PPI Recommendation J

Recommended Hydronic Snow & Ice Melting (SIM) System Performance Level Selections for Residential, Commercial, and Institutional Applications

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1. Introduction

Modern hydronic technology combined with proven plastic piping materials can provide responsive and efficient snow and ice melting system solutions. These systems are widely used in demanding climates across North America. With proper design and installation, these systems provide long-term performance and reliability, as well as saving the time and energy spent on traditional snow and ice removal using mechanical equipment (e.g., shovels, snowplows, snowblowers, trucks).

Hydronic snow and ice melting (SIM) systems were pioneered in the 1940s using wrought iron piping embedded in concrete. Modern SIM systems use flexible plastic tubing, typically crosslinked polyethylene (PEX) or polyethylene of raised temperature resistance (PE-RT), the same piping materials which are used for indoor radiant heating/cooling systems.

Benefits of hydronic snow and ice melting systems include safety, convenience, reduced liability, minimized environmental impact, improved long-term reliability, and reduced snow removal costs, no matter what the outdoor application. Hydronic snow and ice melting systems have been shown to reduce facility operating costs by 50% or more, as compared with mechanical snow removal. Hydronic SIM systems eliminate the need for frequent sanding and salting and the inconvenience and cost of snowbanks left behind. Plus, when equipped with the right control strategy, these systems can be fully automatic.

2. Snow and Ice Melting Design Steps

By circulating warm anti-freeze mixtures (e.g., glycol and water) through plastic piping, outdoor surfaces are heated, melting snow and ice and evaporating the remaining water. These closed-loop systems typically include a heat source, circulating pump, piping, manifolds, controls, and other mechanical devices such as compression tanks and safety valves (see local codes for safety requirements).

The five primary design steps for a hydronic snow and ice melting system are:

1. Select the appropriate performance level with the customer
2. Determine the required heat output/heat flux for the area
3. Select and size the heat source to meet the required heat output
4. Design the piping distribution system (e.g., diameter, spacing, circuit length)
5. Size hydronic equipment such as circulator pumps, compression tanks, etc.

This Recommendation is intended to assist with Step 1, selecting the appropriate performance level based on customer requirements and expectations.

3. Snow and Ice Melting Performance Levels

Unlike in an indoor heating system, where the methods to calculate heating loads are well defined, for SIM systems the designer and customer collaborate to select the capability of each system based on factors such as the type of outdoor area, its exposure, and customer requirements and expectations.

In the 2023 ASHRAE Handbook *HVAC Applications*, Ch. 52 “Snow Melting and Freeze Protection” provides guidance to designers of SIM systems. Ch. 52 includes Table 1 *Frequencies of Snow-Melting Surface Heat Fluxes at Steady-State Conditions* for forty-six (46) major US cities.

The heat flux values are listed under the sub-heading “Heat Fluxes Not Exceeded During Indicated Percentage of Snowfall Hours from 1982 to 1993, Btu/h-ft^2” with percentage values of 75%, 90%, 95%, 98%, 99%, and 100%. For example, a 95% value indicates that 95% of the time, the snow melting heat flux load should be at the given value, or lower. These are referred to as **Frequency Distribution** values.

Within Table 1, each city also has three rows referring to **Snow-Free Area Ratios (Ar)**, defined as:

- **Ar = 1.0** Snow-Free Area of 100% (i.e., no accumulation during snowfall, see Fig. 1)
- **Ar = 0.5** Snow-Free Area of 50% (i.e., some accumulation allowed during snowfall, see Fig. 2)
- **Ar = 0** Snow-Free Area of 0% (i.e., the surface is allowed to be covered with snow during heavy snowfall, melting snow from the bottom of the layer, see Fig. 3)

Table 1: Frequencies of Snow-Melting Surface Heat Fluxes at Steady-State Conditions*

Location	Ar	75%	90%	95%	98%	99%	100%
Albany, NY	1	89	125	149	187	212	321
	0.5	60	86	110	138	170	276
	0	37	62	83	119	146	276

*Table extracted from 2023 ASHRAE Handbook *HVAC Applications*, Ch. 52 “Snow Melting and Freeze Protection”

Note 1: The data in Table 1 from Chapter 52 of the 2023 ASHRAE Handbook was generated from a large dataset covering a period from 1982 -1993; this data may have shifted since that time. Additionally, those numbers are for only the surface of the slab, and specifically for a slab of width 20 ft (6.1 m) and an emittance value of 0.9. For cities not found in Table 1 of the Handbook, designers can select a city listed in the table that closely matches the snowfall rates, winter temperatures, wind speeds, and elevation for the system location. Otherwise, a series of calculations, shown in Ch. 52 of the Handbook, can be performed by the designer to estimate the heat flux requirements based on historical weather data for the location.

