**Project profile**
Refrigeration technological innovation

RAPB
REFRIGERATION ACTION PROGRAM FOR BUILDINGS

# Val-des-Monts Arena (Québec)

## NEW CONSTRUCTION


**Summary**

- Potential for total heat recovery from refrigeration system
- Extensive integration of the refrigeration system with the heating, ventilation and air conditioning system
- Seasonal heat storage and cold storage
- Radiant floor heating
- Refrigeration integrated with geothermal system
- Variable condensing temperature and pressure *(floating head pressure)*


## Characteristics of Arena

| | |
|---|---|
| Owner | Association récréative de Val-des-Monts |
| Built in | 2001 |
| Rink and bleachers | |
| Surface area (footprint) | 2,000 m² (21,500 sq. ft) |
| Volume | 14,000 m³ (500,000 cu. ft) |
| Building | |
| Surface area (footprint) | 3,000 m² (32,000 sq. ft) |
| Volume | 18,000 m³ (636,000 cu. ft) |
| Number of rinks | 1 |
| Seating capacity | 350 |
| Months operated/year | 10.5 |
| Hours open/week | 104 |
| Times ice resurfaced/week | 70 |
| Heated bleachers | Yes, to 15°C (60°F) |
| Annual energy consumption (100% electricity) | 760,000 kWh – 255 kWh / m² (24 kWh / sq.ft) (in 2001-2002) |
| Contract power | 100 kW (in 2001-2002) |
| Annual energy cost | $50,000 (in 2001-2002) |



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## Refrigeration System Installed

| | |
|---|---|
| Equipment type | Factory-built, modular, commercial units |
| Compressors | 6 hermetic compressors |
| Condensers | 6 plate condensers |
| Evaporators | 6 direct-expansion plate evaporators |
| Heat rejection system | Geothermal storage with excess heat routed to fluid cooler |
| Refrigerant | HFC, R-404a (combined total of 35.4 kg in 6 units) |
| Total cooling capacity | 72 tons |
| Operation of condenser | Floating head pressure and temperature |
| Heat transfer fluid in cold secondary loop | Mixture of water and methanol |
| Heat transfer fluid in warm secondary loop | Mixture of water and methanol |

## Energy Efficiency Measures

### *Design*

**Heat recovery**

| | |
|---|---|
| Bleacher heating | Radiant floors. Uses condensation heat recovered in the warm secondary loop |
| Player's rooms heating | Same system as for bleacher heating |
| Service rooms heating | Same system as for bleacher and player's rooms heating; provision for heat pump heating in the event of future expansion to second floor |
| Domestic water heating | Using heat from warm secondary loop, temperature of which is raised to 50°C by heat pump |
| Heating resurfacing water | Same system as for domestic water, including electric elements as make-up for temperatures over 50°C |
| Preheating outdoor air | Heat exchanger between exhaust air and outdoor air |
| Preheating domestic water | No |
| Heating under ice rink slab | Using heat from warm secondary loop |
| Heat recovery from waste water | No |
| Use of surplus heat exceeding arena heating requirements | Fitting provided to route surplus heat to adjacent J.A Perkins community centre in the event of a second construction phase |

## Thermal Storage

| | |
|---|---|
| **Heat storage** | |
| Short term | Reserve of 2,500 litres (560 gallons) for domestic water 50°C |
| | Reserve of 500 litres (120 gallons) for resurfacing at 60 °C |
| Seasonal | An underground horizontal exchanger (piping length of 12 km) |
| **Cold storage** | |
| Short term | A horizontal exchanger is buried under the rink slab<br>Cooling capacity: 1,000 kWh (300 ton-hour) |
| Seasonal | No |

