8 CURLING ICE IN AN ARENA

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To overcome the problems of dealing with different situations for different purposes, there will be some duplication in the section, which is presented as two different approaches to a similar problem.

FROM ICE TO CURLING ICE

The words of this heading are carefully chosen, because the two items are very different. Ice is simply the result of water being frozen by lowering its temperature to below 0ºC, whereas curling ice is a manufactured product of specific definition that has been made from ice, or by freezing water in a very specific way.
It is the purpose of this half of the section to bring together the relevant essential pieces of information scattered throughout the manual, to enable technicians to convert ice to curling ice in an efficient and cost-effective way on a regular basis. In the next half of this section, Curling Ice In An Arena, the same subject is addressed, but there it is aimed at providing excellent ice for a competition of some duration.

The problems

1. In many areas where curling is undeveloped, there is not (yet) a dedicated curling rink and not many players, but there is a modern skating facility prepared to sell ice time for curling. The ice is not however curling ice and has to be improved.

2. Ice in a skating rink is not perfectly level, but curling ice should be perfectly level to be playable.

3. The water that was used to make the ice was not clean and the ice contains many impurities and minerals, mostly salts. Curling ice requires a very clean surface, to be pebbled with very clean water at the right temperature.

4. Skating damages the ice, leaving deep gouges in places, which take time to repair.

5. No markings, lines or equipment have been installed and will have to be added quickly, and probably removed afterwards.

6. There is not sufficient time to do a good job, nor the equipment, nor trained technicians.

7. The ice-surface temperature is very important for curling. To complicate the matter it is very difficult to measure accurately, unless a probe can be placed on the ice surface where it is likely to be damaged.

The solutions

1. As every experienced curling manager knows, someone has to provide the driving force and maintain the momentum, but one person cannot hope to do it all himself.
   The skating-ice technician is the person with much to do and not enough time and now, with curling on the scene, someone is giving him even more to do. The skating-ice technician is also a very important person, respect his position.
   To solve this, form a club of all known curlers, have a meeting and select a committee. Let this committee take responsibility for the running of the curling and its ice, and the most knowledgeable and diplomatic member must liaise with the skating staff. Good communication and teamwork will solve most of the problems and develop a healthy atmosphere.
   Then have a fund-raising exercise to raise as much money as possible for equipment and specialised training for a curling-ice technician, who will take responsibility for the weekly conversion to curling ice along with the skating-ice technician.

2. If the skating ice is maintained well, it will remain reasonably level. A good Zamboni driver will find ways of compensating for high corners and middles, and will keep changing his patterns to improve the level. The more level the surface can be maintained, the less work to make it level for curling. In fact, if the ice is well maintained in a busy skating rink the constant scraping will lessen the effects of salts in the surface too (see Point 3).
   For maintaining the level of skating ice a powered edger is a must. It will “grind” down the higher sides and corners very quickly and is much easier than using a hand scraper. This should be done routinely, and is normally done every day in busy skating rinks. Edgers are available from both Zamboni and Olympia.
   The dedicated and willing skating technician should have a laser level at his disposal to regularly check his floor and see for himself where he is going wrong, and there is no simpler way.
   Scraping the surface with the Zamboni without flooding makes a big difference, because it will scrape down irregularities

without adding water, but scrape gently and both down and across the ice if possible. If only four sheets are needed in a full-size skating rink, it will be easier to level the middle of the rink than the side(s).
If the surface is reasonably level an overnight flood with warm water will give the best result for level, as well as the smooth surface required for curling.
Ideally, the best scenario is to keep the surface as level as possible during the skating phase, scrape and flood with the Zamboni to level off the surface, flood overnight with warm water and finish in the morning by pebbling and cutting with a powered cutter. These machines are expensive, but they do a very good job and without them it will be very difficult to achieve a level surface, especially if the work will be on a weekly basis. In most curling rinks they are used every day to maintain the pad. If a powered curling cutter is not available, the Zamboni/Olympia can be used to do a light, dry scrape (using little pressure) across the rink, which will remove the worst impurities and provide a reasonable surface for pebbling.

