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FINAL REPORT

For

Lane Events Center – ICE Center

796 West 13th Avenue

Eugene, Oregon 97402



June, 2010

Prepared For:

Lane County

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TABLE OF CONTENTS

Final Report

I. Existing Ice Rink Area

- A. Description
- B. Structural Condition Observations
- C. Analysis
- D. Potential Repair Options and Opinions of Probable Cost
- E. Summary

II. Existing Ice Rink Refrigeration System

- A. Description
- B. Observations
- C. Analysis
- D. Potential Repair Options and Opinions of Probable Cost
- E. Summary

III. Arena Mechanical Systems

- A. Facility Continuing as an Ice Rink
- B. Facility as a Multipurpose Dry Floor Events Center
- C. Summary

IV. Drawings, Sketches & Supporting Documentation

AVAILABLE FOR REVIEW AT
COUNTY ADMINISTRATION FRONT DESK

A. RINK DESCRIPTION

The Ice Center is located on the Lane County Events Center grounds in Eugene Oregon. The structure was originally constructed as a horse arena with a design date of August 21, 1978 on the construction documents. The facility was later converted to the current Ice Center usage and the associated design drawings are dated January 1989. Design documents for both phases of construction were provided by the County for our review.

The design drawings show the primary structure is supported on piles that appear to be founded on the relatively shallow bedrock. The primary structure is concrete tilt up wall panels with open web steel roof joists and girders supporting steel roof deck. There is a wood framed 2nd floor area over the dressing area to the north of the ice surface. Amazon Creek is approximately 90' to the south of the building.

The design drawings show the rink ice surface concrete slab placed over foam insulating panels and a 6" sand leveling course. No sub grade preparation at the rink slab, beyond the sand leveling course, was indicated on the drawings which are consistent with the boring logs in the geotechnical engineering report for the current evaluation. The design finish floor elevation (FFE) of the ice surface concrete slab was 414.5'. The design drawings show the floor slabs of the elevated seating areas to the east and west of the ice surface (design FFE of 421.5'), as well as the office and retail areas to the north (design FFE of 419.0'), to be underlain by a rock base course over the native soils. The ice surface concrete slab is approximately 192' by 85' in plan view with the corners radiused to 28'. The ice surface concrete slab is separated from the adjacent apron slab by a joint.

The design drawings of the ice surface concrete slab show 5" thickness with 5/8" inside diameter steel refrigerant tubing running in a north – south orientation and spaced approximately 3 1/2" on center placed over a mat of #4 rebar at 18" on center each way. The drawings also show a mat of 6x6-10/10 welded wire reinforcing mesh placed over the steel tubing. The north and south ends of the slab have a thickened edge which encapsulates the coolant supply and return headers. The design drawings do not show a thickened slab edge on the east or west slab edges.

The coolant supply lines run from east to west on the south end of the rink coming from the cooling plant in the southwest corner of the building

Site Observations

We visited the site on March 22, 2010 to observe the condition of the ice surface while the ice was in place, on April 2, 2010 to take elevation measurements after the ice had been removed and again on May 6, 2010. The elevation measurements are shown on Figures 1, 2a and 2b.

B. STRUCTURAL CONDITION OBSERVATION

Primary Structure and Floors beyond the Rink Apron

We observed no indications that the heave in the floor slab has affected the primary structure, the interior concrete and CMU walls, or the floor slabs beyond the rink apron. We observed no evidence of cracking or differential movement in these elements, including the CMU wall just to the south of rink which is within several feet of the ice surface. We observed no discernable movement in the building joints which would indicate to us that the structure was moving. In addition the elevation measurements of the floor slabs, and the concrete wall at the edge of the apron, showed measurements which were within expected construction tolerances from the design elevations shown on the construction documents.

Apron Slab

We observed significant cracking and degradation of the apron slab surface in some areas. However, as shown on the elevation data of Figure 1, the apron is not significantly heaved in a vertical sense. The dasher boards connected to the apron slab show significant splaying.

