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Standard Guide for Ice Hockey Playing Facilities[1]

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INTRODUCTION

Since its inception, the game of ice hockey has evolved as a result of a convergence of ideas from Canada, the United States, and Europe. As a result of differing influences, there are a wide variety of playing facilities currently in use, accompanied by wide disparities in margins of safety provided to players, game officials, and spectators.

The purpose is to provide a guide for safer ice hockey playing facilities. Attention is called to the dimensions of the ice surface. The majority of facilities in Europe comply with those of the International Olympic Committee, 200 ft (60 m) in length and 100 ft (30 m) in width, while in North America, the majority of facilities are 200 ft (60 m) in length and 85 ft (26 m) in width.

In the interest of future standardization, it is recommended that ice surface dimensions of all new facilities are those found in this guide.

It is recognized that ice hockey playing facilities also are used for figure skating, speed skating, pleasure skating, and for the sports of broomball, curling, sledge hockey, and ringette. Organizers of these sports may adopt the present guide as written, or modify the guide in accordance with their special interests.

1. Scope

1.1 The intent of this guide is to provide consistent safety considerations in the design specifications and construction of new ice hockey playing facilities. It is intended to standardize facility conditions and establish guidelines that will provide a level of conformity for the purpose of competition and reduce potential hazards to players, game officials, and spectators.

1.2 This guide should be taken into consideration by architects, planners, engineers, construction companies, construction contractors, and appropriate inspectors who may be involved in the design and construction of new ice hockey playing facilities. This guide applies to the construction and development of new ice hockey playing facilities.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in SI units are for information only.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A53/A53M Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A60 Specification for Chromium-Vanadium Steel Bars for Springs; Replaced by A 689, A/t552 (Withdrawn 1966)[3]

A185/A185M Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

C150 Specification for Portland Cement

C260 Specification for Air-Entraining Admixtures for Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
D1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)
F355 Test Method for Impact Attenuation of Playing Surface Systems and Materials

2.2 *ANSI Standards:*[4]
ANSI Z87.1 Occupational and Educational Personal Eye and Face Protection Devices
ANSI Z535 Specification for Signs
ANSI Z97.1 Specification for Glass

2.3 *DIN Standards:*[5]
DIN 18 036 Hallen fur den Eissport

2.4 *Other Standards:*[6]
MIL-STD-810F Environmental Engineering Considerations Laboratory Tests

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *board cap, caprail, or rail, n*—wood, plastic, or other high impact material 3 ± 1 in. (7.62 ± 2.54 cm) in width, attached at right angles to the top of the boards.

3.1.2 *dasher boards, n*—enclosure of wood or plastic-coated wood, plastic-coated aluminum or steel, fiber glass, or other high-impact material that surrounds the ice surface and is part of the playing area. Also called *the boards*.

3.1.3 *enclosure, n*—that part of the playing area that surrounds the perimeter of the ice surface and consists of two sections, a lower section, known as the boards, that contacts the surface of the ice, and a vertical extension which attaches the shielding to the top of the boards. Together, these two elements are meant to confine the area of play.

3.1.3.1 *facility, n*—building which also accommodates an artificial ice surface and is used for ice activities or non-ice activities. Also known as *the arena*.

3.1.3.2 *rink, n*—playing area consisting of a horizontal ice surface surrounded by a vertical enclosure used for the sport of ice hockey.

3.1.4 *game lines, n*—colored lines drawn below the ice surface that divide the playing surface into various areas as described in the rules of play. See Appendix X1.1.1 for more detail.

3.1.5 *Goal*—combination of the goal frame and goal netting.

3.1.5.1 *anchoring of goal, n*—goal should not have any type of screwed in pipe fastening system. A type of sleeve system should be used so that the goal post may be dislodged when hit by a player sliding into the goal post and does not move upon impact of the puck. Refer to applicable rule book in Appendix X2.1.