1. The ice that was used for curling in earlier days and is still used in many areas today, cannot be curling ice unless the surface has been cleaned of salts and impurities. In a curling rink this will be done over several days, by which time the surface will be clean and will remain so until the next flood. In skating rinks the constant scraping between sessions will maintain the surface quite well and a good dry scrape after flooding will remove the bulk of the salts. Of course, if the ice has been made with purified water there will not be a problem with salts at all.
The pebble water, on the other hand, has to be clean, at the right temperature (about 40ºC, depending on the hole size), using the right pebble head, with the ice-surface temperature at – 4.5ºC, the relative humidity at about 40% (at 1.5m) and the air temperature at 8ºC (at 1.5m) to give a dew-point temperature of – 4.3ºC, or all the other work that has gone before will be going to waste.
In short, install a water-purification system and a heater or heat-exchange system of sufficient capacity to enable flooding with clean and warm water.

2. To keep on top of the damage caused by skating, the ice surface has to be well maintained. Keep the problem small and it will be easier to repair. Curling-ice technicians will routinely fill in marks and holes with a little water before cutting the ice and this takes time, but if they don't do it the problem can get out of hand when only a flood can save them. The skating-ice technician will no doubt welcome a volunteer who will fill in the worst marks before he has to dress the surface with his Zamboni.

3. Installing the essential equipment depends entirely on co-operation between the skating and curling staff. The liaison member of the committee must work at this.
If the curling is going to be a regular event throughout the winter, it is best to install the lines and houses in the ice for the season, or paint the houses on the floor before the ice is installed. If the curling is less regular, simply measure up and scribe the circles in the ice – this is what is still done today for outdoor curling and it works.
The hacks will be easy to melt into place if the supporting frames are made of aluminium or steel, and are very quickly removed again.
The stones often present the biggest problem. Carrying the best part of sixty-four stones twice a week is not a task for the unfit and has inherent dangers of damage or injury. Either find a safe and dry area nearby to store the stones at a cold temperature (preferably – 4ºC), or have trolleys made that can each carry sixteen stones upside down in safety and create as cold an area as possible for them where, again, they will remain safe and dry. If space is available, consider installing a chiller similar to what butchers use, large enough to hold the trolleys and keep the temperature down.
Stones that are allowed to get wet will absorb moisture. Putting these stones on the ice will freeze the moisture, which has penetrated the stone through natural veins in the granite. When the moisture freezes it expands, putting the stone under stress. Hit the stone with another and it can acquire a "pit", which is when small particles of granite are jarred loose. See Section 21 on Curling Stones.
Stones stored in a humid area and in a temperature lower than the freezing point will soon be covered in frost. An example is shown below.

This is not for good them and also bad for playing conditions, as these stones have to be warmed before play causing the frost to melt on the surface of the stone. See below.

Having to do this to stones shows a clear lack of care and must be avoided.
Remember that a cold stone in a humid environment will quickly collect condensation, therefore the humidity HAS to be controlled. Again the butcher's chiller with a dry environment will prevent this from happening.
Bringing stones back to the ice every week will depend on how warm they are, and stones that are not at the same temperature as the ice surface will not play well. Stones must be treated carefully and correctly, they are very expensive!
Other equipment, such as mops, pebble cans, etc. will also need to be stored in a safe and clean environment, and it is as well to remember that any item can grow feet and walk.

4. The problem of time is not really a problem, because there is never enough time when perfection is at stake. It is a reality, there is only so much of it, and it has to be used efficiently.
Plan, organise, streamline, save where possible and invest in the proper equipment, and there will be time to spare. Although curling-ice equipment is expensive, it is always worth buying the right tools for the job because this will save time and so money.
An Ice King or similar, with good blades, will be essential. Mops, pebble cans, pebble heads, brooms, etc. are not that expensive and are indispensable.
Thermometers and hygrometers are not always essential and are usually installed somewhere already, but a good infrared thermometer for the ice-surface temperature will be extremely helpful. There are also combined thermo-hygrometers available for the air temperature and humidity which are not expensive and are very accurate.
Buy the ice technician a laser level for Christmas. Then send him on a good curling-ice course to learn the science while the rest of the club raises funds to buy all the other equipment he asks for when he comes back. A well-equipped, well-trained and well-motivated ice technician can make beautiful curling ice, and he will be worth every accolade. Be sure to reward him well.