Ice Surface Slab

We observed some cracking of the ice surface slab. The slab has experienced vertical movements in excess of 10" from the design elevations as shown on Figure 1, and has significant curvature at the edges of the ice surface. The cracks mentioned above are relatively narrow and are generally located in the areas of high curvature. Ice Center staff indicated that they had observed voids beneath the edge of the ice slab and that the required ice thickness at the edges of the rink was substantially more than in the center. An elevation difference of between 3 and 5 inches was observed between the apron and ice slab at the dasher boards. We visually confirmed the slab thickness, welded wire mesh reinforcing, refrigerant tubing orientation and rebar size discussed in the rink description at one of the slab core locations.

Sump

We observed the water elevation in the sump approximately 10 feet from the south west corner of the rink. The water elevation was measured as 412.15', which is approximately 2'-4" below the existing apron slab in this area. We also observed ice buildup around the insulated coolant lines while the coolant plant was in operation. Please note that, per the geotechnical report, the observed water may represent a perched water table and not the true water table.

Coolant Plant Room

We did not observe any significant cracks, indications of significant movement or signs of structural concern in the coolant room walls or floors. We did note that the coolant supply lines had crushed the wallboard several inches above the CMU wall where they pass into the rink. Ice Center staff indicated that this movement fluctuates when the coolant plant is taken down for seasonal maintenance.

C. ANALYSIS

The maximum calculated allowable cantilevered span of the 5" slab at the perimeter is approximately 36". However, the Ice Center staff reported observed voids beneath the edge of the slab longer than 36" and the apparent distances based on the elevation survey appear to confirm this. Therefore, it appears that the slab is currently in danger of cracking and potentially rupturing the coolant lines.

The geotechnical report indicates that the average depth to bedrock is approximately 8' and the soil is frozen that full depth. The report also indicates that without remedial action the soil will continue to heave. The report recommends removing the 8' +/- of frozen soil for budgeting purposes. This depth of material over the 85' by 192' footprint of the rink slab gives a material volume of 5,000 cubic yards. Please see Figures 3 and 4 for schematic cross sections of this condition.

D. POTENTIAL REPAIR OPTIONS and ASSOCIATED OPINIONS of PROBABLE COST

Removal and Replacement of Rink Ice Surface, Apron and 8' of Frozen Soil

Remove and dispose of existing slab and foam insulation

18,600 sq ft @ \$11 / sq ft = \$205,000

Remove and dispose of frozen sand and soil / Place and compact open graded fill material

5000 yds @ \$60 / yd = \$300,000

Install drainage piping, sump with pump and moisture barriers

\$64,000

Install new insulation, sand pad & 5" rink slab

18,600 sq ft @ \$9 / sq ft = \$167,000

Install coolant piping in slab and under slab heating system

See EIS report

Slab Leveling with Foam Injection

The geotechnical report indicates that the frost heave will continue to occur making the lifespan of this repair relatively short term. In addition, the potential stress applied to the supply and return lines, which are likely to be embedded in the frozen material beneath the slab, could fracture the lines if the slab above them is lifted. Please see the associated details from the original construction documents shown in Figures 5 and 6, specifically detail A/3 which shows the piping connection. Excavation around the edge of the slab to free the piping may be possible, but given the unknown as-built configuration of the piping we are not able to determine an opinion of the costs involved. The probable cost for the foam injection leveling itself is \$100,000.

Relocation of the Facility

This option is beyond the scope of this report but the costs may be lower than those required to repair the existing facility.

Reuse of the Facility for Other Purposes and Associated Opinions of Probable Cost

Please be aware that an occupancy change can trigger mandatory upgrades to the structure in accordance with Section 3406 of the Oregon Structural Specialty Code, and any decisions to change the use should be carefully considered.

The geotechnical report indicates that the soil will move as it thaws making it unsuitable for support of the floor in the current condition. Options for addressing the issue include:

Removal and Replacement of Rink Ice Surface, Apron and 8' of Frozen Soil

As noted above.

