ENERGIE
INNOVATION INC.

"ASTRO-RINK"

REFLECTIVE INSULATING MATERIAL

OWNER'S MANUAL

2970 Halpern, Saint-Laurent (Quebec) Canada H4S 1R2
Tel: (514) 334-3783; 1-800-363-0931 Fax: (514) 334-3925
info@energie-innovation.com www.energie-innovation.com

Table of Contents

1.0 About *"Astro-Rink"* Low-Emissivity Insulation

Your facility has invested in one of the most beneficial items on the market for energy efficiency, which has been designed to last for many decades to come.

The information contained within this manual is composed to serve facility staff with information and recommendations which will provide for assurance that the site can achieve the greatest possible benefits, following installation of an *"Astro-Rink"* Low Emissivity ceiling.

After reading this manual and following the recommendations contained within, you will experience lower hydro consumption, and reduced levels of condensation related problems. Of course, should you ever have any further questions please contact our office for assistance.

2.0 General Description

"Astro Rink" Low-E insulation has been used for many decades as a long lasting insulator which, when installed correctly, also provides a complete air seal, increased "R" value and negates the radiant heat gain with its Low-E qualities. These properties provide great assistance in the efforts to achieve an ideal environment in arena applications. "*Astro-Rink"* is reinforced to prevent damages caused by pucks and other flying objects; therefore protective netting is not required.

An "*Astro-Rink"* reflective ceiling, scientifically known as low emissivity ceiling, translates into significant potential savings since the ceiling is the source of 28% of the refrigeration load. In short, the ceiling must be equipped with a reflective surface such as "*Astro-Rink"* to reduce the emissivity from 90% to 5%.

Furthermore a reflective ceiling will reduce humidity condensation on the ceiling and the drops of water that fall on the ice. In fact, ceiling temperature will be higher, which will delay condensation when the humidity increases. Finally, a reflective ceiling can improve the quality and level of lighting by 40%.

Table 1: Technical Data

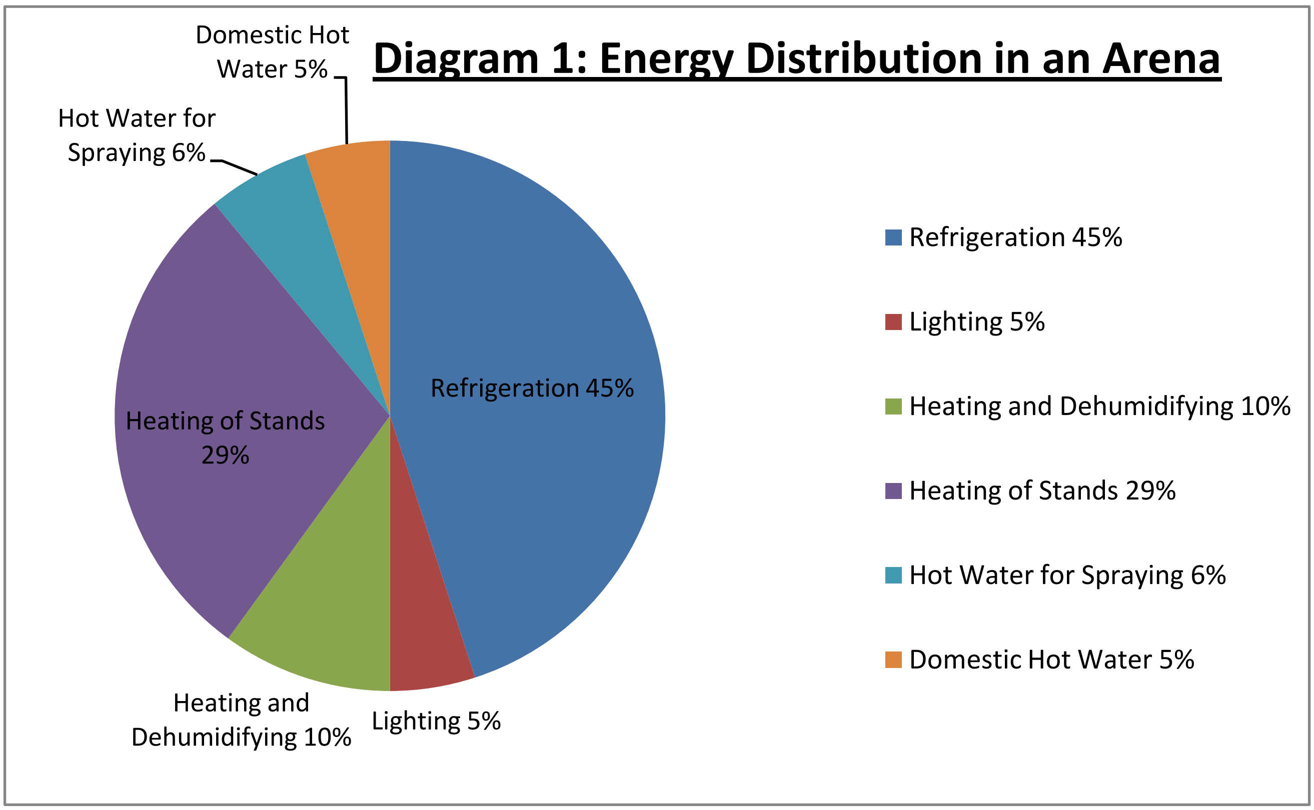
Thickness	8mm (5/16 inch)
Weight	342 g/m^2 (1.12 oz./ft^2)
Temperature range	-50 to 82 °C (-58 to 180 °F)
Flame spread and Smoke Developed Index (ASTM E-84-05)	Class 1 / Class A, 0 and 15 respectively
Flame spread and Smoke Developed Value (CAN/ULC-S102)	0 and 33 respectively
Linear shrinkage	None
Puncture resistance	3 200 kPa (464 lbs/in^2)
R-value	RSI 0.94 (R 5.34)
Emittance	4.7%
Reflectivity	97%

