Standard Guide for Skating and Ice Hockey Playing Facilities[1]

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INTRODUCTION

Ice skating and ice hockey have 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 skating and ice hockey-playing facilities currently in use.

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, with both having as near as possible to 28 ft (8.53 m) radius corners. However, variations may exist.

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 skating and ice hockey-playing facilities are also 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 considerations for the design, construction, and retrofitting of ice skating and ice hockey playing facilities. It is intended to establish guidelines that will provide a level of functionality for recreational skating, conformity for the purpose of competition and reduce potential hazards to skaters, players, game officials, spectators, and employees.

1.2 This guide should be taken into consideration by owners/operators, architects, planners, engineers, equipment manufacturers, construction companies, construction contractors, and appropriate inspectors who may be involved in the design and construction of new ice skating/hockey playing facilities. Whenever possible, environmental sustainability and energy efficiency should be taken into consideration in the planning and design of facilities. This guide applies only to the construction and development of new ice skating/hockey playing facilities. Portions, however, may be useful for renovation projects, such as, replacing worn out dasherboards.

1.3 Every arena is unique in material, architecture, and engineering, and therefore will require technical review. This guide is not meant to provide an architectural prototype, but is a guide to set forth measures for the development of safer ice arena venues.

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

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

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[3]

A185/A185M Specification for Steel Welded Wire Reinforcement, Plain, for Concrete (Withdrawn 2013)[4]

[1] This guide is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.66 on Sports Facilities.

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

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

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
D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
D1667 Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell)

2.2 *ANSI Standards:*[5]

ANSI Z87.1 Occupational and Educational Personal Eye and Face Protection Devices
ANSI Z97.1 Specification for Glass
ANSI Z535 Specification for Signs
ANSI Z535 Warning Labels

2.3 *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 *backerpanel, n*—wood or high-density polyethylene material to enclose the back of the dashers for aesthetic or cleanliness.

3.1.1.1 *Discussion*—They can be mechanically fastened to the dasher frame or a quick release type for multi-purpose facilities.

3.1.2 *board cap, caprail, or rail, n*—wood, plastic, or other high impact material matching the frame width of the boards including the facing (and backer panel, if used).

3.1.2.1 *Discussion*—It should be attached at right angles to the top of the boards with bullnosed-raidiused edges.

3.1.3 *dasher boards, n*—wood, steel, aluminum or fiberglass framed enclosure with wood or other high-impact (high-density polyethylene) facing material that surrounds the ice surface and is part of the playing area. Also called *the boards*.

3.1.4 *design, n*—conceptual detail and configuration of the spaces within and around the ice rink/arena.

3.1.5 *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*.

3.1.6 *rink, n*—playing area consisting of a horizontal ice surface surrounded by a vertical enclosure used for ice sports and activities.

3.1.7 *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.

3.1.8 *goal, n*—combination of the goal frame and goal netting and can also include the bottom and vertical padding of the frame.

3.1.8.1 *anchoring of goal, n*—goal should not have any type of screwed in pipe fastening system. A type of anchoring 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.

3.1.8.2 *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.

3.1.8.3 *goal net, n*—net of appropriate mesh and cord size to restrict the penetration of a high velocity puck shot, connected to the posts and the crossbar.

3.1.9 *ice dam, n*—high impact material (typically steel or polyethylene) that is anchored to the concrete floor and acts as a curb to contain the ice surface when the boards are removed.

3.1.9.1 *Discussion*—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. The ice dam should match the length and width of each dasher panel and be anchored independently from the dasher panel sitting on top.

3.1.10 *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.

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

3.1.12 *netting, n*—flexible mesh material suspended in front of viewing areas to contain the puck.

3.1.13 *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. Building Structures and Environment

4.1 *Design*—The ice skating facility (arena), rink and other interior and exterior components should be designed and engineered by a registered, professional architect and engineer – preferably with industry-specific knowledge and experience. It is also recommended that an owner/operator representative be involved in the design process.

4.1.1 *Handicapped Accessibility*—- Designers, architects, engineers, equipmant manufacturers and installers shall take into considerations all Americans With Disabilities (A.D.A.) regulatory requirements.

4.1.2 *Documentation*—Documentation of the specifications, designs, installation, blueprints, records, permits, catalogs, and manuals from the arena's professional consultants, suppliers, manufacturers, and inspectors of the venue equipment systems should be provided to the owner/operator.

4.1.3 *Selection*—Many factors, including climate, can influence the selection of ice rink systems and other components.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

[6] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

Consideration must be given to such factors in the selection, specification, design, installation, and maintenance of the ice rink/arena systems.

4.2 *Building Configuration:*

4.2.1 The fire capacity of the building, classification of use, and intensity of patron use should be considered in the design process.

4.2.2 *Physical Dimensions*—The length, width, and ice rink/arena configuration should be considered in relationship to the site location on the property.

4.2.3 *Columns and Beams*—The clear span should have no obstacles and their placement should not become obstructive to players, patrons, or spectators.

4.2.4 *Construction Materials*—The durability, strength, wind shear, snow load and fire resistance of materials should be stipulated on all construction plans and specifications in accordance with state and local building codes.