Place a leveling slab over the existing apron to match the existing rink slab edge elevations with planned regular maintenance as needed to maintain a safe and serviceable surface.

8,000 sq ft @ \$8 / sq ft = \$64,000 initial year

Approximate yearly thereafter = \$15,000

Place a sand leveling course over the apron to match the rink surface. Cap the entire rink and apron slab with a thickened and heavily reinforced slab with planned maintenance for leveling.

24,000 sq ft @ \$11 / sq ft = \$265,000 initial year

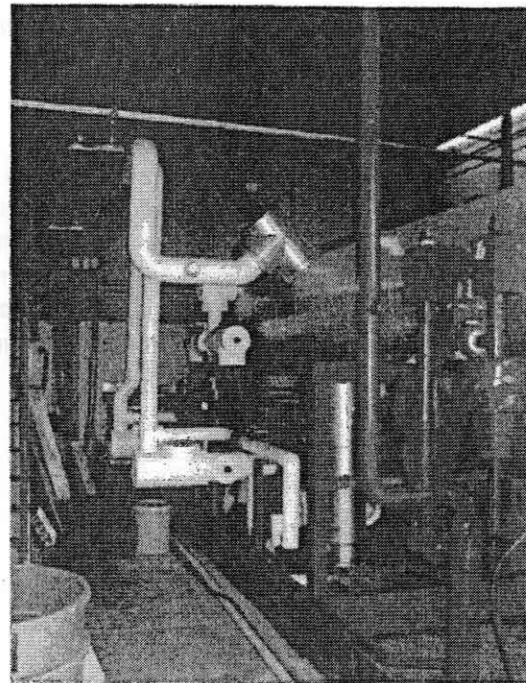
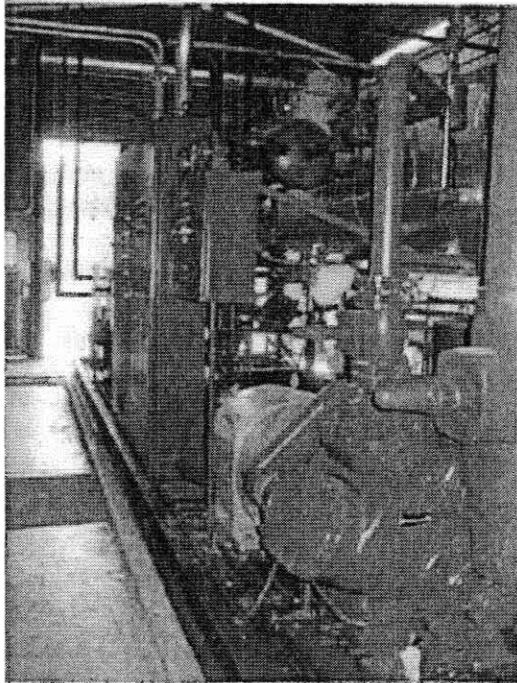
Approximate yearly thereafter = \$8,000

E. SUMMARY

Measurements of the ice surface concrete slab indicate that the slab has heaved in excess of 10 inches in some locations due to frost accumulations at depths of up to 11.5 feet below the slab. Analysis of the slab indicates that it is at imminent risk of failure and the subsequent rupture of coolant lines within the slab. The geotechnical engineering report for the project indicates that the heave is likely to continue which will further increase the risk of failure of the slab. Our recommended repair is removal of the frozen soil and replacement with suitable materials, or relocation of the facility to a properly prepared structure.

A. DESCRIPTION of REFRIGERATION SYSTEM

Direct (Liquid Overfeed) Refrigeration System



The existing mechanical system is "Direct System" as designed by Bonestroo, Rosene and Anderlik of St. Paul, Minnesota. It was installed in 1989 by Holmsten Ice Systems. The system capacity is about 135 tons. At the time this unit was installed, it was considered state of the art. When a facility considers replacing a direct system (with any indirect system), it must be understood that the direct system is at least 20% more efficient than any indirect system on the market. It is also noteworthy that this system at The Events Center has been extremely well maintained and is in excellent condition. The main issue is the failure of the under slab heating grid.