3.0 Energy Use in an Arena

As refrigeration is quite simply, the transfer of heat from one area to another using mechanical means, it is important to realize the sources of that heat in order to reduce its origin, and therefore, refrigeration plant run-time.

The following factors are those that most influence costs in an arena:

- The period of the year during which the ice is being used. It is more costly to make the ice during the summer than the winter.
- The building's interior volume. An arena with stands uses up more energy than one without.
- The thermal resistance and airthightness of the architectural envelope.
- The type of activity that is held there. Hockey is an activity that leads to greater energy consumption than figure skating: the ice needs to be colder, resurfacing is more frequent and showers are used more intensively. Ventilation in the players' dressing rooms must also be more efficient.



As seen in Diagram 1, refrigeration represents the most significant energy load (45%) in an arena.

In order to better understand savings measures in an arena, it is useful to assess the energy needs of the refrigeration system.
The table below reflects this assessment:

Table2: Energy needs of the refrigeration system

Description	Load
Ceiling Radiation	28%
Lighting	7%
Air convection	35%
Zamboni resurfacing	10%
Skaters	4%
Ground and collectors	10%
Brine Pump	6%
Total	**100%**

Approximately 28% of the total cooling load in a typical ice arena or curling rink is due to infrared radiation. This is the area which we are reducing, through the installation of your "*Astro-Rink"* ceiling.

Radiant heat loads can be best exemplified by using two examples common in the arena industry. Radiant heating systems have been used extensively for the spectator areas of arenas. Whether gas-fired or electric, both types, when in operation, radiate their heat to the objects below. It is important to note that if your facility uses this type of heat, ensure that the reflectors around the heating elements shield the ice surface and the boards from direct exposure to the radiant elements. Secondly, with outdoor ice surfaces even with cold air temperatures and a plant providing brine at 10 °F or less, radiant heat from the sun can melt the ice surface. The sun has a similar effect on your facility roof and ceiling, allowing it to gain heat, and radiate it to your ice surface.

4.0 Lowering Radiant Heat Loads

Lowering the temperature at the ceiling can reduce the ceiling radiant heat load. This may be accomplished by keeping warm air away from the ceiling, by increasing the roof insulation, and significantly by lowering the emissivity of the ceiling material to shield the ice from the building structure.

Ceiling and roof materials and exposed structural members have an emissivity that may be as high as 0.9. Special aluminum paint can lower the emissivity to between 0.5 and 0.2. Polished metal such as polished aluminum or aluminum foil has an emissivity of 0.05.