3.1.5.2 *goal frame, n*—two rounded, rigid metal posts connected at the top by a straight crossbar of similar material with rounded ends and placed on the ice surface on the goal line, rising vertically 4 ft (1.3 m) and set 6 ft (1.83 m) apart measured from the inside of the posts. Refer to appropriate rule book in Appendix X2.1 for more detail.

3.1.5.3 *goal net, n*—net of appropriate mesh and cord size to resist the penetration of a high velocity puck shot, connected to the posts and the crossbar. See Appendix X1.1.9 for more information.

3.1.6 *ice dam, n*—high impact material that is placed between the floor and dasher boards and acts as a curb to contain the ice surface. This ice dam should be used in any facility that takes the dasher boards out for non-ice events to eliminate any breaking or tearing of the ice along the perimeter of the ice surface.

3.1.7 *kick-plate, n*—that portion of the boards that contacts the ice surface, made of a high-impact material and also part of the playing surface.

3.1.8 *shielding, n*—transparent, shatter-resistant glass, plastic, or similar material that is also part of the playing surface and extends above the boards.

3.1.8.1 *netting, n*—flexible, transparent, mesh material used in front of viewing areas.

3.1.8.2 *other barrier materials, n*—in some facilities, it may be necessary to use other materials, such as chain link fence or welded wire fabric as shielding.

4. Structures and Environment

4.1 *Surface Configuration*—Ensure that the sides of the rink are straight and the corners rounded to a 28-ft (8.1-m) radius.

4.2 *Dimensions*—The playing surface should be 185 ft (56 m) to 200 ft (60 m) in length and 85 ft (26 m) to 100 ft (30 m) in width, and should have a minimum of 20-ft (7-m) clearance above the ice surface.

4.3 *Dasher Boards*—Dasher boards should be prefabricated in sections. The design of all boards, whether a straight section, curved section, or section in which a gate is located, shall be fundamentally similar. Each section should have a frame made from either steel, wood, or aluminum which extends the full height of the dasher panel. This frame shall allow for fastening of the polyethylene or wood facing at each end. This will ensure flush mating of the facing at the dasher panel joints.

4.3.1 *Caprail*—A caprail should be attached to the top horizontal framing member. The ice side of the caprail should have a smooth and rounded edge flush with the dasher facing. A caprail should be a minimum of 2 in. (cm) in width and ½ in. (cm) in thickness.

4.3.2 *Supports and Anchoring*—The dasher boards should be anchored to the concrete floor using anchors and bolts. The dasher anchors should be an internally threaded flush type that will hold the dasher straight and erect. Anchors should be installed at the time of dasher installation. The minimum distance between the dasher board and any permanent structure should be 3-in. (7.62-cm) minimum. There should be no rigid structure that prevents the dasher boards from flexing.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[5] Available from Beuth Verlag GmbH (DIN-- DIN Deutsches Institut fur Normung e.V.), Burggrafenstrasse 6, 10787, Berlin, Germany.
[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

4.3.3 *Standard Sizes*—Standard size of straight dasher boards should be 96 in. (2.44 m) long, 40 to 48 in. (101.6 cm to 1 m) high, and 3.5 to 6 in. (8.89 to 15.24 cm) wide. Standard size of curved dasher boards should be 95 in. (2.41 m) long.

4.4 *Gates:*

4.4.1 *Access Gates*—If required, access gates for public skating and other large entry use shall be built into standard 8-ft (2.4-m) sections and can vary from 3 to 5 ft (.91 to 1.5 m) in width. Gate latches should be a single latch or can be similar to that used on the equipment gates. Gates on the radius shall have two latching points of contact.

4.4.2 *Players' Gates*—Players' gates should be built into standard 8-ft (2.4-m) sections and should be 30 in. (76.2 cm) wide, swinging either left or right, and swinging away from the ice and to the nearest end of the bench. The gate latch should be a single gravity type of latch. Refer to local ADA requirements.

