longer manufactured in measurable quantities. They have been replaced with steel and aluminum framed systems.

Ice Rink Equipment Room

General Description
The ice rink equipment room is located in the basement of the facility. The room does not meet current code requirements. Some of the concerns include: a non-fire rated access door; holes in the walls; poor lighting; no mechanical ventilation; wet floors; and no visible refrigerant detector. Many of these concerns are life safety issues and should given the highest priority in planning discussions.

Recommendation and Cost Estimates for the Ice System

General

The existing ice system is beyond its useful life. The direct refrigeration system would need to be converted to an indirect system if improvements were made. Limited access to the refrigeration system and the ice equipment room is a concern and increases the cost of repairs and improvements.

Recommendations

We recommend the following;

1. Replace the direct refrigeration system and rink floor with an indirect system. The ice rink floor piping will likely be the first part of the system to fail. It is not recommended that the ice rink floor be replaced with a new, direct refrigerated, ice rink floor because the cost can be $400,000 or more and because of the safety and environmental concerns discussed at the beginning of this section. The new system will include a new motor control center and electrical wiring. The cost estimate also includes inspecting the existing wood flooring and replacing damaged or deteriorated sections.

2. Replace existing dasher board system. The cost estimate for a new dasher board system is based on removing the existing dasher board system, installing a new wood curbing and anchoring system and furnishing and installing a new aluminum or steel framed dasher board system that includes the following:
   - aluminum or steel frame;
   - polyethylene board facing, kickplate and caprail;
   - polyethylene backer panels on each end of the rink;
   - tempered glass supportless spectator shielding on both sides of rink;
   - typical tempered glass supported shielding with protective netting on each end;
   - equipment, player and access gates;
   - safety pads on ends of shielding; and
   - players, penalty and timekeepers boxes, raised floors, rubber flooring and benches.

   The cost of the system will vary depending on the amenities and quality of materials desired.

3. Equipment room improvements. Install a refrigerant leak detector system, lighting improvements, and repair holes in walls.

Cost Estimates

Presented in the table below is the cost estimate for the improvements to the existing ice system.

Table 1. Existing Ice System Improvements – Cost Estimate

Item	Cost
1. Ice system (ice rink floor, refrigeration system, and snow melt pit)[2]	$842,500
2. Dasherboard system, protective netting and new anchoring system	$180,000
3. Ice equipment room improvements	$11,000
Subtotal Estimated Construction Costs	$1,033,500
Estimate, Design and Construction Contingency (10%)[1]	$103,400
Total Estimated Construction Costs	$1,136,900
Engineering, Legal, and Administrative (15%)[1]	$170,600
Total Estimated Project Costs	**$1,307,500**

1. See explanation in Cost Estimate section of the report.
2. Add $175,000 for an industrial grade refrigeration system. Ammonia refrigerant would not be an option with the location of the existing equipment room.

Section 5: Mechanical System Evaluation

Building Construction Concerns

General Description
The existing building construction documents indicate that numerous building materials installed in the building are good candidates to harbor mold growth. Sheet rock has been used in the building wall systems, gypsum plaster has been used on the building wall and ceiling systems, and acoustical tile has been used for numerous wall and ceiling finishes. Sheet rock is a particular concern because all of the elements for mold growth will be present in the building: the building has a high relative humidity level, the sheet rock contains craft paper which is food source for the mold, and the craft paper is located on the back side of the wall where it is dark. We have remodeled numerous ice arenas where sheet rock has been installed in ice arena facilities and they nearly all had mold issues. We strongly suspect the building may have mold issues that should be examined by a qualified environmental engineer.

We are also concerned that the vapor barrier installed on the existing construction may be inadequate to meet the needs of an ice arena facility. Observations and discussions with personnel at the facility indicate that moisture issues have been a concern for the building.