Also because a low-emissivity ceiling is cooled very little by radiant loss, most of the time its temperature remains above the dew point of the rink air, so condensation and dripping is substantially reduced or eliminated.

Low-emissivity ceilings are frequently incorporated into new and existing rinks in order to reduce radiation loads, eliminate condensation problems, and reduce the overall lighting required.

5.0 Operation and Maintenance

Equipment that receives adequate maintenance works longer, more efficiently and at a lower cost than equipment that is not maintained in good working order. Moreover, efficient preventive maintenance results in greater comfort, happier occupants and ensures equipment performance that provides you with better energy cost savings and a healthy environment.

The "*Astro-Rink"* reflective ceiling does not require any maintenance. Although it is a permanently installed product, which will not stretch, sag, shrink, decay or deteriorate in any fashion, it may be removed for access to roof structures by simply removing the tape and screws, then refastening when access is complete. However the heating, ventilation, cooling and control system in your arena must be adequately maintained so as to ensure the foreseen energy savings.

As previously stated, the "*Astro-Rink"* low-e ceiling is impervious to puck damage. However, should the exposed skin be punctured with any sharp foreign object, it will not lose its Low "E" properties as long as the opposite side is not punctured directly above as well. Should the skin be completely punctured, a small piece of reflective aluminum tape can be placed over the hole, rendering it practically invisible.

In order to obtain energy savings with the installation of the "*Astro-Rink"* ceiling, we recommend you follow the operating methods described in the following pages.

6.0 Brine Temperature Control

The installation of your "*Astro-Rink"* ceiling will result in energy savings due to the lower heat load on the ice surface. The ice surface will be colder and harder than previous, resulting in reduced plant run-time. However, this represents only a small percentage of the potential savings.

Since the large radiant heat load has been virtually eliminated, your ice surface temperature will be more stable, allowing for an increase in operating set-point, without the risk of sudden periods of soft ice.

This will allow for the depth of the ice thickness to measure approximately one and one-quarter inch at the highest point of your concrete slab. Weekly measurements should be taken to ensure that this level is being maintained. This level of ice can be safely maintained especially when following our brine set-point recommendations. Brine set-points vary from arena to arena, as there are many variables to take into consideration. Ideally, it is not the brine temperature, nor the temperature of the concrete or sand slab, nor the core temperature of the ice which you desire to control, but the surface temperature of the ice that is critical to your business.

A 3 °C (5°F) decrease in brine temperature can result in an additional 6% refrigeration energy expense per year. Therefore, in order to control brine temperature and to correct the situation, the aquastats and thermostatic valves must be properly maintained and calibrated.

Possible savings with an existing system are associated with brine temperature control, that is to say controlling operation of the compressors. A 3 °C (5 °F) decrease in the suction temperature implies an increase in the energy required.

A decrease in the suction temperature can be due to several factors, but one is noteworthy of attention: partial load operation with two or three compressors operating when only one is needed. This situation translates into a decrease of the suction temperature to -23 °C (-10 °F). Great care should therefore be given to the maintenance and calibration of the aquastats that control compressor operation. An abnormal suction temperature can also be tied to the deficient operation of the thermostatic valve. These also require special attention from qualified personnel.

Studies have shown that the optimum temperature of the ice surface is approximately –3.6 °C (25.5 °F). At this temperature, the ice provides the best “glideability” for skate blades. Colder ice conditions result in the ice becoming “chippy”, deeper ruts developing, figure skaters digging out larger chunks of ice when performing their jumps, and a higher snow load on the ice.

Ice surfaces kept at a warmer temperature will not freeze or “set-up” quickly enough following a typical flood, and provide for a more “sluggish” surface for blades and hockey pucks.

For facilities utilizing computerized controls which employ an over-ice infrared temperature sensor, this method of temperature monitoring for plant control is easily achievable. However, for the vast majority without these state of the art controls there is a simple rule-of-thumb to follow in order to achieve this desired level.