4.4.3 *Equipment/Vehicle Gates*—These gates should be double-leaf gates with a 10-ft (3.05-m) opening. Gate latches should be of sliding bar latch type, using 2-in. (5.1-cm) steel tubing. Equipment gate leaves should lock into the threshold/floor or ice dam by means of a minimum 0.5625-in. (1.43-cm) diameter sliding cane bolt. Each leaf should have a 90° angle of steel tubing, ½ in. (1.27 cm) of which should be locked into the floor. Each equipment gate and access gate over 3 ft (91.4 cm) wide should be equipped with adjustable spring-loaded swivel casters.

4.4.4 Where operation of the gate latch is required from the ice side of the gate, a mechanism should be flush mounted in the caprail to activate the latch system. The mechanism should be large enough to be operated by all users and players wearing gloves. The mechanism should be designed to be simple to operate, yet not allow accidental opening.

4.4.5 *Hinges*—All hinge assemblies should be constructed of low-carbon steel or other equivalent material. The common hinge bracket should be bolted to the dasher panel framing to facilitate removal of the hinge assembly. The hinges should be complete with integral self-lubricating bushings and ball bearings for smooth precision operation. Each hinge should incorporate a built-in vertical height adjustment feature (±0.31 in. (8 mm)). The hinge pins should be a minimum of 0.75 in. (18.3 mm) in diameter.

4.4.6 All precision hardware such as hinge pins, latches, casters, cane bolts, and miscellaneous nuts, bolts, and fasteners should be manufactured in design and application to allow for smooth operation and should not protrude into the playing area.

4.5 *Kick-Plate*—Kick-plates should be constructed of 0.25-in. (6.35-m) or 0.5-in. (12.7-mm) thick high-density polyethylene color-impregnated sheets in 8-in. (20.3-cm) minimum × 96-in. (2.44-m) segments, or 8-in. (20.3-cm) × 95-in. (2.41-m) segments at curved dasher boards. Kick-plates are to be mounted to the bottom portion of dasher panels by means of flush-mounted machine screws.

4.6 *Thresholds*—Should have a polypropylene or equivalent material covering that can be removed and replaced when wearing occurs on player, vehicle, access, or equipment gates.

4.6.1 Thresholds of all access gates should be 1.75 in. (4.445 cm) above floor level.

4.6.2 Thresholds of all players' gates should not exceed be 8 in. (20.3 cm) above the non-refrigerated floor level.

4.6.3 Thresholds of all equipment gates should not exceed 1.75 in. (4.44 cm) above floor level.

4.6.4 Thresholds for other events shall be flush with the ice, for example, sledge hockey.

4.6.5 Tolerance between the access gate and threshold should be no greater than ⅜ in. (0.9525 cm).

4.7 *Shielding and Netting*—Shielding should be clear and colorless tempered glass or acrylic. All tempered glass must meet ASTM or CSA standard specifications. The edges of the tempered glass should be seamed on channel sides and flat ground on the top side, and the top two corners should have a 0.25-in. (6.35-mm) radius.

4.7.1 Rink ends should have 0.625-in. (1.58-cm) thick tempered "impact" glass or acrylic extending a minimum of 6 ft (182.88 cm) above dasher boards in facilities where there is no viewing on the ends.

4.7.1.1 Where there is viewing above the height of the glass, it is strongly recommended netting material should be considered.

4.7.2 Rink sides should have a minimum of 0.5-in. (1.27-cm) thick tempered "impact" glass or acrylic extending a minimum of 4 ft (121.92 cm) above dasher boards.

4.7.3 Bench areas should have 0.5-in. (1.27-cm) thick tempered "impact" glass or acrylic extending 4 ft (121.92 cm) to 6 ft (182.88 cm) above dasher boards at the ends and behind the players bench area.

4.7.4 *Mounting*—The shielding should be mounted 1 to 3 in. (2.5 to 7.6 cm) away from the playing side surface of the board cap or railing.

4.7.4.1 *Mounting of Shielding on Gates*—Each gate should have a support post at each end to minimize the flexing and breakage of the shielding.

4.7.5 Enclosure support posts that form a corner and are exposed to the playing area (player and penalty benches) should be padded to a minimum thickness of 3 in. (7.6 cm) with a closed-cell shock absorbent material. The material should be covered with a non-cellular flexible cover to protect against abrasion of the absorbent material.