4.2.5 *Windows, Size, and Location*—Thermal sound modulating glazing should be considered in the design process.

4.2.6 *Doors, Size, and Location*—The type and use of doors should be considered in the design process.

4.3 *Spaces*—The ice arena may include various spaces for the conduct of the business such as mechanical room, entry arena, participant changing areas, spectator, and administrative areas.

4.4 *Ice Rink Area*—This area should be large enough so that building walls or bleacher systems do not contact the dasher board system. There should be a minimum of 20 ft (6.1 m) above the ice surface. Building utility lines should not be installed under the ice surface area. A drain should be installed at the ice resurfacer entrance outside of the ice surface.

4.5 *Ice Resurfacer Storage Area*—This area should be designed requiring the least amount of turning for the ice resurfacer. The ceiling height should provide enough clearance to operate the snow tank of ice resurfacer being used in the "raised" snow dump position. Turning radius of machines should be considered. A snow dump pit may be constructed to hold up to of 125 ft^3 volume per ice sheet. The pit should be able to melt 125 ft^3 of snow per hour per ice sheet. All garage doors to this area should be a minimum 9 by 9 ft wide (2.74 by 2.74 m). Also, this area should be constructed to be used as a repair garage and meet the appropriate building codes. This area should provide adequate ventilation. This room should be heated and have adequate floor drains. A minimum of electrical equipment should be located near the ice resurfacer room since it is a wet environment and water may be splashed in this area. Entry area should be designed to allow access only to employees.

4.5.1 A snow melt pit may be designed to use the waste heat from the refrigeration system.

4.5.2 A hot water heating system should be included in the design to allow the operator of the ice resurfacer to meet hot water temperature requirements for ice making.

4.5.3 Water treatment for ice making water should be considered if there is more than 150 ppm of all total dissolved solids in the water content and no more than five total grains of hardness. Water treatment for the refrigeration/cooling system must be considered regardless of water quality.

4.5.4 *Fuel Handling and Storage*—Fossil fuel machines being used in the facility gas detection devices and proper ventilation should be installed. Levels of carbon monoxide (CO) and nitrogen dioxide (NO_2) need to be kept at levels below 30 ppm CO and 0.5 ppm NO_2. Fuel storage, handling, and refueling areas to be determined and built accordingly. Sources of ignition should not be in these areas. Always wear personal protective equipment when refueling machines (that is, gloves, goggles, long sleeve shirt).

4.5.5 *Battery Precautions*—Facilities using battery operated machines should have proper equipment installed. Batteries should be stored and worked on in well-ventilated areas. The hydrogen concentration should not exceed 1 % by volume. Acid neutralizing solutions and shower stations should be installed in these areas. Sources of ignition should not be in these areas. Always wear personal protective equipment ANSI Z87.1 (US Standard) approved face shield and splash proof goggles when working on or near batteries with acid resistant clothing (that is, gloves, apron, long sleeve shirt). Please refer to the manufacturer's recommendations prior to handling batteries. If the electrolyte is splashed into an eye or taken internally, get prompt medical attention.

4.6 *Seating Area*—Seating should be designed to accommodate the average expected attendance for the majority of the events conducted in the arena. Bleachers should not be accessible to anyone wearing skates.

4.6.1 *Height and Location*—Bleacher height, location, and protection shall meet the regulations of the Consumer Product Safety Commission (CPSC) and bleacher industry standards.

4.6.2 *Spectator Area Heating*—Heaters should be installed so as to not adversely affect the ice surface. Thermostats or timers should be installed to prevent continuous running and should not be accessible to the general public.

4.7 *Rest Rooms*—Rest rooms shall meet current local codes.

4.7.1 Public rest rooms shall be separate from player locker rooms.

4.8 *Skate Changing Area*—Adequate skate changing areas should be provided and have non-slip protective flooring.

4.9 *Locker Rooms*—An ice rink/arena should have at least five team rooms per ice sheet. Each team room should be at least 250 ft^2 and have an adjacent shower area and meet current codes. Benches should be placed around the room. These benches should be supported by angled brackets if mounted on the wall. Hooks or shelves should be provided at a safe height above the benches. Locker rooms should have a non-slip protective flooring. Player/skater locker rooms should have vandal proof wall coverings, automatic flush toilets/urinals, and vandal proof partitions.

4.10 *Food Service Area*—Food service areas should meet local health and fire department codes. A vending machine area may be considered.

4.11 *Skate Rental Storage Room*—This room should be adequate size to accommodate the number of skates to be stored. This room needs large counters to hand out and return rental skates. A well-ventilated room is needed to promote drying of the rental skates. This room should have protective non-slip flooring and may include odor removal equipment.

4.11.1 Skate sharpening space should be included adjacent to the skate rental room. Additional ventilation should be provided along with skate sharpening dust removal equipment and protective non-slip flooring.

4.12 *Official's Room*—The official's room should be separate from the player locker rooms and if possible located in a place away from player and or spectator areas. This room should be adequate size to accommodate the anticipated number of officials and have a restroom/shower area and meet local codes and should have protective non-slip flooring.