An Ice surface with an ideal surface temperature will react as follows: During a “typical” flooding procedure, the operator should shave enough ice to fill the snow tank to approximately two-thirds full, remember that warmer ice does become as “cut-up”, nor is there as much snow as colder ice. Therefore a full bucket of snow on an Olympia or Zamboni is not required! If the resurfacer is equipped with “wash water” continue to use it. Control the flooding water flow (hot water) recognizing the fact that since the ice is not being gouged as much, you do not have to set the blade cutting depth as deep as previous settings. Floodwater should not be set at full flow, and be shut off on areas of frequent overlaps such as the creases. When following the above criteria, the ice should freeze or “set-up” approximately two laps after passing over that area. Given this scenario, the ice is at its ideal temperature of approximately –3.6 °C (25 °F), and the compliments will start coming in!

In most cases a brine set-point of –8 °C (17.6 °F) will provide this, however you will have to experiment with your plant as operating conditions differ. Additionally during periods of non use or infrequent flooding, the ice will become colder, as the heat gain is practically non existent, therefore brine set-point should be raised again to compensate, then lowered when frequent flooding returns.

Following the above guidelines will allow you to gain the maximum benefits from your ceiling in reducing your plant run-time.

7.0 Ice Thickness and Temperature

Ice temperature and thickness also effect compressor consumption.

Brine returned at –8 °C (17.6 °F) can usually maintain a good ice quality. Maintaining the brine at –12 °C (10.4 °F) requires approximately 8% more energy per year.

We have planned on a **1 °C (2 °F) rise in the brine return temperature** in order to obtain energy savings with the installation of the "*Astro-Rink*" ceiling.
As for Ice thickness, thin or thick ice each has its own advantages as to its hardness and thermal inertia; however, with respect to energy consumption, the difference between a 13 mm (1/2 inch) and a 38 mm (1 1/2 inch) ice amounts to 5% per year.
It is important to periodically measure ice thickness in several places and to quickly correct any abnormalities noted.

8.0 Ice Temperature Modulation

Activities that take place on the ice do not all require the same ice hardness. In fact, the requirements are as follows:

Table 3: Recommended ice temperature for different activities

Activity	Ice Temperature
Professional Hockey	-6 °C (21.2 °F)
Figure Skating	-3 °C (26.6 °F)
Recreational Skating	-2 °C (28.4 °F)

When the Activities take place at set hours, a schedule can easily be prepared to adjust the temperature automatically or manually depending on the method chosen.

9.0 Verification of Brine Density

Brine density must be checked: brine that is too concentrated requires more energy from the pump. A 10% increase in brine density represents an additional 1.5% energy expense.

10.0 Lighting in Your Rink

The lighting in your rink is one of the first items noticed by your patrons. Therefore the aesthetic quality of your ice surface and lighting levels are crucial for customer satisfaction and safety.

The polished aluminum surface of your "*Astro-Rink*" ceiling has a reflective value of 90%, whereas typical arena construction materials (steel, wool and concrete) have relative low reflective values of 30%. The new ceiling increases the light levels, provides for a more even distribution of light, and reduces the shadows and glare.

The light levels in an arena will typically increase 25% - 40% over previous levels following the installation of a Low-E ceiling. Several clients have seized the opportunity to decrease their lighting level output by strategic switching, relamping with lower wattage bulbs, installing dimming devices etc… This results in energy savings directly from the decrease in kilowatt consumption, as well as the reduction in radiant heat from the bulbs, and heat gain from ballasts. The following lists the lighting levels recommended by the Illuminating Engineers Society (I.E.S.) for arenas, and corresponding uses:

Table 4: Recommended lighting levels and corresponding uses

Event	Foot candles	Lux
Ice Maintenance	10 – 15	100 – 150
Figure Skating	15 – 20	150 – 200
Public Skating	20 – 30	200 – 300
Recreational Hockey	30	300
Semi-Pro Hockey	50	500
Pro Hockey (Television Level)	100	1,000

11.0 Condensation and Fog in Your Arena

In addressing humidity concerns, no Low-E product will remove or prevent humidity. In order to achieve this, a mechanical process is required.

During warmer weather periods, typically early spring or late fall, condensation will form and drip off the components of an arena enclosure, i.e. ceiling, beams, light fixtures, speakers etc… This situation occurs because the components are experiencing a cooling effect as a result of rapid heat loss, and result in the formation of “ice bumps” which are unsightly, dangerous for skaters and require extra maintenance to remove. Due to its composition, your “*Astro-Rink”* Low E ceiling will maintain a ceiling temperature above the dew point temperature thereby virtually eliminating ceiling dripping. What does occur however is the formation of moisture on other surfaces that are below the dew point temperature. This may result in the formation of water puddles in the lower stand areas, and a higher level of condensation on arena boards and glass.