4.7.6 The frames for the tempered or acrylic glass should not have a gap greater than 1 in. (2.5 cm) at the caprail.

4.8 Shielding should not be removed for photographers during any hockey activity.

5. Players' Boxes

5.1 *Location*—See X2.4 (Figs. X2.1-X2.3).

5.2 *Dimensions*—Each players' box enclosure should be 24 ft (7.31 m) minimum in length and 5 ft 6 in (1.67 m) in width with the floor elevated above the ice surface to a height equal to the height of the kick-plate. The players' benches should be separated by a distance of 3-ft (0.91-m) minimum when on the same side. The bench should be securely fastened to the floor.

5.3 *Gates*—There should be two gates, one at each end of the players' box, to facilitate player movement on and off the ice. Gates must open into the players' box and toward the end of the bench closest to the near end of the players' box. Gates

should be located within the neutral zone or as close to the neutral zone as possible.

5.4 *Shielding*—Shielding should be installed behind and alongside, but not in front of the players' boxes. At shielding corners, a corner pad should be supplied and installed.

6. Penalty Boxes

6.1 *Location*—There should be a penalty box for each team separated by the off-ice official's box.

6.2 *Dimensions*—Each box should be 6 ft 6 in. (1.98 m) in length minimum and 5 ft 6 in. (1.67 m) in width minimum, and have one door opening away from the playing surface.

6.3 *Shielding*—Shielding should be installed behind, alongside, and in front of the penalty boxes.

7. Off-Ice Officials Box

7.1 *Location*—The off-ice official's box should be located between the penalty boxes.

7.2 *Dimensions*—The off-ice official box should be a minimum 5 ft (1.52 m) in width and minimum 8 ft (2.44 m) in length and have an access door on the back wall or side penalty box door. A writing surface should be provided for the off-ice officials.

7.3 *Shielding*—Shielding should be installed behind if there is spectator seating behind the officials-box, alongside, and in front of the off-ice official's box.

7.4 *Communication Port*—On the section of glass that faces the playing surface, a hole 2.5 in (6.35 cm) (to stop the puck from passing through) maximum in diameter, should be cut through the shielding at a height of 5 ft (1.52 m) from the surface of the ice to facilitate communication between the timer and scorekeeper and the referee(s) or on-ice officials.

7.5 To ensure player's safety, there should be a gate into each penalty bench from the official's bench so that an off-ice official or volunteer can ensure each gate is securely latched after a player returns to play.

8. Signal and Timing Devices

8.1 *Signal Device*—Each rink should have a sound-type signal device (buzzer, siren, or horn) with controls in the off-ice official's box to signify the end of each period of play.

8.2 *Timing Device*—Each rink should have an electrical clock for accurately indicating all time elements at all stages of the game, including the time remaining in any period and the penalty time remaining in any period for at least two non-simultaneous penalties. Controls for the timing devices should be located in the timer's and scorekeeper's box.

8.3 *Goal Lights*—Behind each goal there should be two lights for the use of the goal judge. A *red* light may be used to signify the scoring of a goal. A *green* light may be used to signify the end of a period or the game. The red light, if any, should be connected to the game's timing device so that when a period ends and the green light is turned on, the red light cannot function.

9. Dressing Rooms

9.1 Each rink shall have a minimum of six player dressing rooms to accommodate adequately a minimum of twenty players and an officials' dressing room to accommodate adequately three game officials. Players' and officials' dressing rooms shall be separate and equipped with toilets and shower facilities. Each dressing room shall have fixed benches, that is, to floor, and shall provide for hanging clothes to eliminate potential tripping hazards.

9.2 Floors of dressing rooms, the officials' room, corridors to the playing surface, and all player, penalty, and off-ice officials' benches should be covered with a resilient non-slip floor covering that will not affect the sharpness or wear of the skate blades.