The mechanical systems are often pointed to as the moisture problem in ice arena facilities. Our experience indicates that an entire building approach is required to properly dehumidify an ice arena facility. The building envelope must be properly designed to minimize moisture transmission through the walls and ceiling. Any unprotected openings will allow moisture to infiltrate into the building increasing energy costs and becoming a source for humidity related problems.

Many of the humidity related issues are difficult to see and may remain hidden for many years. Roof decks rust, insulation gets saturated with water and loses its insulating value, water condenses inside walls and ceiling systems, mold grows inside wall cavities; electrical systems get wet and begin to deteriorate, and exposed metal surfaces begin to rust. Other humidity related issues are readily apparent; fog builds up in the arena, moisture condenses on the floors and walls, and mold grows on wet surfaces. We have been told that the existing dehumidification systems do not function properly and are currently not being used. We strongly recommended that the systems either be replaced with new systems or the existing systems be serviced and brought back into proper working condition.

Mechanical Systems

General Description
The building construction documents indicate that the ice arena portion of the building was originally heated, cooled, and dehumidified with a large built up air handler located in a roof pent house. The system was a multi-zone air handler with five heating and cooling zones circulating a total air quantity of 67,000 CFM. Supply air ductwork was routed above the exhibition hall ceiling to round supply air diffusers. Return air is circulated back to the air handler through a return plenum ceiling. Discussions with the arena staff indicated that the system was abandoned in place during the ice arena remodel of the facility and is currently not functional.

In 1976 the building was remodeled into an ice arena facility and two new air handling units were installed to heat, cool, and dehumidify the facility. Existing documents indicate that the following equipment was installed in the west balcony of the arena.

1. Air handling unit AH-1 is located over office M4. It is a Pace model A-20/18 draw through forward curve fan coil unit, 7,500 CFM at 3" external static pressure, 7.5 H.P., 460/3/60, 8 row, 14 fin per inch dehumidification coil, 4 row, 8fin per inch hot gas reheat coil. The dehumidification coil is connected to the refrigeration plant designed to maintain the ice sheet. The hot gas reheat coil is used to reheat the air when dehumidification is required but building cooling is not required. The hot gas reheat coil is connected to the condenser side of the ice plant refrigeration system. We were informed by arena staff that the dehumidification and cooling portion of the air handling system is no longer used because of the high cost of operation. The system does not have outside air intake ductwork or louvers.
2. Air handling unit AH-2 is located over staff room M9. It is a Pace model A-20/18 draw through forward curve fan coil unit, 7,500 CFM at 3" external static pressure, 7.5 H.P., 460/3/60, 8 row, 14 fin per inch dehumidification coil, 4 row, 8fin per inch hot gas reheat coil. The dehumidification coil is connected to the refrigeration plant designed to maintain the ice sheet. The hat gas reheat coil is used to reheat the air when dehumidification is required but building cooling is not required. The hot gas reheat coil is connected to the condenser side of the ice plant refrigeration system. We were informed by arena staff that the dehumidification and cooling portion of the air handling system is no longer used because of the high cost of operation. The system does not have outside air intake ductwork or louvers.

The existing ice equipment room is not properly ventilated and the facility should consider upgrading to current code requirements. This item is a safety issue and should be given the highest priority in planning decisions.

Code Review of Outside Air Requirements

Existing System Description
Current building codes require that the ice arena portion of the building be ventilated with outside air to provide fresh air for the building occupants and to dilute the build-up of contaminants in the building. The original penthouse HVAC system that was designed in 1968 included adequate outside air provisions to properly ventilate the building. We have been informed that this system is no longer operational and that is has been abandoned in place. The newer dehumidification units installed in 1976 do not provide any outside air into the facility. Building ventilation is a serious code deficiency that should be addressed in the immediate future. We recommend that outside air be delivered through the building dehumidification system. When outside air is introduced into the building through the dehumidification system moisture contained in the outside air is removed from the airstream before the air ever enters the building. This eliminates the largest source of moisture in the building.