Selecting the snow-free area for each SIM system is a design choice. Although having the SIM area completely free of snow during the snowfall is typically preferred, maintaining a snow-free area of 100% (Ar = 1.0) requires that the system melts all snow on contact and requires far more energy than if a thin layer of snow is allowed to accumulate on the surface during the snow event.

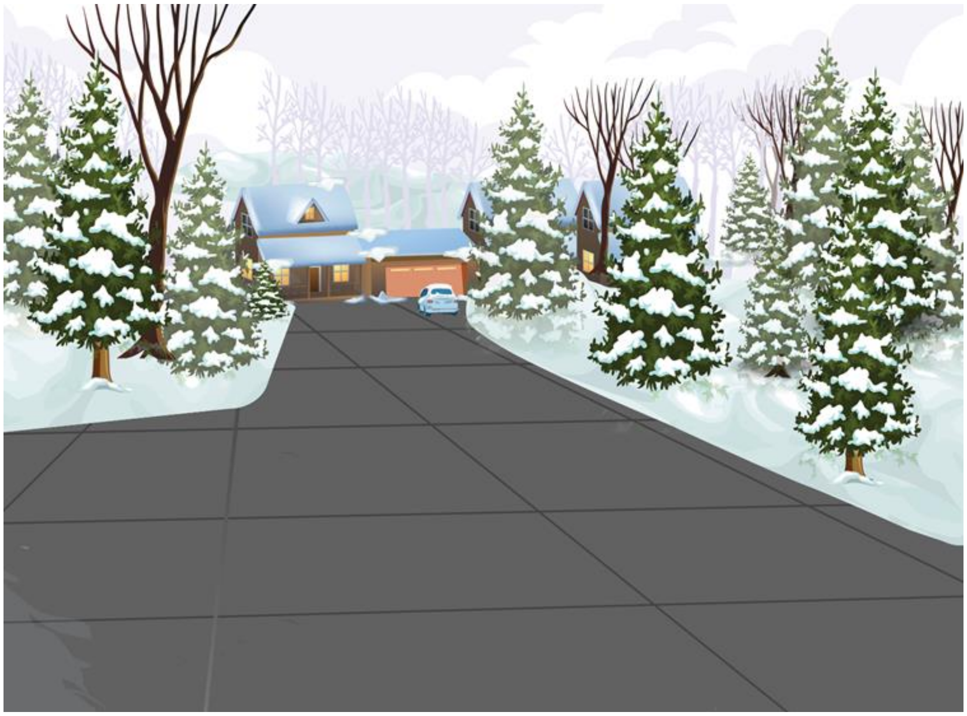

Figure 1 - Snow-free area ratio of 100% (Ar = 1.0)