10. Ice Rink Floor Design

10.1 The floor should be a durable, level surface on which to build the ice sheet.

10.1.1 The floor should be capable of supporting the loads to be imposed upon it for the ice surface or alternate usage.

10.1.2 The main rink floor should be installed only after proper subfloor preparation with freeze protection.

10.1.3 The floor should be free from voids and cracks (concrete).

10.2 The ice rink floor may be a concrete or sand base type. The sand bed rinks usually have the sole function of supporting the ice surface, and after the piping grid is level and in place, clean sand is used to encase and cover the piping to a level finish. An ice floor may include the following:

10.2.1 A subsurface drainage system, if ground water is a concern, shall have a porous fill to facilitate drainage and a sand bed to support the floor;

10.2.2 Subsurface heating system to prevent freezing below the floor may be considered;

10.2.3 Insulation and vapor membrane;

10.2.4 Pipe chairs and pipe grid;

10.2.5 Reinforcing steel and wire mesh for concrete floors;

10.2.6 Concrete or sand; and

10.2.7 Perimeter surface treatment.

10.2.8 Ensure that the ice along the perimeter of the ice rink, known as the edge, should extend and is flush to the kick-plate and without any gaps. See Appendix X2.3.

11. Illumination

11.1 To ensure safe visibility, the level of illumination at the ice surface should be of evenly distributed intensity to comply with federal, state, and local codes. The Illuminating Engineers Society (IES) recommends the following foot candles for ice hockey:

11.1.1 *Professional*—125 Horizontal/100 Vertical (for television),

11.1.2 *College*—100 Horizontal/75 Vertical,

11.1.3 *Amateur*—75 Horizontal/ 50 Vertical, and

11.1.4 *Recreational*—50 Horizontal/ 25 Vertical.

11.1.5 Light fixtures should have protective coverings to prevent breakage.

12. Emergency Medical Care

12.1 Exit(s) and corridor(s) should be designed and located to provide easy access for emergency, personnel, equipment, and vehicles to the facility and the ice rink, close to the area designated for the temporary retention of a stricken person, avoiding areas of normal patron congestion as much as possible.

12.2 Medical devices used for emergency lifesaving, such as an A.E.D (automated external defibrillator) should be available.

12.3 *Signs*—There should be specific signs regarding mechanical equipment and hazardous materials.

12.4 *Patron Signs*—There should be specific signs for skaters and for the conduct of the spectators.

12.5 *Signage*—Directional signage should be included (see ANSI Z535).

12.6 *Exits*—Fire exits shall be illuminated.

13. Refrigeration and Dehumidification

13.1 *Tonnage*—Refrigeration tonnage needs to be sufficient to remove the heat necessary to provide proper ice conditions during entire operating season.

13.2 *Refrigerant Storage*—Refrigerant storage needs to be in accordance with all federal, state, and city regulations.

13.3 *Refrigeration Room*—All refrigeration rooms need to be constructed for the refrigeration type being used. Proper signage and detection devices should be included.

13.4 *Dehumidification*—The dehumidification system needs to be able to provide proper ice conditions and a dry environment during entire operating season.

14. Keywords

14.1 dasher boards; goal; ice dam; illumination; penalty boxes; player boxes; rink

APPENDIXES

(Nonmandatory Information)

X1. ADDITIONAL TERMS AND INFORMATION

X1.1 *Descriptions of Terms*:

X1.1.1 *blue line, n*—blue line, 1 ft (30.5 cm) in width, drawn parallel to and 60 ft (18.3 m) from the goal line and extending up to the top of the boards.

X1.1.2 *center circle, n*—blue circle, 2 in. (5.1 cm) in width, 30 ft (9.1 m) in diameter, whose center point is the midpoint of the center line.

X1.1.3 *center face-off spot, n*—circular blue spot, 1 ft (30.5 cm) in diameter, whose center point is the midpoint of the center line circle.

X1.1.4 *center line, n*—red line, 1 ft (30.5 cm) in width, that divides the ice surface into two halves, drawn at right angles to the long axis of the playing surface and extending up to the top of the boards.