The refrigerated skating surface is 192ft. X 85ft. with 28ft. radiused corners. Under this slab is the sub floor heating grid. In the slab is the refrigerated piping grid. By design, some of the heat being rejected by the compressors is piped through a heat exchanger, collected and pumped under the refrigerated floor to a set of PVC manifold headers. These headers distribute the warm glycol solution. This heating loop is usually a mixture of water and anti freezing agent. In this case, (according to the original drawings) it would contain a 40% mixture of propylene glycol and water. Originally the charge of this loop would be about 450 gallons. While in operation the propylene glycol temperature would be 40 to 45 deg F water and circulated by a 2hp pump. This under floor heating system was designed to keep the sub base of the rink area above freezing, thereby eliminating frost buildup.

In this application the contractor used 2.5" PVC headers to distribute the warm glycol. A flaw in the design is that as the headers transitioned to the actual run outs, steel nipples were used at the point of connection. This connection is shown on Dwg. 3, detail E-3. Overtime these nipples have had a tendency to break down and leak.

After meeting with the Arena staff, on both March 22, 2010 and April 2, 2010, we cannot be sure of when or how the leaks in the under floor began. Did the under floor heat pump inadvertently get shutoff, freeze and then rupture or did the floor materials breakdown, leak and then get shut off?

Each year the refrigeration system ran without the sub floor heating loop the perma frost went deeper and deeper.

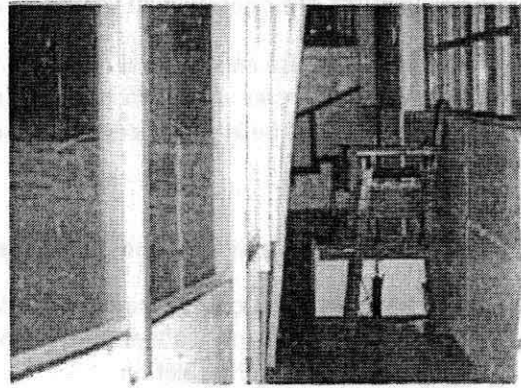
The cold floor piping loop in the direct system is cast into the refrigerated floor. The cold floor piping grid is about 60,000 ft., (10 miles) of 5/8" steel tubing. Two 2" steel welded liquid mains feed liquid R-22 the length of the ice to a 4" steel welded suction main that returns the refrigerant back to refrigeration package. As the liquid travels down the rink it absorbs heat (from the water as it turns to ice) boiling off into a gas. The gas is sucked through the suction header back to the compressors. The system charge of R-22 (often referred to as Freon) is somewhere between 3,000 and 5,000 pounds.

B. OBSERVATIONS

We visited the site on March 22, 2010 to look at the ice rink and to visit with the arena staff. The effects of the permafrost problem were evident. At this time the ice was still being used. We returned on April 2, 2010 to get some additional information, measurements and pictures. The ice was gone and the permafrost heaving of the slab was more pronounced.

Dasher Board System

The dasher system is in very poor condition. If a decision is made to continue skating, we strongly suggest that some immediate remedial work be done on the boards. At the very least all of the openings where sticks, legs, hands, elbows or heads could go through must be eliminated. The most dangerous points exist at most of the gate. Knee bracing and supports should be added wherever necessary.



C. ANALYSIS

The under floor heating grid in the existing refrigeration system is no longer functional. A year round rink cannot be operated without the under floor heating system. The heating grid cannot be repaired without the removal of the existing floor and cold piping grid.

The dasher system is beyond repair and should be totally replaced.