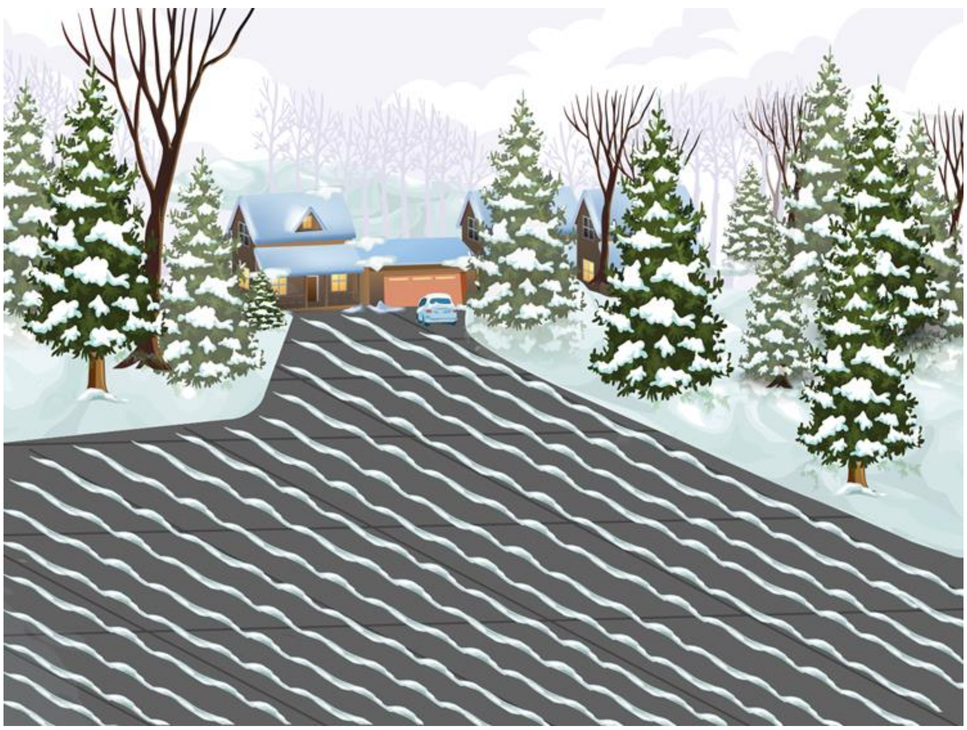

Figure 2 - Snow-free area ratio of 50% (Ar = 0.5)

On the other hand, a snow-free area of 0% (Ar = 0) means that the area might have a layer of snow on its surface during the snowfall event, but once the snowfall rate slows down, the snow will be melted and then evaporated to leave a dry surface. It's practically a matter of how much time is allowed to melt the snow and ice.

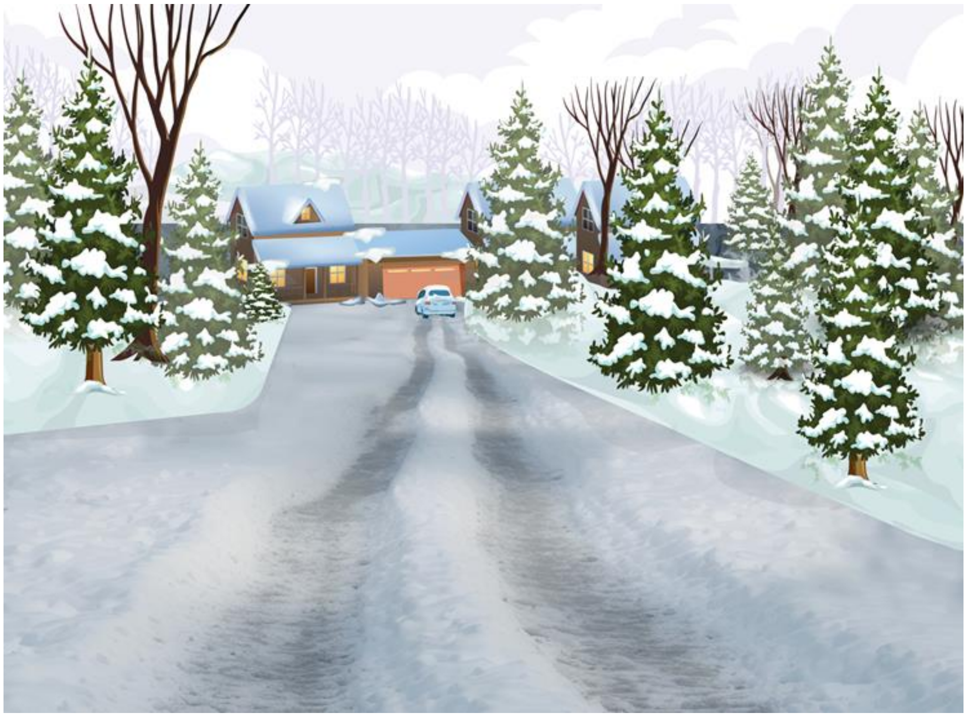

Figure 3 - Snow-free area ratio of 0% (Ar = 0)

Designing for a snow-free area of 100% (Ar = 1.0) will require a much larger heat source, larger circulating pump(s), larger pipes, and other mechanical equipment to achieve the 100% snow-free surface during snowfall events. Designing for Ar values of 0.5 or 0 can dramatically reduce the size of this equipment, as well as energy consumption and operating costs.

In principle, the designer and customer agree to the most appropriate Snow-Free Area Ratio and Frequency Distribution for a given system. The customer should select how capable their system should be. Then, the specific heat flux loads, typically expressed as British Thermal Units per hour per square foot of area (i.e., Btu-hr-ft^2) can be selected from the published data, weather research, and/or case studies.