X1.1.5 *face-off circle, n*—red line, 2 in. (5.1 cm) in width, 30 ft (9.1 m) in diameter, forming a circle, whose center point is 22 ft (6.7 m) from the midpoint and 20 ft (6.1 m) away from the goal line.

X1.1.6 *face-off spot, n*—circular red spot, 2 ft (61 cm) in diameter, whose center point is the same as the face-off circle. Within each face-off spot, draw two parallel lines 4 in. (10 cm) from the top and bottom of the spot. The remainder should be painted white. All lines (center, blue, goal, goal crease, face-off circles, and spots) should be applied below the ice surface except for placement on the boards.

X1.1.7 *goal crease line, n*—red line, 2 in. (5.1 cm) in width, 6-ft (1.83-m) radius, forming a semi-circle with the open end facing the nearest end of the rink and whose center point is the midpoint of the goal line. This area, excluding the red lines, should be painted a light blue color.

X1.1.8 *goal line, n*—red line, 2 in. (5.1 cm) in width, drawn parallel to the center line, typically located 10 to 15 ft (3.04 to 4.57 m) from the end boards (refer to applicable rule book).

X1.1.9 *goal net, n*—goal net should be loosely draped over and attached to the metal framework of the goal extending behind the goal line. There should be attached to each goal frame a net made of white nylon cord which should be draped in such manner as to prevent the puck from coming to rest on the outside of it. The net should be made of three-ply twisted twine (0.130-in (0.33 cm) diameter) or equivalent white nylon with an appropriate tensile strength of 700 lb (317 kg). The size of the mesh should be 2.5 in. (6.35 cm) (inside measurement) from each knot to each diagonal knot when fully stretched. Knotting should be made as to ensure no sliding of the twine. The net should be laced to the frame with medium white nylon cord no smaller in size than No. 21.

X1.1.10 *goal skirting, n*—skirt of heavy, white nylon fabric or heavyweight white canvas should be laced around the base plate of the goal frame in such a way to protect the net from being cut or broken. This skirt should not project more than 1 in. (2.54 cm) above the base plate. At the base of the frame and extending up the center support post, 2- to 3-in. (5.08- to 7.62-cm) canvas covered padding should be secured on the inside of the goal to prevent the puck from rebounding out of the goal off the frame.

X1.2 *Facing*—The ice side of the dasher panel is to be faced with either 0.5-in. (12.7-mm) thick, high-density white color-impregnated polyethylene dasher facing or 0.75-in. (19.05-mm) Type A/R exterior-grade plywood painted with two coats of white alkyd fungicide enamel paint faced with 0.25-in. (6.35-mm) polyethylene facing. Facing is to be attached using 0.25-in. diameter Type F thread cutting countersunk screws with the fasteners' heads color matching the facing material. The dasher facing also may be attached to the dasher framing by means of through bolts secured with nylon insert nuts. This will allow for ease of removal at a later date. Color extensions of red and blue lines shall be inlaid in the facing and kick-plate in conformance with National Collegiate Athletic Association (NCAA), National Hockey League (NHL), International Ice Hockey Federation (IIHF) Rule Book, or USA Hockey rink layouts.

X1.3 *Mounting*—The shielding may be set in a horizontal aluminum C-channel mounted on top of the caprail or in a groove in the caprail. This channel or groove shall run continuously between vertical aluminum shielding supports. The shielding shall be held vertically by an aluminum support placed at a maximum of every 48 in. (1.22 m) with a removable front mullion piece. This aluminum support shall fit through a 2-in. (5.1-cm) hole in the caprail extending to within 1 in. (2.54 cm) of the top of the shielding, extend down to the center horizontal angle steel, aluminum, or wood frame member of the dasher panel framing, and be held in place with a steel bracket or bolt. Angle support shield mounting supports for gates and corners shall be made of solid extruded aluminum and designed in one piece. This type of mounting hardware shall be used at corners where the glass meets at 90° angles. The spectator shielding shall be held in place with a removable aluminum mullion strip with mounts to the vertical support. Through bolts with nuts and washers are not acceptable. Both aluminum support and mullion strip shall be of Alloy 6061-T6 structural aluminum and be manufactured in the United States. Poly(vinyl chloride) (PVC) cushion inserts shall be full length and inserted between the shielding and mullion to prevent direct contact between the shielding and aluminum (see Table X1.1).