4.13 *Management/Administrative Offices*—These offices should be adequate size to acccommodate the anticipated number of staff. A secure money counting area should be considered.

4.14 *Cashier/Ticket Box Office*—This office should have adequate space for computer ticketing equipment. The flow of patrons during busy sessions or events should be considered while designing this space and may be adjacent to the manager/administrative offices, retail space or skate rental room.

4.15 *Conference Room*—If needed, this room should be adequate size to be used by user groups for meetings and for employee training sessions.

4.16 *Janitorial Room*—Janitorial/custodial room closets and cabinets space need to be located near the locker rooms, rest rooms, concession, and conference areas.

4.17 *Employee Break Room*—This area should be 100 ft^2 minimum and is needed for employee communications and a place for breaks and lunch away from public.

4.18 *Party/Meeting Room*—Should consist of at least 400 ft^2 with non-slip protective flooring and be located adjacent to the ice surface without stairway access.

4.19 *Storage Space*—Adequate storage space should be considered into the design phase for maintenance, concession, pro shop, and arena programs.

4.20 *Parking Lots*—An ice arena is a special use buildings and may not fall under regular parking space guidelines. During the design phase, refer to local codes regarding parking spaces.

4.20.1 Approximately 80 parking spots per ice sheet should be considered as a guideline. The ice arena should include exterior spaces for traffic, vehicle, and pedestrian circulation, parking, service, and emergency vehicle access. The area outside the ice arena should be designed by a registered landscape architect preferably with industry-specific knowledge and experience.

4.21 *Entry and Exit Areas*—Access to all doorways and walkways to the ice rink/arena should be designed to protect patrons or employees from falling snow or ice falling from roof structures.

4.22 *Retail Outlet*—If desired space should be designed for a retail store (pro shop) including adequate room for product display, equipment fitting, merchandise storage, and retail sales. The area should be placed so as to maximize visual exposure and allow easy access from the outside. It may be designed to incorporate the admission sales area and/or be adjacent to the management office.

4.23 *First Aid*—Adequate space should be allowed for the removal and treatment of injured participants, spectators and employees. Such area should be located out of public view and congestion and easily accessible by emergency personnel, equipment and vehicles.

5. Rink Configuration

5.1 Ensure that the sides of the rink are straight and the corners rounded to a 28-ft (8.1-m) radius.

5.1.1 *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.

5.2 *Dasher Boards*—Dasher boards should be fabricated in sections. The design of all boards, whether straight, curved, or 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. Frames should be constructed with concealed fasteners, or by welding, or a combination of both. 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.

5.2.1 *Dasher Facing*—The ice side of the dasher should be faced with either 0.5-in. (12.7-mm) thick high-density white color-impregnated polyethylene 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 should be attached using either 0.25-in. diameter Type F thread cutting countersunk screws or through bolts secured with nylon insert nuts or equivalents. All fastener heads should match the color of the facing material. Color extensions of red and blue lines should be inlaid in the dasher facing to align with the same lines in the ice.

5.2.2 *Caprail*—A caprail made out of high-impact material such as plastic, wood or extruded thermoplastic should be attached to the top horizontal framing member. The caprail should be radiused to have a smooth, rounded edge flush with the dasher facing. A caprail should be a minimum of 2 in. (5.08 cm) in width and match the total width of the boards including frame, facing and backerpanel, if used. It should be a minimum of ½ in. (1.27 cm) in thickness.

5.2.3 *Anchoring*—The dasher boards should be anchored to either the refrigerated or perimeter concrete floor using anchors and bolts. For sand floors, the boards are mounted to the perimeter floor. For concrete perimeter floors use threaded rod and nuts. For refrigerated concrete floors use threaded pre-cast anchor rods set into the concrete prior to the pour. Dasher installers should coordinate the installation of dasher anchors with the refrigeration contractor. The minimum distance between the dasher board and any structure should be 3 in. (7.62 cm). There should be no rigid structure that prevents the dasher boards from flexing. Some dasher installations may include a polyethylene or metal angle called a "gap closure" that covers a space of no larger than 3 in. (7.62 cm) between the boards and bleachers, stairs, ramps or any other raised structure behind the boards. Gap closures should be fastened on one edge only to allow for movement of the boards.

5.2.4 *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 up to 95 in. (2.41 m) long.

5.3 *Gates:*

5.3.1 *Access Gates*—If required, participant access gates shall be built into standard 8-ft (2.4-m) sections and can vary from 3 to 5 ft (0.91 to 1.5 m) in width. Gate latches should be a single latch or can be similar to those used on the equipment gates. Gates on the radius are discouraged, however, if used, should have a minimum two latching points of contact.

5.3.2 Where operation of the participant access 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.

5.3.3 *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.