D. POTENTIAL REPAIR OPTIONS and OPINIONS of PROBABLE COST

When deciding on how best to replace the refrigeration system, there are a number of items to consider. As was stated in earlier report, you have a very good and well maintained 135 ton direct refrigeration package. If we were to reuse this machine, we would only have to replace the floor. The main concern with reusing the existing system and installing a new floor is the environmental issue resulting from the use of the R-22 refrigerant. R-22 is a halocarbon and has been listed as an ozone depleting agent. The production of any new R-22 was prohibited as of last year. R-22 cannot be used as a refrigerant in any new refrigeration or air conditioning systems as of January 1, 2010. However reclamation has made sources almost limitless. The amount of the charge is somewhere between 3,000 to 6,000 lbs. In confined area the R22 displaces oxygen and can cause asphyxiation. This amount makes the EPA and safety engineers nervous. New monitors were installed recently to safe guard alarm in case of leaking R-22.

Our second option and maybe more environmentally correct would be to replace the entire refrigeration system with the most energy efficient equipment you can get. Energy is the largest expense in any ice rink operation. It should be a major concern in any ice arena design.

For comparison, we use an industrial ammonia 150 Ton indirect system. Ammonia is ozone friendly and has the best heat transfer characteristic of any usable refrigerant. From a pricing point of view, any industrial systems will be in this price range. The main points of this selection are energy efficiencies.

OPTION 1---Use existing system and replace refrigerated floor only:

1. The replacement cost of the Direct System floor would be\$575,000.00
 - a. Under floor heat system/fusion welded headers and 9,000ft. of tubing
 - b. 4" of floor insulation
 - c. New liquid and suction headers
 - d. 60,000 ft. of 5/8" stainless steel tubing
 - e. Floor sensor
 - f. 5" reinforced concrete floor
2. New Dasher Board System.....\$150,000 to \$180,000
3. In addition to the above , the following cost must be added:
 - a. Remove slab and insulation.....\$205,000.00
 - b. Remove and dispose of frozen sand and soil/place and compact open graded fill materials.....\$300,000.00
 - c. Install under floor drainage system:
 1. Piping.....\$32,000.00
 2. Sump & sump pump.....\$20,000.00
 3. Moisture barrier.....\$12,000.00

OPTION 2 –Replace refrigeration system and refrigerated floor:

1. The replacement cost of the refrigeration unit and floor.....\$1,135,000.00
 - a. 150 Ton Ammonia Package
 - b. Matching Evaporative condenser
 - c. Under floor heat reclamation/fusion welded headers and tubing
 - d. Cold and warm floor pumps
 - e. Fusion welded cold floor headers and 60,000ft. of tubing
 - f. DDC control system
 - g. 4" of insulation
 - h. 5" reinforced concrete floor
 - i. Floor sensor
 - j. Infra red control
2. Electrical upgrade.....\$45,000.00
3. New dasher board system.....\$150,000.00 to \$180,000.00
4. In addition to the above, the following cost must be added:
 - a. Remove slab and insulation.....\$205,000.00
 - b. Remove and dispose of frozen sand and soil/place and compact open grade fill materials.....\$300,000.00
 - c. Install under floor drainage system:
 1. Piping.....\$32,000.00
 2. Sump & sump pump.....\$20,000.00
 3. Moisture barrier.....\$12,000.00

E. SUMMARY

Throughout this report, especially in our geotechnical portion, we have expressed our concern with the possible problems that may occur if you choose to continue operating this facility in its present condition. Whether you choose to operate this building as a rink, or, as an assembly hall, our team believes you must address the structural integrity of the slab.

From an ice rink prospective either Option 1 or Option 2 will work fine. The county may need to weigh the cost differences and the environmentally concerns that the community might rise. If the community chooses to stay with the direct floor, they would not be alone. A number of municipalities in the Greater Chicago area have opted to stay with their direct floor system. Other municipalities have made the change to an indirect system.

A. Arena HVAC Modifications for continued sole use as an Ice Rink

The arena's existing HVAC system consists of area gas unit heaters, a single desiccant air dryer and a low emissivity ceiling. The unit heaters have reportedly been in a state of disrepair for some time but both the desiccant dehumidifier and the low emissivity ceiling function well.