TABLE X1.1 Cushion Insert Specifications

Property	Units	Standard	Specifications
Density	kg/m^3 (lb/ft^3)	Specification D1667	80 (5) min
Compression deflection, 25 %	kN/m^2 (psi)	Specification D1056	35–55 (5.0–8.0)
Water absorption	% weight	Specification D1056	5 % max
Compression set, 50 %	%	Specification D1056	50 % max
Tensile	kPA (psi)	Test Methods D412	517 (75) min
Elongation	%	Test Methods D412	75 % min
Fungus resistance	...	MIL Std. 810C	pass
Flammability	mm/min (in. min)	MVSS 302	102 (4) max
Resilience	%	Bayshore rebound	10 % max
Energy attenuation	*G* force	Test Method F355 (2 ft drop Procedure A)	100 G max

X1.4 *Sub-floor Drainage, Porous Fill, Sand Bed, and Freeze Prevention*—The sub-floor drainage, porous fill, sand bed, and frost protection should be done in a manner to provide for good drainage, subsurface freeze protection, and a compacted level sand bed to support the concrete floor. This space below the floor will become inaccessible after the finished floor is in place, so careful attention to design and construction of this area is required.

X1.4.1 The subsurface heating piping should be installed over a subgrade of 6 in. (15.24 cm) of sand, leveled to ±0.125 in. (3.18 mm), over the entire surface of the rink, with no joints, and placed in a manner (no more than 24 in. (61 cm) wide) to uniformly provide heat to prevent frost accumulation. The piping and steel headers should be tested to 75 psi for 24 h and made leak-free prior to placing further sand and the insulation. This piping is usually of a heavy-wall Schedule 80 PVC. Temperature sensors should be placed in the subsurface sand bed to be used to control and monitor the subsurface temperatures. Once the subsurface piping is in place, a minimum of 6 in. (15.24 cm) of sand should cover this piping and be compacted to 98 % compaction prior to placement of the insulation barrier.

X1.4.2 If a sub-floor drainage system is necessary, it should be of perforated pipe designed and placed to drain the area below the rink. The drainage should be passed through a separation basin outside the rink area so as to provide a means to monitor the condition of the effluent.

X1.5 *Insulation and Vapor Barrier*—Sufficiently rigid insulation should be applied to minimize the potential for subsurface freezing conditions to exist. There is evidence to suggest that a standard arena will penetrate a 4-in. (10.16-cm) insulation barrier in a nine-month period. The insulation board should have low-moisture absorption characteristics and sufficient compressive strength to carry the floor load with minimal loss of insulation effect. The insulation should be applied over the sand bed in two layers, with joints staggered, and placed to ±0.125 in. (3.18 mm) of level. The insulation should be of high quality and moisture resistant, similar to Dow SM Specification C578, Type IV, and available in 8-ft (2.4-m) × 4-ft (1.3-m) sheets. In addition, there should be a reverse inverted-curb concrete perimeter surrounding the arena of sufficient depth to extend below the two layers of insulation.

X1.5.1 A vapor barrier should be laid over the insulation with 6 in. (16.24 cm) of overlap and sealed at the joints. The vapor barrier material is available in rolls and can be applied with continuous sheets the full length of the rink. The vapor barrier should be a 0.02-in. (.6-mm) thick, clear, polyethylene, high-quality, internally reinforced material, so as to be durable and minimize the probability of damage during the preparation and placement of the concrete floor.

X1.6 *Piping and Concrete Reinforcement*—Pipe support chairs should be used for alignment and leveling of the piping system. The chairs should be installed 3 ft (91.4 cm) on center for polyethylene tubing or 5 ft (1.5 m) on center for steel pipe, or both, and overlapped at least two tubing rows for proper