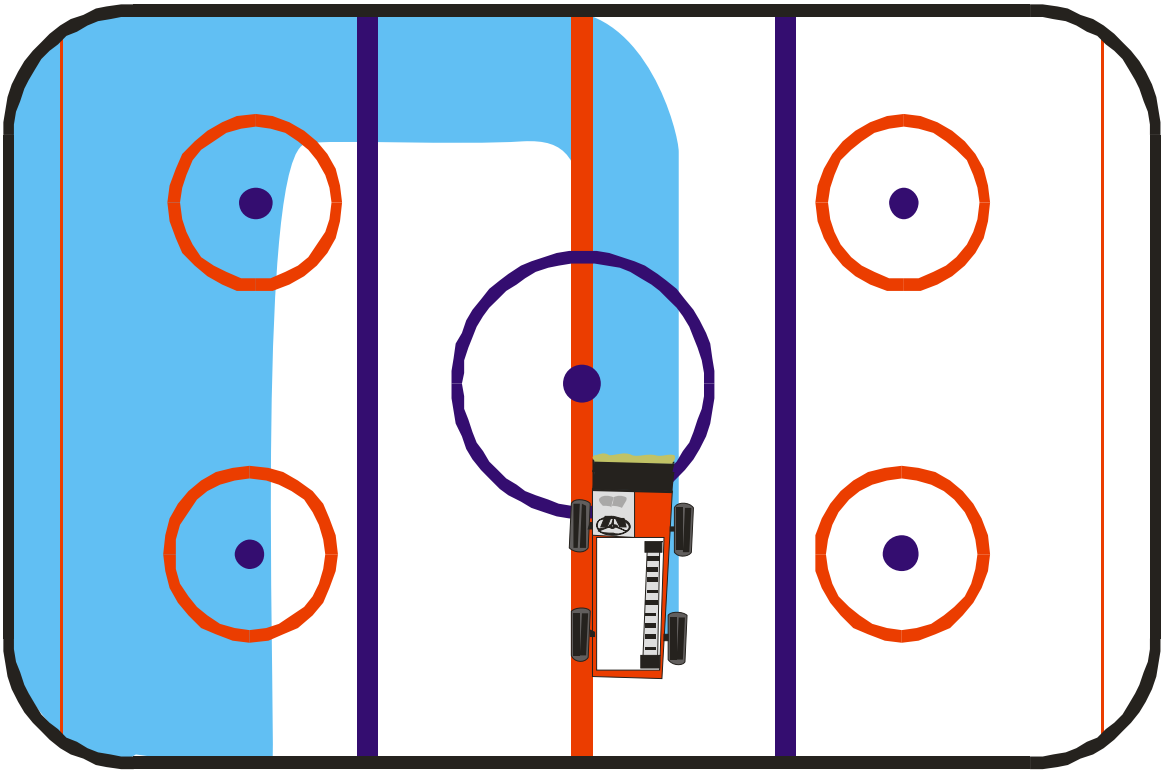
5. The ice-surface temperature is the most critical aspect of good curling ice. Not only must it be established at a given temperature, usually between – 4.5ºC and – 5ºC, it must be kept at that temperature, and an infrared thermometer is about the only instrument that can conveniently read the temperature. Unfortunately these are only reliable if the reading is taken at the same point, which means fixing one to a stand to aim at a chosen spot and provide a reading when needed.