5.3.4 *Equipment/Vehicle Gates*—These gates should be double-leaf gates with a minimum 10-ft (3.05-m) opening. Gate latches should be either a single or double sliding bar latch type, using 2-in. (5.1-cm) steel tubing. Equipment gate leaves should secure in place to withstand reasonable loads expected during play. All gate facings should be flush creating a smooth ice side surface. Each equipment gate and access gate over 3 ft (91.4 cm) wide should be equipped with adjustable heavy-duty spring-loaded swivel casters that can be adjusted both vertically and horizontally to properly align the gate.

5.3.5 *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 or 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.

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

5.4 *Kick-Plate*—Kick-plates should be constructed of 0.5-in. (12.7-mm), or greater, thick high-density, color-impregnated polyethylene sheets in 8-in. (20.3-cm) minimum height × the full length of each straight or curved dasher panel. Kick-plates are to be mounted to the bottom portion of dasher panels by means of corrosion-resistant, self-tapping flat-head screws or flat-head machine screws with a nylon insert lock-nut and washer. When using an ice dam, the height of the kickplate should be increased to account for the height of the ice dam. For sand floors, the height of the kickplate may be increased to extend below the bottom of the dasherboard penetrating the sand and reducing the amount of leakage during ice making.

5.5 *Thresholds*—Should have a polypropylene or equivalent material covering that can be removed and replaced when necessary.

5.5.1 Thresholds of all access gates should be a minimum of 1.00 in. (2.54 cm) above the non-refrigerated, perimeter floor level.

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

5.5.3 Thresholds of all equipment gates should not exceed 1.50 in. (4.44 cm) above the non-refrigerated, perimeter floor level. Raised flooring in player and penalty box areas can be made of wood or aluminum-framed construction. The vertical step up from the ice should not exceed 8in. (20.3cm) above the above the refrigerated floor level.

5.5.4 Space between the bottom of all gates and the threshold should be no greater than ⅜ in. (0.9525 cm).

5.6 *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 both tempered glass and acrylic should be seamed on channel sides and flat ground on the top side, and the top two corners should have a minimum 0.25-in. (6.35-mm) radius.

5.6.1 Rink ends should have 0.625-in. (1.58-cm) thick tempered "impact" glass or 0.50-in. (12.7-mm) thick or equivalent acrylic extending a minimum of 6 ft (182.88 cm) above dasher boards.

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

5.6.2 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 the caprail.

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

5.6.4 *Shield Mounting*—The shielding should be mounted no more than 3 in. (7.6 cm) away from the playing side surface of the board cap or railing. 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 no further than 13 in. (33 cm) from the top of the shielding and down to the center horizontal stringer of the dasher panel frame. It should 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 or 6005-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 1).

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

5.6.5 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 or equivalent for a minimum of 3 ft above the caprail. The material should be covered with a non-cellular flexible cover to protect against abrasion of the shock absorbent material. The closed-cell shock absorbent material should meet the following minimum specifications:

5.6.6 On a supported shield system with vertical posts, the bottom of the tempered glass or acrylic should sit on top of the caprail. For self-supported acrylic systems, a ⅜-in. deep recessed groove should be notched into the caprail to prevent the acrylic from popping out on impact. This channel or groove shall run continuously between vertical aluminum shielding supports. Seamless glass systems require no support posts except at gates and terminations. Seamless glass is held in place with a combination of a top clip, bottom clip, and shield groove welded or fastened in place and located 3.5 to 4 in. down from the top of the caprail. The channel and top clip are instrumental to providing movement of the shield.

6. Players' Boxes

6.1 *Location*—See X1.4 (Figs. X1.1-X1.3).

6.2 *Dimensions*—Each players' box enclosure should be a minimum of 24 ft (7.31 m) 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.

6.3 *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 closest end of the bench.

6.4 *Shielding*—Shielding should be installed behind (if there is public access) and alongside, but not in front of the players' boxes. See 5.6.5 regarding shielding support posts.

7. Penalty Boxes

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

7.2 *Dimensions*—Each box should be a minimum of 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. A bench should run the full length of the box.

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

8. Scorer/Timekeeper Box

8.1 *Location*—The scorer/timekeeper box should be located between the penalty boxes.

8.2 *Dimensions*—The scorer/timekeeper 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 table should be provided and run the full length of the box.

8.3 *Shielding*—Shielding should be installed behind if there is public access behind the scorer/timekeeper box, alongside, and in front of the scorer/timekeeper box.

8.4 *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.

8.5 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.

9. Signal and Timing Devices

9.1 *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.

9.2 *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.

9.3 *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.

TABLE 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

10. Dressing Rooms

10.1 Each rink shall have a minimum of five player dressing rooms to accommodate 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 adjacent toilet and shower facilities. Each dressing room should have wall-mounted benches and shall provide hooks at a safe height above the benches for hanging clothes.

10.2 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.

10.3 Dressing rooms should be designed with increased capacity for heating, ventilation, air conditioning and dehumidification sufficient to handle the additional requirements caused by heat and humidity.

11. Illumination and Sound

11.1 Lighting and sound systems for rinks should be controlled from the office or a control booth, or both. Special consideration should be given for cabling and media connections if it is anticipated that the facility may be used for televised events or events with special effects.