The State of California has adopted ASHRAE 62 as its outside air ventilation code. The code requires that sports facilities be ventilated as follows:

- Sports floor areas require 0.3 ft^3/S.F. of outside air.
- Spectator areas require 7.5 ft^3/person of outside air plus 0.06 ft^3/S.F. of outside air for the floor area.
- We have estimated that the required outside air for the facility is approximately 6,750 ft^3/minute

Recommendation and Cost Estimates for Mechanical and Electrical Systems

General

The existing mechanical and electrical systems are beyond their useful life. The mechanical systems are undersized or not working properly to meet current code requirements. The only electrical system evaluated in this study was the arena lighting system.

Recommendations

We recommend the following:

1. Desiccant Dehumidification System Improvements. We recommend that a new desiccant based dehumidification system be designed for the facility. State of the art technology uses waste heat from the refrigeration plant to regenerate the desiccant wheel reducing the cost of both the dehumidification system and the ice plant. The system could be located in the rooftop penthouse and existing ductwork could be used to distribute the air to the space. Return air would need to be ducted directly to the eliminating the existing return air plenum ceiling.

2. Ventilation Improvements. Control of the outside air is crucial in ice arena facilities. We recommend that a CO2 demand controlled ventilation system be installed in the system. This system modulates the amount of outside air introduced into the building based on actual occupant use. As people breath they give off CO_2. As the CO_2 level builds up in the arena the outside air dampers will open and flush the contaminants from the building. This type of system can be designed directly into the new dehumidification system.

Cost Estimates

Presented in the table below is the cost estimate for the improvements to the existing mechanical and electrical systems.

Table 2. Existing Mechanical and Electrical System Improvements – Cost Estimate

Item	Cost
1. New dehumidification system	$305,000
2. New ice equipment room ventilation system	$38,000
3. New resurfacer room water filling station	$22,000
4. New resurfacer room ventilation system	$5,500
5. New lighting system in the arena	$71,000
Subtotal Estimated Construction Costs	$441,500
Estimate, Design and Construction Contingency (10%)[1]	$44,200
Total Estimated Construction Costs	$485,700
Engineering, Legal, and Administrative (15%)[1]	$72,900
Total Estimated Project Costs	**$558,600**

1. See explanation in Cost Estimate section of the report.

Section 6: Building Improvements

General

In addition to the ice system and mechanical and electrical system improvements that have already been discussed; the existing Exhibition Hall or Ballroom building will require significant improvements to bring the building up to current industry standards including meeting current code requirements such as mechanical, electrical, health and safety, fire, and accessibility.

Evaluating the existing building was beyond the scope of this study, however, for comparison purposes, it is important to understand the costs associated with renovating the existing building to meet these standards. The costs presented in the table below are estimates of the work that is needed to renovate the interior of existing building. The costs do not include work related to renovating the historic nature of this building including the building's exterior, skylights, roof, windows ,doors, signage, etc., structure, and any environmentally or hazardous remediation that may be required. All costs include demolition, removal and disposal.

Table 3. Building Improvements – Cost Estimate

Item	Cost
1. General conditions (permits, bonds, etc.)	$74,750
2. New building sprinkler system	$186,300
3. Install elevator for access to mezzanine (assuming a location can be found in the existing building's footprint)	$172,500
4. Mold remediation and replacement of walls	$221,375
5. Life safety (emergency lighting, fire protection, exits, etc.)	$126,500
6. Replace existing rooms on mezzanine level	$336,375
7. Renovate rooms on main level	$132,825
8. Relocate restrooms to main level	$77,050
9. Refinish and repair existing wood floor in main ballroom	$87,400
10. New rubber flooring or skate tile	$80,500
Subtotal Estimated Construction Costs	$1,495,600
Estimate, Design and Construction Contingency (10%)[1]	$149,600
Total Estimated Construction Costs	$1,645,200
Engineering, Legal, and Administrative (15%)[1]	$246,800
Total Estimated Project Costs	**$1,892,000**

1. See explanation in Cost Estimate section of the report.

Section 7: New Ice Arena

General

In addition to evaluating the existing Ice Skating Center, we also briefly reviewed the feasibility to build out the existing tensile structure located adjacent to the Ice Skating Center transforming it into an ice arena. In general, the existing building and surroundings work well for this use.