Summary

The days of simply using ice and saying it is curling ice are being left behind. This manual clearly states that curling ice is a product of science and effort and, even for curling ice made from skating ice, if the definition is applied the objective will be achieved. The above supplies the basic essentials of converting from ice to curling ice, and anything less will not achieve the objective. Experienced ice technicians all know this and, if they are abreast with developments, they will acquire a complete copy of this new manual of the WCF, *Curling Ice Explained*.

For those who feel they have good reason to ignore the above advice, there follows information on how to break the rules and curl on ice according to the art of the possible. To avoid any confusion about skating ice, flip-over ice once a week or curling ice, the definition applied to this kind of ice will be "borrowed" ice, where ice is converted to something that can be curled on, in a short space of time and at irregular intervals.

The following page contains two pictures to help illustrate scraping across the rink, which causes less problems with lines that could deflect a stone from its intended course.

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Further notes

1. The easiest way to maintain a level ice pad is to keep it that way. Make very good friends with the skating-ice technicians and persuade them to do good work every day, and this will make it very much easier when the ice has to be converted for curling. Better still, teach them to curl!
2. Be sure not to flood with the ice surface too cold (try for – 4.0ºC). In fact, raising the surface temperature a little to about – 3.5ºC during flooding will help the water to level better, but this is no way to level a very uneven pad!
3. Avoid air movement over the ice surface, which at worst will create rippled ice and at best cover it in a thick patch of frost. Keep the humidity down and if needed supply some heat. The standard for curling ice is to measure the air temperature and humidity at a height of 1.5m and aim to achieve 8ºC and 40% relative humidity (dew-point temperature of – 4.3ºC at 1.5m), with the ice-surface temperature at – 4.5ºC.
4. A quick way to visually see how level an ice surface is, is to watch it as it freezes after a flood. With the surface no colder than – 4ºC, and with a drawn plan of the floor at the ready, note which areas freeze first. These will be where water has run off towards lower areas and where the ice is therefore thinner. Do not think everything will be level, because the areas that freeze first are in fact higher and can be scraped (dry) separately with the Zamboni if their positions have been carefully noted. It will make a substantial difference to the overall level of the ice surface.
5. Get the stones to the ice as soon as possible to cool them down. Where they won't be in the way, put them on plastic beer-draining mats on the ice to prevent them melting the ice and absorbing water. Depending on how warm they are, it will take at least two hours, which is about the time needed for the cutting and cleaning.
6. As a rough job, circles can be scribed with quality felt-tip markers and even coloured in with larger markers. Remember to cover the ink with a very fine misting spray to freeze it in, and pebble the area along with the rest of the rink. Also remember to pebble behind the hacks to enable new curlers to have somewhere to get used to the feel of the ice (and to cool their feet down before curling!).
7. It is very difficult to curl on ice with a high salt content in the surface, because the pebble will melt in the salty surface. If the ice was made with unpurified water an attempt MUST be made to cut the salts off. The quickest is to pebble with hot water (60ºC) and cut clean, repeating the process as many times as time will allow.
8. Remember that a Zamboni or Olympia scrapes the ice, because the blade is not very sharp. An Ice King or similar powered cutters cuts the ice, because the blade is extremely sharp and actually shaves a fraction off the ice surface. A dull blade on a powered cutter is a waste of time.
9. Surface-ice temperatures for skating vary. For curling purposes and when flooding or cutting, ask the ice master to adjust the plant so that the ice-surface temperature will be around – 4.5ºC.
10. Good, clean ice is not very slippery. Some curlers in fact use chamois-leather cloth as a quick hack solution, which has sufficient grip to do the job.
11. If the pebble starts going flat (wearing down), it will do so along the sliding lines first. A quick extra pebble along these lines with a fine pebble head will overcome the problem for a few ends of curling.
12. When searching for equipment, it pays to surf the web and find what is available more locally. Simply specify the exact product and search. Be careful, however, with pebble heads in particular, because they vary a great deal between makers and models. Ask trusted and experienced curling-ice technicians where to go, because they know.