11.2 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:

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

11.2.2 *College*—100 Horizontal/75 Vertical,

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

11.2.4 *Recreational*—50 Horizontal/ 25 Vertical.

11.2.5 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 should be readily available and conspicuously marked.

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

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

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

12.6 *Exits*—Fire exits must be illuminated.

13. Mechanical Systems

13.1 *Selection*—Many factors, including climate, can influence the selection of ice rink and other mechanical systems. The following guideline should be taken into consideration for the selection, specification, design, installation and maintenance of ice rink/arena systems.

13.1.1 Documentation of the design blueprints and specifications, installation records, permits, catalogs and manuals from the arena's professional consultants, suppliers, manufacturers and installers should be provided to the owner/operator and kept on file for future reference.

13.2 *Refrigeration System*—The refrigeration system is the heart of any ice arena and should be designed by a registered professional engineer with industry specific knowledge and experience.

13.2.1 *Tonnage*—Refrigeration tonnage needs to be sufficient to remove the heat necessary to provide proper ice conditions during the entire operating season. Refrigeration equipment should be able to maintain an ice surface temperature between 18 and 26°F (–8 to –12°C) with 1 to 2 in. (2.54 to 5.08 cm) of ice thickness.

13.2.2 *Refrigerant Storage*—Refrigerant storage needs to be in accordance with all federal, state, or local regulations.

13.2.3 *Refrigeration Room*—All refrigeration rooms need to be constructed for the refrigeratant type being used and should be adequately sized to allow for maintenance and repairs. Proper safety signage and detection devices should be included.

14. Ice Rink Floor Design

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

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

14.1.2 The main rink floor should be installed only after proper sub-floor preparation with freeze protection.

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

14.2 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:

14.2.1 *Sub-Floor Drainage, Porous Fill, Sand Bed, and Freeze Prevention*—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. 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.

14.2.2 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.

14.2.3 *Subsurface Heat Grid*—A subsurface heating system to prevent permafrost or condensation forming below the floor should be considered for year-round facilities. 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.

14.2.4 *Insulation and Vapor Membrane*—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 by 4-ft (2.4 by 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.

14.2.5 *Vapor Barrier*—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. (0.6-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.

14.2.5.1 *Pipe Chairs*—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 support of the piping without sagging. Reinforcing bars (die-formed Specification A60 No. 4 bar) are then placed 24 in. (0.61 m) square.

14.2.6 *Pipe Grid*—The pipe of diameter and type (polyethylene or steel) to be used is fabricated in place. If the headers are to be embedded in the concrete, a depression for the headers in the sub-floor preparation is required. It is recommended that only Schedule 40 black carbon, seamless, Specification A53/A53M Grade B, SRL steel headers be considered for embedding in the concrete. Whether a header trench is used or the headers are embedded in the concrete, particular care should be taken at the area the pipe penetrates into the concrete floor.

14.2.6.1 The piping grid should be assembled carefully and in a manner to prevent leaks from occurring at joints and connections. The entire grid shall be tested hydrostatically at 150 psig for steel or 100 psig for polyethylene for a period of 24 h. After the testing has been witnessed and approved, the pressure should be lowered to 50 psig and held until the concrete is poured as visual evidence that the piping has not been damaged during placement. The piping should be level to ± 0.125 in. (3.18 mm) and capable of providing a complete and uniform ice sheet. Laser beams are generally used for the leveling process. Steel pipe can be leveled and aligned more readily than PVC pipe due to steel's rigidity and low thermal expansion characteristics.

14.2.6.2 For safety and energy efficiency, the freezing grid should not extend beyond the dashers. If the headers are embedded, it is necessary to run a freezing circuit around the perimeter of the rink to ensure good ice quality at the edge of the rink. It is important that this circuit be installed fully embedded within the concrete to prevent melting and damage at the expansion joint.

14.2.7 *Reinforcing Steel and Wire Mesh for Concrete Floors*—A reinforcing welded wire fabric using Specification A185/A185M, 6 by 6, 10 by 10 black steel wire mesh should be placed over the pipes and tied down such that it will be fully embedded in the concrete. Any inserts of temperature sensor boxes, goal posts, tennis nets, or circus tie-downs are then put in place. Care must be taken to ensure that these inserts do not affect the pipe spacing and that they are secured or grouted in place so as not to move during the pour.

14.2.8 *Concrete Floors*—A proper concrete mix and placement is very important for a satisfactory rink floor. The concrete thickness is usually between 4 in. (10.16 cm) and 6 in. (15.24 cm), with a strength of about 4000 to 5000 psi after 28 days. The concrete floor is a monolithic slab and placed with a continuous pour. When the boards are mounted on the refrigerated slab, coordination should be made with the dasher manufacturer to be on-site so they can set the anchors at the time of the concrete pour.

14.2.8.1 All cement shall be Type I Portland cement or its equivalent and shall conform to Specification C150. The concrete mix shall be approximately five to seven sacks per cubic yard (0.91 m) depending upon the strength required, and should contain no more water than necessary. Adding cement increases shrinkage, causing cracks, and excess water affects the curing process. A high range water reducer admixture (superplasticizer) should be used to give the concrete a temporary high slump with a minimum amount of water. All admixtures should conform to Specification C494/C494M, Type F or G. An air entraining admixture conforming to Specification C260 shall be used in concrete for rinks exposed to the weather. Standard community rinks that keep ice during nine months of the year normally do not require air entrainment. In addition, a corrosion inhibitor is recommended, especially for steel pipe installations.