Table 1 in the ASHRAE Handbook provides the relative heat flux load data to help design a SIM system to meet customer expectations and the associated risk involved with the exposure area, but guidance is often requested to help select these parameters. See examples below:

- **Example 1:** A residential driveway for a home in a neighborhood does not need to be 100% snow free in the worst case expected blizzard. To reduce both capital and operating costs, the customer agrees to design parameters of Ar = 0 and *Frequency distribution* of 75%, recognizing that during a snow event, a light layer of snow may be present, but a vehicle and a pedestrian can still pass over it, and the snow will eventually be melted to leave a 100% snow free and dry area.
- **Example 2:** A doctors’ office expects the sidewalk, steps, and wheelchair ramp for their clinic to be 100% snow free in storms equal to 90% of the worst case expected blizzards, based on historical weather data. In the worst 10% of snow fall events, they anticipate canceling appointments and closing the clinic, because roadways will not be safe for their clients. This system should use design parameters of Ar = 1.0 and *Frequency distribution* of 90% to keep the walking area snow free in 90% of expected snow fall events.

- **Example 3:** A new gas station is being constructed, and the owners want it to be open even in bad winter weather. They recognize that their customers can still drive their vehicles over a light layer of snow due to the level surfaces, so they agree to design parameters of Ar = 0.5 and *Frequency distribution* of 95% for the main vehicle areas, and an Ar = 1.0 for the sidewalks, to reduce liability and help prevent tracking snow into the building. In more severe weather, they will still be melting snow, but a build-up will be allowed until the snowfall rate diminishes.
- **Example 4:** A hospital rooftop medivac landing pad is intended to accept aircraft even in very severe blizzards and the customer expects the landing area to be 100% snow free in storms equal to 99% of the worst case expected blizzards, based on historical weather data. This level of capability will also reduce blowing snow when the helicopter is landing and taking off. This system should use design parameters of Ar = 1.0 and *Frequency distribution* of 99% to keep the area snow free in 99% of expected snow fall events.

To help manage customer expectations and construction costs, **Table 2** includes suggested Snow-Free Area Ratio and Frequency Distribution values for common SIM applications in most winter regions of Canada and USA. Actual selections on a specific basis are the responsibility of the design engineer, project owner, or other responsible party. Specific outputs may be limited due to capacities of thermal mass materials, heat source, other equipment and unknown variables.

Note 2: This content includes courtesy suggestions to help manage customer expectations. Each customer should decide and confirm what is expected for their project.

Note 3: For detailed information about SIM system design, heat flux selections, installation details and more, see 2023 ASHRAE Handbook *HVAC Applications*, Ch. 52 “Snow Melting and Freeze Protection” and piping manufacturers’ guidelines.

Note 4: Proper controls are essential. A SIM system cannot meet its performance level without correct sensors, placement, and operational parameters.

Table 2: Suggested Snow-Free Area Ratio and Frequency Distribution Values for Typical SIM Applications*

Application	Snow Free Area Ratio (Ar)	Frequency Distribution %
Private residential sidewalk, steps, ramp	0.5 or 1.0	75 or 90
Private residential driveway	0.0 or 0.5	75 or 90
Private residential driveway, inclined	1.0	90
Apartment building sidewalk, steps, ramp	1.0	95 or 98
Apartment building parking lot	0.5	75 or 90
Apartment building parking ramp	1.0	90 or 95
Public building sidewalk, steps, ramp	1.0	90 or 95
Public building parking lot	0.5	90
Public building parking ramp	1.0	90 or 95
Public building loading dock	1.0	90 or 95
Commercial building sidewalk, steps, ramp	1.0	90 or 95
Commercial building parking lot	0.5	75 or 90
Commercial building parking ramp	1.0	90 or 95
Commercial building loading dock	1.0	90 or 95
School sidewalk, steps, ramp	1.0	90
School parking lot	0.5	90
School parking ramp	1.0	90 or 95
Fire/rescue station sidewalk, steps, ramp	1.0	95, 98, or 99
Fire/rescue station parking lot	0.5	95
Fire/rescue station vehicle ramps	1.0	95 or 98
Hospital sidewalk, steps, ramp	1.0	95, 98, or 99
Hospital parking lot	0.5 or 1.0	90 or 95
Hospital parking ramp	1.0	95
Hospital MediVac landing pad	1.0	99
Airport public entrances	1.0	95
Airport ramp/apron/taxiway/runway	0.5	95
Private landing pad (helicopter)	1.0	90 or 95
Private ramp/apron/taxiway/runway (airplane)	0.5 or 1.0	90
Car wash and aprons	1.0	90

**This content includes courtesy suggestions to help manage customer expectations. Each customer should decide and confirm what is expected for their project.*

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