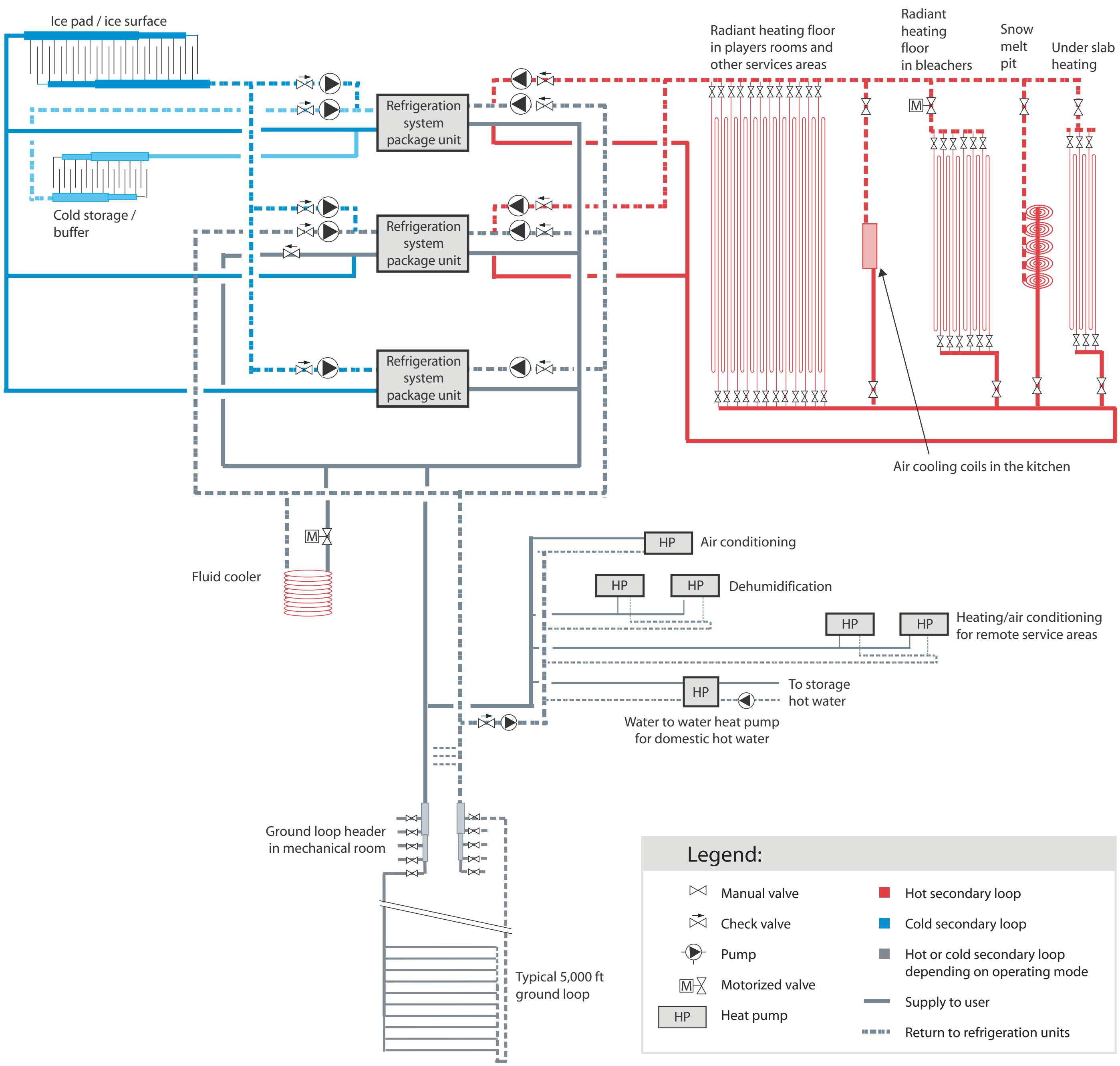
## Other measures

| | |
|---|---|
| Dehumidifying bleacher air | The air is dehumidified by an air-liquid heat pump operating in air conditioning mode. The heat is discharged in the warm secondary loop of the refrigeration system |
| Meltig rink scrapings | The walls of the snow pit are heated by the warm secondary loop |
| Modulating circulation pumps | Six 3 HP pumps are used as required |
| Reduction of maximum flow in cold secondary loop | Yes, by having 5 passes in secondary fluid circuit. The collector pipes are in the mechanical room. |
| Low-emissivity ceiling | Yes, suspended canvas |
| Building Automation System (BAS) | Implementation in progress |
| Efficient lighting | |
| High-intensity discharge (HID) lamps | Metal halide, power 10.5 kW |
| Lighting intensity varied to suit different activities | 4 levels, controlled by BAS and keyed to activity schedule |
| Lighting switched off when arena not in use | To be controlled by BAS and keyed to activity schedule |

## *Operation*

| | |
|---|---|
| Modulation of condensing temperature to suit refrigeration and heating needs and outside temperature | Modulation to be controlled by BAS |
| Electric demand control through peak-load shifting | No |
| Resurfacing water temperature lowered | Adjusted manually |
| Modulation of ice temperature set point | Not controlled |
| Indoor temperature lowered during unoccupied periods | Yes, controlled by BAS |
| Refrigeration system shut down during unoccupied periods | Seldom done due to storage and heating by heat recovery |
| Circulation pumps shut down during unoccupied periods | Not useful with modulation of number of pumps in operation |
| Ventilation shut down during unoccupied periods | Yes, controlled by BAS |
| Ice thickness management | Yes, from ¾ to à 1¼ inches |
| Lighting reduced for certain activities | Yes, controlled by BAS and keyed to activity schedule |
| Ice temperature monitored by infrared sensor | Yes, controlled by BAS |