14.2.8.2 Timing in the placement of the concrete is critical and it is important to select a plant that has adequate capacity, the necessary number of trucks available, and proximity to the job site.

14.2.8.3 Perimeter pipe to ensure that the ice along the perimeter of the ice rink, known as the edge, extends and is flush to the kick-plate and without any gaps. See X1.3.

14.2.8.4 There should also be a back-up facility selected as a standby in the event of problems at the initial plant. Problems do sometimes arise that can affect the concrete work. In addition, the concrete should be pumped from the trucks to the point of placement, therefore a backup pumper should be available at the site as well.

14.2.8.5 Place the concrete in a continuous process with no cold joints. A screed should be used for leveling, and the concrete should be fully agitated to eliminate all voids and the possibility of any honeycombing, especially around the headers and at the perimeter of the surface.

14.2.8.6 There should be a continuous monitoring of the surface level. The tolerance should be kept within ±0.125 in. (±3.18 mm) over the entire rink.

14.2.8.7 The freezing grid should be kept under air or water pressure with continuous monitoring of the surface during the pour so as to detect any leaks that may occur or might be present in the piping. Mechanics should be available to repair any detected leaks as quickly as possible so as not to affect the concrete work.

14.2.8.8 The cement contractor and his entire crew should be briefed about the importance of the piping and insert placements, and made aware of the importance of having the surface perfectly level prior to starting the work. Also, it is suggested that workmen not be allowed to smoke, especially on jobs with polyethylene piping.

14.2.8.9 Test cylinders should be taken as the point of placement for every 50 yd (45.7 m) of concrete. The slump should be continuously conveyed to the concrete contractor and batching plant.

14.2.8.10 Curing is very important to obtaining a good, crack-free floor. The concrete should be allowed to cure slowly by keeping it wet as long as possible. A polyethylene cover can be applied after spraying the surface with a light coat of water with additional water sprayed on top of the cover to ensure a good seal. The cover should remain in place a minimum of 14 days before applying concrete sealer. It is recommended that no heavy traffic should be allowed on the concrete for 28 days and no foot traffic prior to 4 days.

15. Dehumidification and Heating, Ventilation, Air Conditioning (HVAC) Systems

15.1 There are a number of pollutant sources within enclosed ice skating rinks that may affect the air quality, including ice resurfacing equipment, ice edgers, space heaters, refrigerants, outside vehicle emissions and other possible sources. Use of electric powered equipment can help to reduce such air pollutants.

15.2 The dehumidification and HVAC systems need to be able to provide a dry and comfortable environment for both the ice and off-ice areas during the entire operating season. The following guideline should be considered in the design and selection of ice arena/rink equipment.

15.2.1 A typical 200 by 85 ft (60.95 by 25.9 m) NHL size ice surface will require 33 to 100 lb of moisture to be removed each hour.

15.2.2 Ice rink building temperature is typically maintained between 45 and 65°F (7 and 18°C). The lower the building temperature, the higher the relative humidity can be and the higher the building temperature the lower the relative humidity should be.

15.2.3 *Air Temperature 3 ft (1.52 m) Over the Ice*—35 to 45°F (7 to 18°C).

15.2.4 *Relative Humidity*—35 to 45 % should be maintained during the entire operating season.

15.2.5 *Dew Point*—32 to 37°F (0 to 3°C).

15.3 Indoor Air Quality (IAQ) should meet local and state codes in regards to CO (carbon monoxide) and NO_2 (nitrogen dioxide, also known as oxides of nitrogen (NO_x). Indoor air quality monitoring devices and controls should be used and can be designed into the dehumidification or HVAC system, or both.

15.3.1 HVAC should be considered for the entire facility with the ability to control each zone of the facility from a central location.

15.3.2 Air currents from the dehumidification and HVAC systems must not affect ice quality and should be designed to have the capacity to be directed onto the floor for non-ice activities.

16. Keywords

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

APPENDIX

(Nonmandatory Information)

X1. SUPPORTING DOCUMENTS AND SOURCES OF INFORMATION

X1.1 *Rule Books*:

X1.1.1 National Hockey League Rule Book[7]

X1.1.2 USA Hockey Rule Book[8]

X1.1.3 Hockey Canada Rule Book[9]

X1.1.4 International Ice Hockey Federation Rule Book[10]

X1.1.5 NCAA Hockey Rule Book[11]

X1.1.6 National Federation of State High School Associations Rule Book[12]

[7] Available from The National Hockey League, 1251 Avenue of the Americas, 47th Floor, New York, NY 10019.

[8] Available from USA Hockey, Inc., 1775 Bob Johnson Drive, Colorado Springs, CO 80906.