General Building Construction

The existing tensile structure is located on top of concrete parking structure and has a 42 inch wide concrete curb around the perimeter of the building. The building was constructed in 2005 and manufactured by Summit Structures. We understand the building design includes double wall construction with 18-24 inch thick wall insulation (R-30), roof insulation, water proof material, and sprinkler and fire alarm systems.

Figures 1 through 3 show one option to transform the existing tensile structure into an ice arena facility. To accommodate the desired programming (i.e. support spaces, number of team rooms, etc.) for the building, it was necessary to extend the existing building 20' to the north using the same tensile building material. This option also shows two rooms added to the south of the building for the resurfacer and ice equipment. These rooms are constructed of light gauge metal stud walls with acrylic stucco finish to minimize the impact on the parking structure. Sound proofing of the ice equipment room was not included in the cost estimate.

The existing parking structure, constructed in 1973, is reportedly rated at 250 pounds per square foot (psf) and is a post-tension structure. Based on this information it appears the existing structure is adequately designed for the proposed improvements as well as adding a floor topping to the existing sloped concrete top slab. The tensile structure building is "anchored" by a massive concrete curb that is doweled and epoxied into the structural slab of the parking structure. The 20 foot addition would likely require a similar anchoring system to be installed. Additional costs have been included in the cost estimate table below for these modifications to the existing parking structure.

The existing parking lot slab was leveled with concrete for the old plaza area. No additional leveling was included in the cost estimate. The ice rink floor will be leveled with the subfloor sand layer.

The interior building improvements include: 9 foot tall metal stud walls with acrylic stucco finish; rubber flooring; HM doors; suspended ceilings and sprinkler system extensions in the offices, skate rental, meeting rooms and concession areas; infilling existing opening that are no longer needed, new or relocating doors, new flashing where needed, and bleachers. The cost estimate in the table below also includes a $15,000 allowance for scoreboards. The existing portable restrooms would remain in use. The City may consider using exterior modular units for team rooms in place of the interior build-out for these rooms.

Demolition of the existing north wall of the structure is included in the cost estimates.

Mechanical Systems

General Description
The building is heated and cooled with a series of 9 air cooled heat pump units located on grade along the east wall of the building. The following observations have been made about the existing mechanical systems for the building.

Fire Protection System

1. The existing building is fully protected by a wet fire protection system.
2. We do not have documentation of the sprinkler system installed in the building but we are confident that it will meet the needs of the ice rink facility.
3. Modifications will be required to accommodate the revised floor plan with new wall and ceiling systems. Additional heads will be required to accommodate the new walls and sprinklers will need to drop down into any new ceiling ceilings installed below the roof structure.
4. The Owner may want to consider adding wire sprinkler head covers over the existing sprinkler heads in the arena portion of the building. We typically specify protective covers in the arena portion of the building to prevent pucks from setting the sprinkler system off.

Plumbing Systems

1. Toilet rooms for the building are located outside the tensile structure in self contained toilet room buildings. The occupant load for the building will be reduced when its use is switched to an ice arena application. We expect that the toilet room count will be adequate to meet the code requirements of the new facility but a code study has not been completed on the building. We recommend that a code study be completed during the design development of the project to confirm that the toilet rooms are adequate to meet the new use of the facility.
2. The existing building has limited plumbing systems inside the bent frame structure. The new ice arena will require sanitary sewer, water and vent piping for the following systems:
    a. The resurfacer room will require trench drains for general floor drainage, a new snow melt pit for resurfacing needs, non-potable water heaters for ice resurfacer use, water fill stations for the ice resurfacer and a hose reel for flooding the ice.
    b. The ice equipment room will require non potable water for the ice plant, general floor drains and a drain for the ice system.
    c. The concessions area will require sinks, floor drains and potable hot water heating systems.
    d. Building codes will require water coolers be installed in the facility.
    e. We typically recommend that floor drains and wash down stations be installed in the team rooms. We will want to discuss this item with the Owner.