# Simplified System Schematic



## Project Cost

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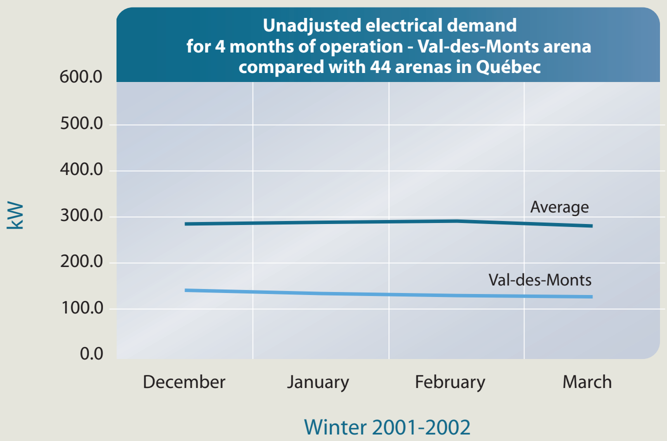
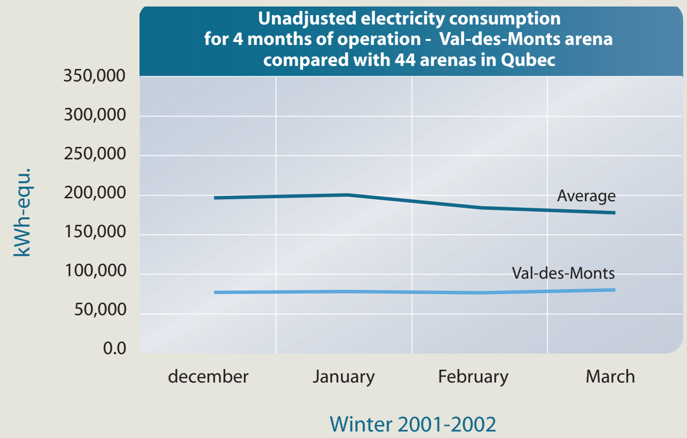
|---|---|
| **Overall cost of arena construction work, including engineering (before financial assistance):** | **$2,75 M** |
| **Financial assistance for energy efficiency** | |
| Agence de l'efficacité énergétique du Québec (AEE) | |
| Office of Efficiency Energy (OEE through CBIP), | |
| CETC-Varennes (through RAPB), | |
| Hydro-Québec | |

## Benefits

| | |
|---|---|
| **Energy Consumption** | **58% less than of the CBIP reference arena and 60% less than of a typical arena in Québec** |
| Contract power | Contract power of 100 kW, or about 50% of the contract power of the typical arena in Québec |
| Note : | The energy savings and reduction in power demand for Val-des-Monts arena represents a reduction of $60,000 in their annual operating expenses compared with the typical arena in Québec. |
| **Environmental benefits** | |
| Effect of refrigerant on the ozone layer | Refrigerant not subject to the Montreal Protocol (no effect on the ozone layer) |
| Greenhouse gas (GHG) emissions | GHG emissions resulting from refrigerant leaks over 80% less than the typical arena in Québec due to the use of hermetic compressors and the small quantity of refrigerant |
| **Other benefits** | |
| Reduction of maintenance costs | No special skills required to start up the system in the fall and shut it down at the end of the season |
| Qualitative benefits | Good quality ice<br>System reliability<br>Exceptional comfort for spectators |




## Rationale

- Necessity of having a regional sports facility
- Desire to reduce operating costs
- Environmental vision for energy efficiency and reduction of GHG emissions
- Solution considered cost-effective based on life cycle cost analysis, over a period of 20 years
- Payback period of 3.5 years, considered reasonable and calculated on the basis of additional costs associated with energy efficiency measures

## Suppliers and Contractors

| | |
|---|---|
| General contractor | Project Management by owner |
| Refrigeration contractor | Ice Kube Systems Ltd. |
| Manufacturer of refrigeration equipment | Frontier Refrigeration Ltd. |
| Control system | Combustion RP |
| Mechanical, electrical and structural engineers | Stantec Expert-conseils Ltée |

### RAPB

The Refrigeration Action Program for Buildings (RAPB) fosters the use of innovative refrigeration practices in order to reduce the greenhouse gas emissions that result from the efficient use of energy and the reduction of refrigerant leaks in supermarkets, ice and curling rinks.

A French version is also available

FOR MORE INFORMATION
**CANMET Energy Technology Centre - Varennes /** Natural Resources Canada
1615, Lionel-boulet Boulevard, P.O. Box 4800, Varennes, (Québec) J3X 1S6 CANADA
Telephone: (450) 652-4621, Facsimile: (450) 652-5177, Website: http://cetc-varennes.nrcan.gc.ca, Email : CTEC-CETC.Varennes@rncan.gc.ca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