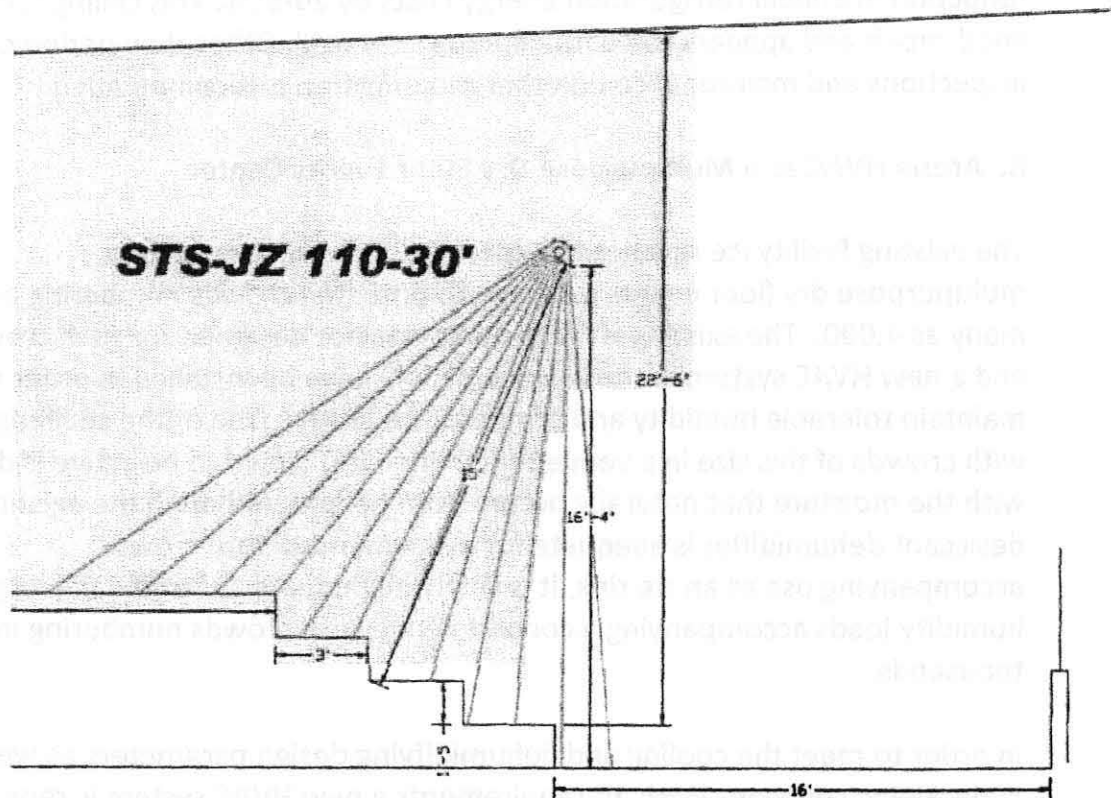
The existing arena heating is accomplished via space heating the air. Space heating in an ice rink can be quite expensive to operate. Not only does it require energy to heat the entire volume of air in the ice rink area, but it also creates a higher convective heat load on the ice which must be removed by the refrigeration system. One useful alternative to heating the ice rink space is by installing infrared radiant heaters. These long tubular heaters effectively heat the people in the stands by radiation without directly heating the air in the ice rink area. As a result, the heating costs are reduced and the convective heat load on the ice is drastically reduced since the air in contact with the ice is much cooler. The energy savings associated with this type of heater varies with the amount of time the heaters are actually used. The refrigeration energy savings possible with this type of equipment range from 3-12% annually.

Air movement over the ice surface also drastically increases the convective heat load on the ice. This heat load increases with any increase in air speed over the ice surface. Although some air circulation above the ice is permissible, it is estimated that the refrigeration costs can be increased by up to 25% with excessive air movement in the rink.