[9] Available from Hockey Canada, Father David Bauer Arena, 2424 University Drive NW, Calgary, Alberta T2N 3Y9, website: www.hockeycanada.com.

[10] Available from International Ice Hockey Federation, Brandschenkestrasse 50, Postfach, 8039, Zurich, Switzerland, website: www.iihf.com.

[11] Available from National Collegiate Athletic Association, 6201 College Blvd., Overland Park, KS 66211.

[12] Available from National Federation of State High School Associations, 11724 NW Plaza Circle, Box 20626, Kansas City, MO 64195.

X1.2 *ASTM Special Technical Publications (STPs)*: [13]

X1.2.1 *Safety in Ice Hockey*, ASTM STP 1050, ASTM International, 1989.

X1.2.2 *Safety in Ice Hockey: Second Volume*, ASTM STP 1212, ASTM International, 1993.

X1.2.3 *Safety in Ice Hockey Guide: Third Volume*, ASTM STP 1341, ASTM International, 2000.

X1.2.4 *Safety in Ice Hockey Guide: Fourth Volume*, ASTM STP 1446, ASTM International, 2004.

X1.3 *ASTM Publications*: [13]

X1.3.1 Montebell, G. M., "Ice Skating Surfaces," *Standardization News*, June 1992.

X1.4 *Rink Layouts*:

X1.4.1 See Figs. X1.1-X1.3.

X1.5 *Canadian Sledge Hockey Guidelines*, 2007.

[13] Available from ASTM International Headquarters, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959