HVAC Systems

1. The existing tensile structure is heated and cooled with a series of nine heat pump units. The units are located on grade on the east side of the building. Ductwork from the heat pumps is routed into the building and distributed through plastic duct material.
2. The existing HVAC system is designed to accommodate an occupant load of between 1,000 and 2,000 people. The new Ice Rink facility will be designed to accommodate an occupant load of around 500 people. The ventilation air requirements of the building will be reduced as the occupant load is reduced.
3. The existing heat pump units are not suitable to dehumidify the building down to the needs of an ice arena facility. We recommend that a new desiccant dehumidification unit be installed in the building to maintain humidity levels and to deliver the outside air into the building.

The outside air intakes on the existing heat pump units will be closed and the openings sealed to prevent moisture from migrating into the building.

4. We anticipate that the heating and cooling needs of the facility will be reduced when the building is converted into an ice arena facility. The ice sheet imparts a large cooling credit on the building which reduces the building cooling requirement on the HVAC system. The heating temperature is also dropped down to near 50°F which will reduce the heating needs of the facility. We estimate that several of the existing heat pump units will be designed out of the system. The new dehumidification system can be located in the space currently occupied by the extra heat pump systems.
5. New exhaust systems will be required to meet the needs of the ice resurfacer room and ice equipment rooms.
6. We have been informed that the facility desires the team rooms to be open ceiling rooms heated and cooled from the arena HVAC system.
7. The concessions area will need to be reviewed to determine if a grease hood with make-up air system is needed for the facility. Most ice arenas we design do not require grease exhaust systems and we have not included the cost in our estimates.
8. Radiant heating systems are used to heat the spectator seating area. The system provides localized heating for the spectators without affecting the quality of the ice or imposing a large cooling load on the ice plant.

The cost estimates presented in the table below include: a new exterior grade mounted dehumidification system; modify ductwork to meeting rooms, concessions, etc.; ventilation systems in the ice equipment and resurfacer rooms; and radiant heat system for the spectator seating area.

Electrical Systems

General Description
The electrical system for the building will need to be modified for the new ice arena facility. The following modifications will be required:

Lighting System

1. We assume the existing lighting system, which reportedly measures approximately 75 foot candles at the floor is adequate and therefore the cost estimate does not include a new lighting system. We typically recommend that multi-level high bay fluorescent lighting be installed over the ice surface area. Overall lighting levels will need to be reviewed with the Owner and can from 50 foot candles for open skating activities to 100 foot candles for higher level hockey games.
2. The new team rooms will require additional vandal resistant lighting systems.
3. Office areas, concessions, and meeting rooms will all require new lighting systems designed to meet the specific needs of each space.

Power Systems

1. The existing electric service to this facility is 1200 amps. A new 600-800 amp service will be required to serve the ice equipment room. We estimate that a new 800 amp service will need to be extended from the main service panel to the ice equipment building. This service will be used to power the new ice plant and associated pumps.
2. The existing electrical service currently serving the bent frame building will be used to serve the new facility. New power connections will be required for the revised building layout, the new dehumidification equipment, new resurfacer room ventilation concessions equipment and other general power needs of the building.

The cost estimates presented in the table below includes: a new electrical service for the ice equipment room; modifications to the lighting and power systems for meeting rooms, entry, concessions, and other dropped ceiling areas; and new arena lighting systems.