Heating recommendation

The existing space heaters are both inefficient and ineffective for personal comfort. In the event that the arena is repaired and maintained as an ice rink it is suggested to replace the space heating system with localized infrared heating similar to that shown below.

SIDE VIEW



The probable cost associated with the purchasing and installing 12 new gas radiant heaters is on the order of \$35,000

The dehumidifier was installed at the facility in 2001 and has the ability to remove about 161 pounds of moisture per hour providing dry air over the rink in a ducted system. It is reportedly effective in eliminating fog over the ice. It is suggested to continue to use the dehumidifier.

The arena currently has a low emissivity ceiling that appears to have been installed at the time that the dehumidifier was installed. Low emissivity ceilings are an automatic first choice for energy savings in almost any ice skating rink, especially for rinks operating in summer months. These suspended ceilings are actually foil faced radiant barriers. They nearly eliminate the radiant heat load in an ice rink that typically represents 25-40%

of the overall refrigeration load. This radiant heat load naturally occurs when a large ice surface directly faces a large relatively warmer ceiling surface. Low emissivity ceilings, then, can reduce this load by up to 95%. This represents a reduction in annual refrigeration energy costs by 20-35%. This ceiling is in a good repair and appears to be functioning very well. Other than periodic inspections and maintenance no other modification is recommended.

B. Arena HVAC as a Multipurpose Dry Floor Events Center

The existing facility ice rink has the potential to be converted to a multipurpose dry floor events center with potential crowds numbering as many as 4,000. The existing HVAC system was not designed for such crowds and a new HVAC system in the arena area will have to be installed in order to maintain tolerable humidity and temperature levels. One of the challenges with crowds of this size in a venue that invites the crowd to be active is dealing with the moisture that naturally occurs from people. Although the existing desiccant dehumidifier is adequate for use with moderate crowds accompanying use as an ice rink, it is vastly inadequate to handle the larger humidity loads accompanying a concert venue with crowds numbering in the thousands.

In order to meet the cooling and dehumidifying design parameters as well as maintaining sufficient fresh air requirements a new HVAC system is required. We were asked to determine an order of magnitude estimate on the HVAC for the County's information to assist in decision making for future use of the arena.

One of the most economical options to achieve the cooling and dehumidifying needed for a large venue is with the installation of mechanical refrigeration. The most economical is roof top units with a direct expansion refrigeration coil, as opposed to building a central chilled water plant to circulate chilled water to the air handling units. Some loss in efficiency occurs in this design but it is assumed that the units would be used only at times that events are scheduled so economically it's not justifiable for the added expense of a chilled water system.

Four (4) new roof mounted DX- 50 ton chillers were priced at a total installed cost of in the vicinity of \$175,000. It should be noted that the electrical service and roof loading have not been analyzed for capacity loading so the cost may exceed this price.

The preliminary Design is below.

Air Handling Unit Schedule

TAG No	SCFM	ENTER	ENTER	LEAVE	LEAVE
		DB	WB	DB	WB
AHU1	15000	80	70	60.4	58.8
AHU2	15000	80	70	60.4	58.8
AHU3	15000	80	70	60.4	58.8
AHU4	15000	80	70	60.4	58.8

C. Arena HVAC summary

The existing dehumidification system in conjunction with the low emissivity ceiling at the Lane County Ice Rink Arena is a functional mechanical system enabling use as an ice rink. The heating system for personal comfort for spectators has room for improvement. In our opinion, the most economical and effective method for heating an ice rink is with radiant heaters as addressed in this report. There is no immediate safety issue or hazard to personnel should it be decided do nothing in regards to the heating of the arena.

In the event that the use is converted to a multi-use facility with larger crowds there is concern with the existing ventilation system as well dehumidification. In order to compensate for the increased load from a crowd of up to 4,000 people then alterations need to be made to the HVAC system. There are many designs available to accomplish the requirements; we have just provided an order of magnitude for a fairly economical approach to provide a level of comfort to the crowd.