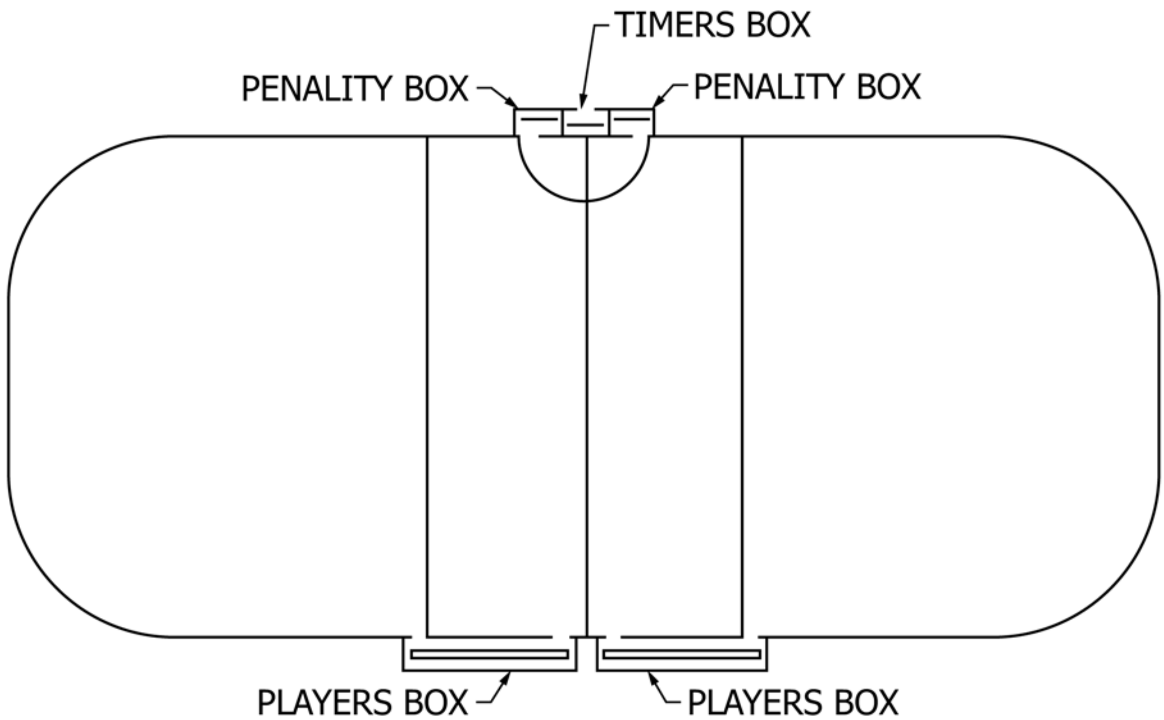

FIG. X1.1 Rink Layout 1

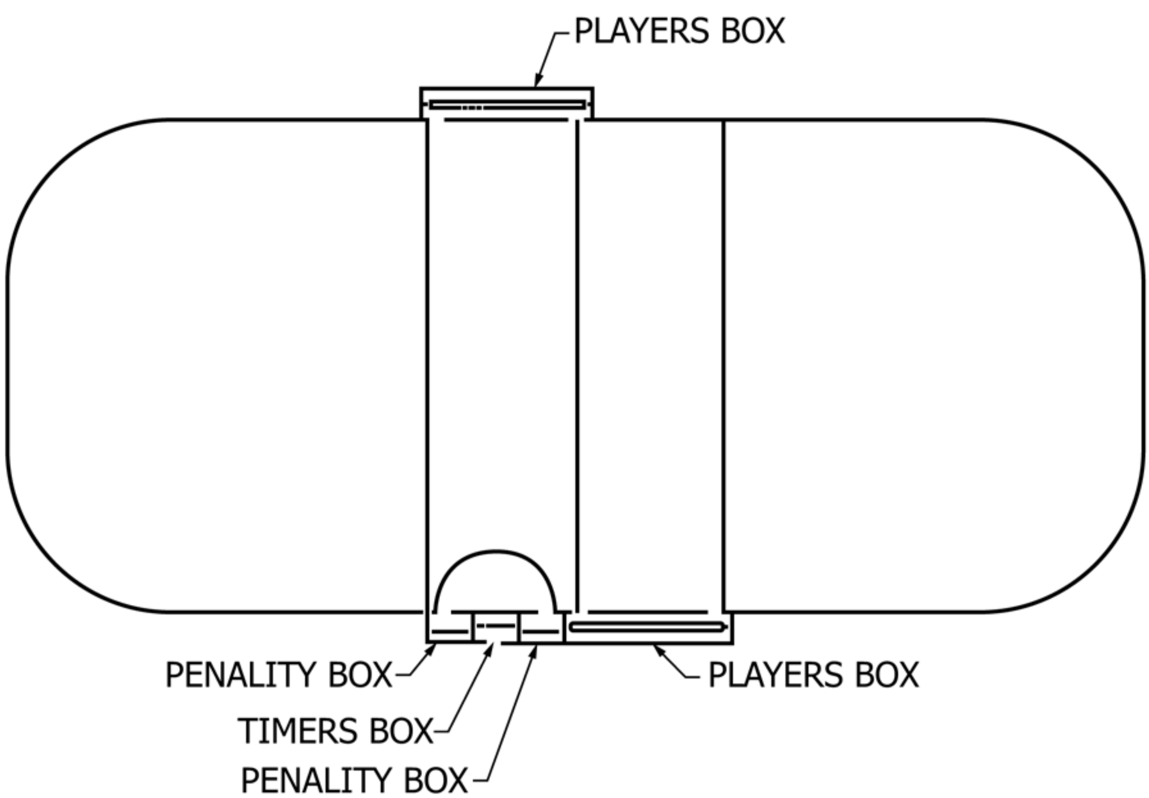

FIG. X1.2 Rink Layout 2

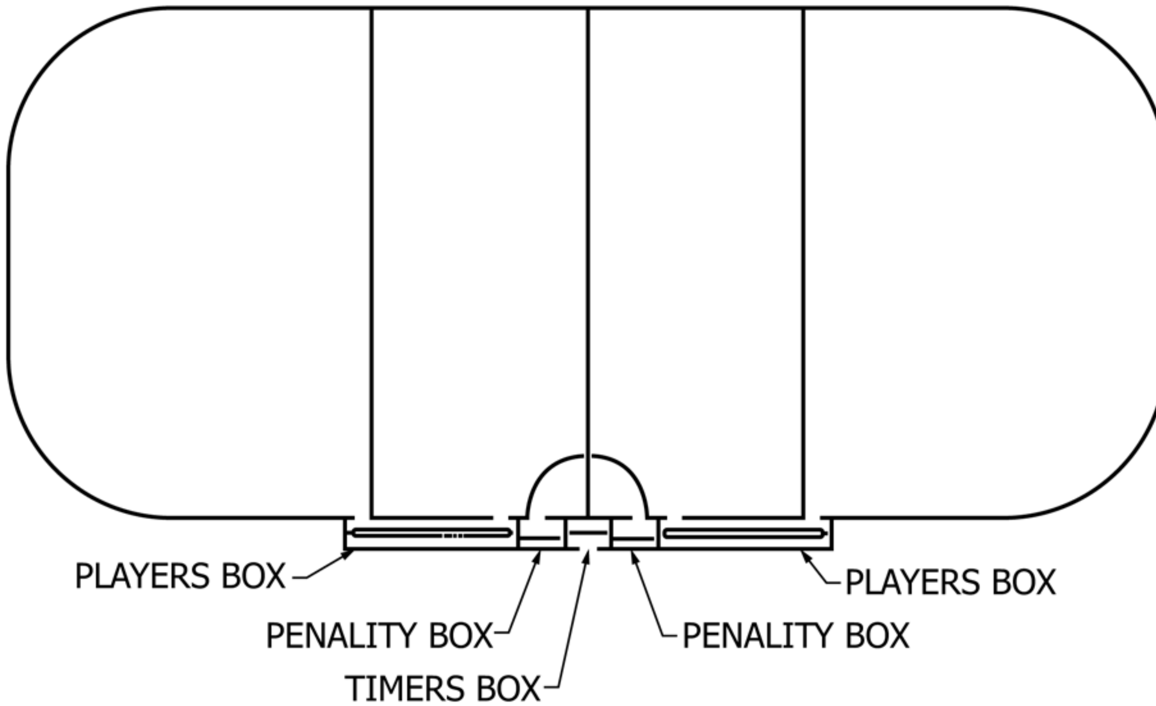

FIG. X1.3 Rink Layout 3