If your facility typically experiences these types of conditions, it is imperative that you ensure your dehumidifiers are functioning at their optimum level.

12.0 Reducing Humidity in Your Arena

With or without mechanical dehumidification in your facility, there are several operational procedures to follow in order to reduce the level of humidity, and the resulting fog and condensation problems.

First and foremost, it is important to recognize that humidity travels rapidly to cold air environments, as cold surfaces can “hold” less moisture than warmer surfaces. This can be best displayed by the evidence of moisture on the interior side of the windows in the house during the winter. The moisture is condensing on the cold surface. The relative humidity outside will be in the 85 % range at –15 °C (5 °F), as you struggle to keep your home humidity above 40% to prevent static, dry throats etc…! The humidity in the house escapes to the colder outside air.

In your arena, the reverse is taking place. As the temperature inside the arena enclosure is colder than the outside air, humidity is drawn inside. Weather-stripping on all doors should be examined and replaced as required. The operation of ventilation fans should be kept to a minimum, and louvers on dampers should seal tightly. If mechanical dehumidification is present, have it serviced regularly. Typically at arena temperatures of 5 to 15 °C (41 to 59 °F), relative humidity at or below 80% should reduce fogging, however you may require lower levels to reduce all condensation and provide a better comfort level for users. And the most critical item, as mentioned previously, ensure that your ice surface temperature is no colder than absolutely required! After all, this is why you had your ceiling installed in the first place!

With all these factors combined, you will reduce the level of humidity, maintenance time and costs, lower your equipment run-time, resulting in lower energy costs.

13.0 Energy Savings Calculations

Energy savings calculations are derived from data provided by representatives from the site(s) concerned. The stated yearly savings and associated payback period is achievable following the installation of an "*Astro-Rink"* Low-E ceiling. Our engineers' reports have been proven to be accurate, as past installations have shown. However we cannot guarantee these values for the following reasons.

1) Fluctuations in the start-up dates and duration of the ice (in season)

2) Increased energy consumption due to increase in ice usage (increased heat load from flooding, lighting, etc…)

3) Warmer ambient temperatures as a result of higher degree-days than year which data was provided

4) Failure of staff to maintain ice at proper thickness and higher than previously set brine temperatures.

As previously stated, the energy savings are realistically achievable. We at Energie Innovation Inc. are dedicated to ensure that you will be provided with all information to enable your business to realize these savings within the stated period.

14.0 Client Warranty

Energie Innovation Inc. warrants "***Astro-Rink"*** Low Emissivity Insulated Ceilings to be free from defects in material and installation under normal use and service. *Energie Innovation Inc's.* obligations under this warranty are expressly limited to replacement of material, which proves defective during the life of the building application. The labor is guaranteed for 5 years. We guarantee that any damaged material caused by minor water leakage shall be replaced for free.

This warranty does not apply to:

1) Vandalism

2) Damage caused by acts of God, casualty, catastrophe, fire, flood, explosion, tornado, etc.

3) Damage by other than hockey pucks & balls, and lacrosse balls.
4) Damage by removal and/or relocation and replacement of ceiling materials by persons other than *Energie Innovation Inc.* after the date of the original installation

5) Workmanship for installations for which materials are supplied by *Energie Innovation Inc.* and installed by others.

This warranty agreement is expressly in lieu of any and all representations and warranties expressed or implied, including any imply warranty whether arising from statute, common or civil law, custom or otherwise. The remedies set forth in this disclaimer and limited warranty agreement shall be the exclusive remedies available to any person. No person has any authority to bind *Energie Innovation Inc.* to any representation of warranty other than this disclaimer and limited warranty agreement.
Energie Innovation Inc. shall not be liable for any direct consequential or special damages resulting from the use of the "***Astro-Rink"*** ceiling or caused by any defect, failure or malfunction of the product, whether a claim for such damage is based upon warranty contract, negligence or otherwise. In no case will *Energie Innovation Inc.*'s liability exceed the amount paid for the item involved.

NOTES:

NOTES: