



A few facts about ICECO low emissivity ceilings...

ICECO Advanced Arena Products low emissivity ceilings are designed to: reduce refrigeration loads and energy costs; improve lighting levels and quality; eliminate moisture and condensation problems and improve acoustics and appearance in ice rink facilities.

ICECO provides a cost effective solution to the demands of the rink designer, operator and user groups.

Ceiling Radiation

The design and amount of refrigeration energy usage for an ice rink depends primarily on the heat loads (i.e. conductive, convective and radiant) imposed on the ice sheet. Therefore, incorporating products or systems into the design or retrofit of an ice rink that help to reduce the heat loads is the key to an energy and cost efficient design and operation.

It is interesting to note that ceiling radiation is generally the **largest** single heat load source in an ice rink and yet is so often overlooked. In fact, ceiling radiation can account for **25% to 35%** of the total refrigeration requirements. (ASHRAE Refrigeration, 1994, Chapter 33, Ice Rinks).

Indoor ice rinks create a unique condition where a large, relatively cold surface (ice sheet) is maintained beneath a relatively warm surface (rink ceiling). The ceiling is warmed by solar radiation, outdoor air temperatures and internal sources (people, lights, heaters, equipment, air stratification).

Heat gain to the ice comes from the infrared component of the long wave radiation emitted by the warmer ceiling. Unfortunately as this infrared radiation is difficult for people to sense, its importance in ice rinks is easy to ignore. Nevertheless, the amount of heat radiated to the ice is substantial.

For those not familiar with radiant heat transfer; radiation occurs when there are big differences in temperature in an open space, such as when you lie in the sun, sit in front of a fire or stove or huddle up to a radiator. Fortunately for ice rinks, infrared radiation is one source of heat load that can be practically eliminated.

The amount of heat radiated to the ice is controlled by the temperatures of the ceiling and ice, and a factor called **emissivity**.

Materials that are a perfect radiator of heat would have an emissivity of 1, while materials that radiate no heat would have an emissivity of 0. Unfortunately most ceiling materials (wood, steel, insulation, white and colored paints, tile, concrete, white vinyl, etc.) and exposed structural members found in ice rinks will have an emissivity of about **0.90**. The radiant heat flow for general estimation purposes, can be calculated by the equation (ASHRAE, 1990):

$$Q_r = 0.1713 \times A \times e \times (T_c^4 - T_i^4) \times 10^{-8} \quad \{0.005663 \times A \times e \times (T_c^4 - T_i^4) \times 10^{-8}\}$$

Where

- Q_r = Radiant heat load, Btu/hr {kW}
- A = Area, ft²{m²}
- e = Emissivity decimal
- T_c = Ceiling temperature, °R {°K }
- T_i = Ice temperature, °R {°K }

For example, an 85 ft x 200 ft (17,000 ft²) rink with a standard ceiling (e=0.9) temperature of 60°F (520°R) and ice at 24°F (484°R) would have a radiant heat load of **478,058 Btu/hr (40 Tons, 140 kW refrigeration)**.

An **ICECO** low emissivity ceiling would reduce the radiant heat load to **24,000 Btu/hr (2 Tons, 6 kW refrigeration)** - **reflecting an emissivity factor of only 0.03!**

For a more detailed engineering calculation (view factors, grey body configuration, ceiling geometry etc.) refer to ASHRAE Journal, April 1992, Modernizing and Retrofitting Ice Skating Rinks.

Low Emissivity Ceilings

The most practical way to reduce the amount of heat radiated from the ceiling is to install a low emissivity ceiling

ICECO ceilings have a surface emissivity of about **0.03** (ASTM E408). Installing an **ICECO** ceiling in the above example, would reduce the radiant heat load to **20,992 Btu/1ir (2 Tons, 6 kW refrigeration)**. This translates into a savings of over **90%**, in reduced radiant heat loads. Ice rink designers can take advantage of the **ICECO** ceiling to reduce refrigeration plant requirements Tons, kW) and energy (kWh) costs.

This same principle is used in astronaut space suits and hypothermia blankets to prevent people from losing body heat through radiation. In addition, thermos bottles and low E glass take advantage of their low emissivity properties to help prevent heat transfer.

ICECO low emissivity ceilings are designed to:

- **withstand puck impact and rink environments**
- **meet local building and fire codes**
- **be modular and integrate into roof design**
- **enhance rink appearance**
- **eliminate ceiling condensation and drip**
- **improve lighting and acoustic qualities**
- **maintain building integrity**

A common misconception is that by installing ceiling insulation in a rink, the same benefits will be achieved. This thought stems from the assumption that ice rinks are similar in design to other commercial buildings. However; a review of Ice Rink Heat Loads shows that conductive heat transfer (R- value) through the ceiling is **not** even considered a refrigeration heat load source.

Therefore, insulating the ceiling will have very little impact on the refrigeration requirements or energy usage. In addition, insulating ceilings in ice rinks to commercial building standards, may create condensation problems and structural damage. Insulation will reduce the surface temperature of a ceiling, thus increasing the possibility of the surface being below dewpoint.

Furthermore, ice rinks must be concerned with vapor barrier conditions. During warm weather a vapor barrier could be on the cold side of insulation and moisture problems would occur. (Source: ASHRAE Refrigeration, 1994, Chapter 33 and Indoor Ice Arenas Humidity caused Problems and Suggested Solutions, NRC). Puck damage to insulation and vapor barrier is also a concern.

A properly designed ceiling for an ice rink should be as warm as possible (i.e. above dewpoint, minimal insulation), maintain building integrity, meet building and fire codes and not radiate i.e. low emissivity) heat to the ice. **ICECO** ceilings meet these criteria.

Energy Savings

A study conducted by the Canadian Electric Association (CEA 9129 U 858) for Electric Utilities DSM programs concluded that: low emissivity technology was the single most significant energy savings opportunity available for ice rinks. In fact most electric utilities or government agencies will provide incentives to ice rinks that implement these technologies.

Energy (kWh) and demand (kW) savings are a direct result of the reduced refrigeration heat loads created from an **ICECO** ceiling. As a result of reduced heat loads, compressors and auxiliary equipment (pumps, fans) will operate less (kWh) and may be downsized (kW) in many instances.

The actual energy savings from **ICECO** low emissivity have been well documented by many third party organizations like: Ontario Ministry of Energy; Ontario Hydro; B.C. Hydro; Alberta Energy; US Department of Energy; EMR as well as other electric utilities, government agencies and engineering societies.

In addition, hundreds of satisfied ice rink customers throughout the world can attest to the savings and benefits.

Typically low emissivity ceilings will reduce radiant heat loads by over **90%** (ASHRAE). This translates into a total refrigeration energy savings of about **20% to 25%** (ASHRAE, Refrigeration, Chapter 33, Table 2).

Condensation And Drip

A major concern in ice rink operation is ceiling condensation, drip and fog. Fog is best handled through the proper use and design of dehumidification equipment. We have seen that insulated ceilings can actually promote condensation problems. In contrast, **ICECO** ceilings reduce or eliminate moisture concerns.

The heat (457,066 Btu/hr from example) that is no longer radiated to the ice stays above the ceiling, keeping the ceiling area above dewpoint. In fact, a study conducted by the US Department of Energy (DOE/TIC - 10289) estimated that a low emissivity ceiling would raise ceiling space temperatures by at least 10°F (5°C). With the ceiling above dewpoint, moisture will not condense and dripping will not occur.

In addition, eliminating wetness also prevents rust and rot and helps to preserve the rink structure and building integrity. The periodic painting and cleaning of the structural ceiling can be eliminated, saving substantial material, labor costs and rink down time.

Lighting And Acoustics

The highly reflective (0.80, ASTM C-523, 500 nm) surface of the **ICECO** ceiling reduces the number of lighting fixtures required.

Light bounces back and forth between the painted ice and the **ICECO** ceiling in a reflective action that minimizes glare and shadows and improves the overall appearance of the rink. **ICECO** ceilings can improve present and designed illumination levels (fc, lux) by **20% to 30%**.

In addition, the design of the **ICECO** ceiling results in a substantial acoustical improvement in rinks where the volume or quality (reverberation time) of the sound in the arena is objectionable.

ICECO – your trusted ceiling source

The rink manager, owner and consultant should be aware that all low emissivity ceilings are not created equal. Many "copy cat" systems may not perform as well as **ICECO**, may not be suitable for ice rink applications and may actually create more problems than they solve. A case in point are some of the "bubble type" insulated or ceiling panels (i.e. polyisocyanurate foam) presently being marketed as low emissivity ceilings. In many cases as a result of installation methods and poor fire characteristics (flame spread, smoke developed), these systems may not meet the local, national, provincial or state building and fire codes for a rink type facility. In addition, the insulating effect (R-value) and dual foil features of these systems may create condensation and vapor barrier problems.

Finally, although low emissivity ceilings are passive in nature, there are several operational changes that need to be made in order to maximize savings. This can be done manually or the rink can take advantage of our Infrared Ice Temperature Controllers to automate these procedures, generate greater savings and improve ice quality. Based on decades of experience, many satisfied customers and a proven track record, **ICECO** is a name you can trust.

Please feel free to call **ICECO** Advanced Arena Products, if you have any questions @ (905) 315-7939 or E mail info@icecoadvanced.com