Ice System

The proposed design of the ice system includes a concrete ice rink floor and an indirect refrigeration system. There are a lot of options to consider for this system including environmental friendly refrigerants and many uses for waste heat recovered from the refrigeration system. For this report, the proposed design is kept fairly simple and straight forward. During the final design phase we can discuss other options in more detail.

The proposed ice rink floor would be constructed with a concrete perimeter curb that contain the rink floor materials. The ice rink floor construction includes: a subfloor heating grid system imbedded in a 3-6 inch thick sand layer; 3-4 inches of floor insulation; and a 5 inch thick concrete rink floor including reinforcement and a fusion welded polyethylene piping system. Precautions are needed to assure the rink floor is isolated from the parking structure to allow for normal expansion and contraction of the structure without affecting the ice rink floor. Careful planning and design will be required to route transmission mains between the rink floor and the refrigeration room and for placement of the header system piping in the rink floor.

The proposed refrigeration system is commercial grade skid mounted system that is constructed off-site and delivered as one packaged system to the site. The system would use a Freon based refrigerant with either ethylene glycol or calcium chloride as the fluid circulated in the rink floor. This type of system is one of the least cost options and typically has a life of 15 years before some of the components need replacement. The semi-hermetic compressor used in these systems start requiring replacement after 10 years. There are many options to consider for the refrigeration system and all options should be considered during the final design process. We recommend the system be designed with a water cooled condenser system. This unit could be located on the ice equipment room roof or on the parking structure adjacent to the building.

The proposed system would use waste heat from the refrigeration system for subfloor heating beneath the rink floor and heating the snow melt pit. The water from the snow melt pit will need to be routed to the sanitary sewer system. There are other potential uses for the waste heat that should be discussed during final design phase. These include; dehumidification, building heat, etc. These systems are not included in the cost estimates.

Dasher Board System

The proposed dasher board system would be either steel or aluminum framed system with polyethylene facing, caprail and kickplate, and some polyethylene backer panels in the public areas of the facility to provide a finished look. The shielding height used for the cost estimate is 5 feet around the entire rink perimeter. The players, penalty and official boxes would have raised floor with benches, rubber flooring and a coach's walk in the player's boxes. Included in the cost estimate are ramps for the resurfacer and access gates and protective netting on each end of rink. There are many options to discuss during final design of this system.

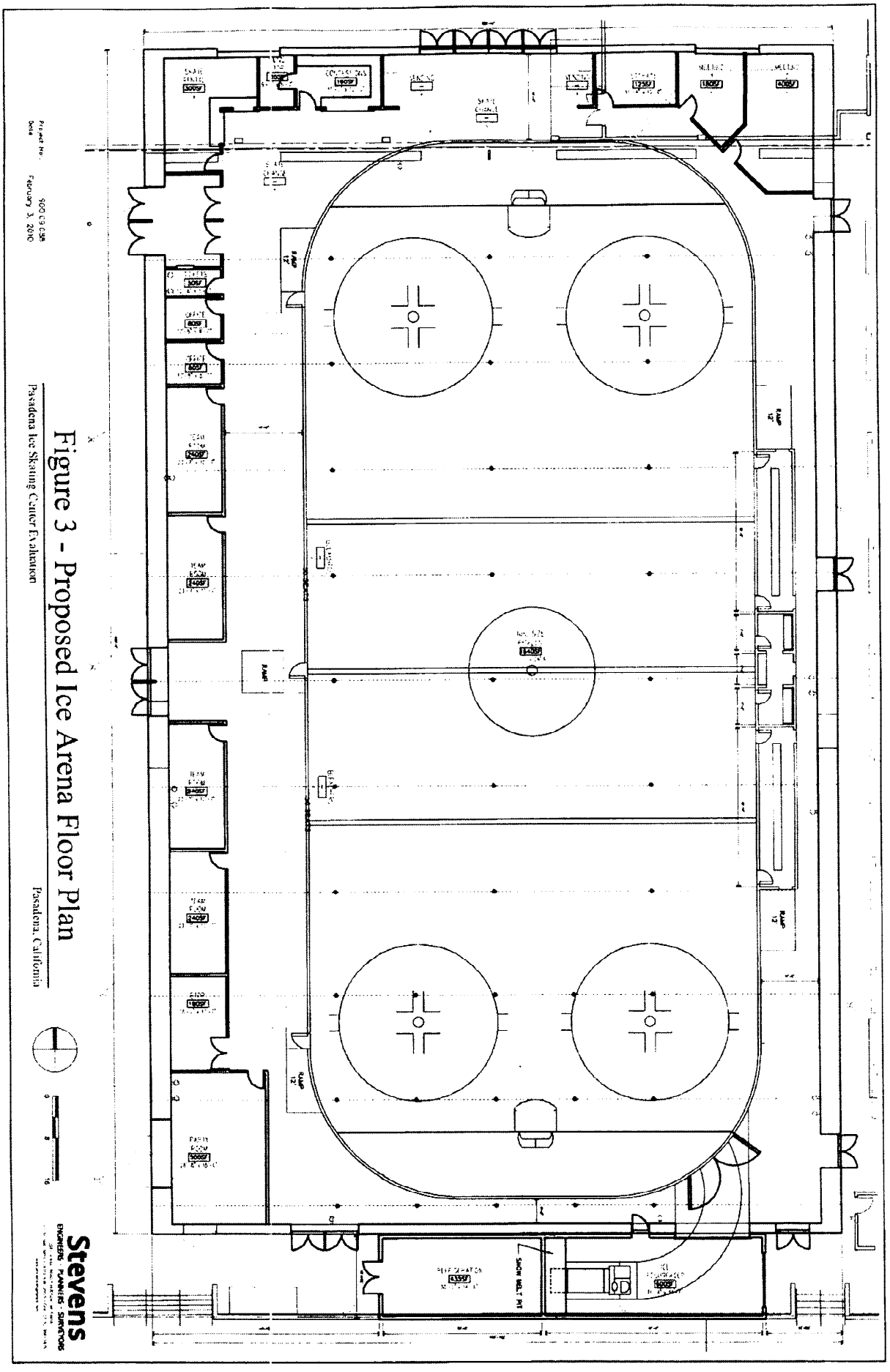
Cost Estimate

Presented in the table below is the cost estimate for the improvements for transforming the existing tensile structure into an ice arena. Included in this table are costs for a new resurfacer and for accessories that will be needed for the new facility.

Table 4. Tensile Structure Improvements – Cost Estimate

Item	Cost
1. General building construction improvements	$590,000
1A. Structural modifications to the parking structure (if needed)	$50,000
2. Mechanical systems	$347,000
3. Electrical systems	$52,000
4. Ice system (ice rink floor and refrigeration system)[2]	$770,000
5. Dasherboard system, protective netting and ramps	$135,000
Subtotal Estimated Construction Costs	$1,944,000
Estimate, Design and Construction Contingency (10%)[1]	$194,400
Total Estimated Construction Costs	$2,138,400
Engineering, Legal, and Administrative (15%)[1]	$320,800
Subtotal	$2,460,200
Propane Resurfacer[3]	$85,000
Ice related accessories allowance (goals, scrapers, hoses, edger, etc.)	$8,000
Total Estimated Project Costs	**$2,552,200**

1. See explanation in Cost Estimate section of the report.
2. Add $175,000 for an industrial grade refrigeration system. Add another $100,000 for ammonia refrigerant.
3. Add $25,000 for an electric resurfacer.


Stevens
ENGINEERS · PLANNERS · SURVEYORS
Pasadena, California
Pasadena Ice Skating Center Evaluation
Figure 3 - Proposed Ice Arena Floor Plan