Miracles

Having to convert borrowed ice into acceptable playing ice is not easy, and miracles are not easy either. An effort will be made to assemble a minimum strategy and it will be added to this section at a later stage, but there are reputations at stake and there is no sense in advising new technicians to provide poor ice simply because it is convenient. The essence of curling is not to shove stones down the ice to see what happens, it is to challenge perfection by playing a good stone on good ice to better the opposition.

CURLING ICE IN AN ARENA

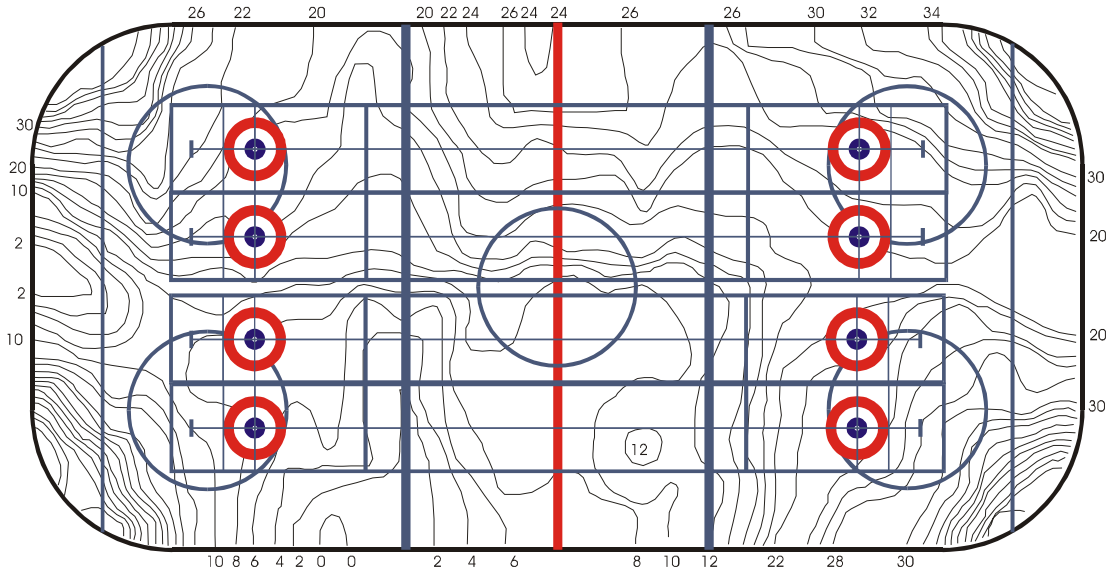
Many ice rinks share the facility between curling and skating, ice hockey and even exhibitions. While this is not an ideal scenario, it is the only means by which the facility can financially survive, as well as the only economical way in most areas for curling to be available to a club. Also, most serious competitions are now held in arenas capable of seating many thousands of spectators, where the ice often has to be converted from skating ice to curling ice. Under both these circumstances the problems are much the same and can be overcome.

The ice in an arena will invariably have been maintained by a machine such as the Zamboni or Olympia. The quality of the ice surface is directly related to the skill and experience of the ice technician and will vary considerably from venue to venue, and if the technician is not qualified in the production of curling ice he will not always be able to understand the degree of precision required. This is particularly relevant if there are regular change-overs, where the use of the Zamboni itself will need to be very skilful if a reasonable surface level is to be maintained. To make matters worse, there is usually insufficient time to do the job properly, which immediately limits the technician to the art of the possible.

All arenas will flood the ice on occasion, usually overnight, to keep the ice as level as possible. The Zamboni will soon destroy the level if there is too long a period between these level floods, yet the technician can only realistically flood so many times. The Zamboni both cuts and floods in the same motion, and while he can adjust how severe to cut the ice he doesn't normally adjust the depth during a cutting session, nor does he adjust the amount of water being applied since the beginning of the session. A further complication is that this work is often done at the end of the day – or in the middle of the night – when the technician is in a hurry to go home, with no patience for exacting ice maintenance.

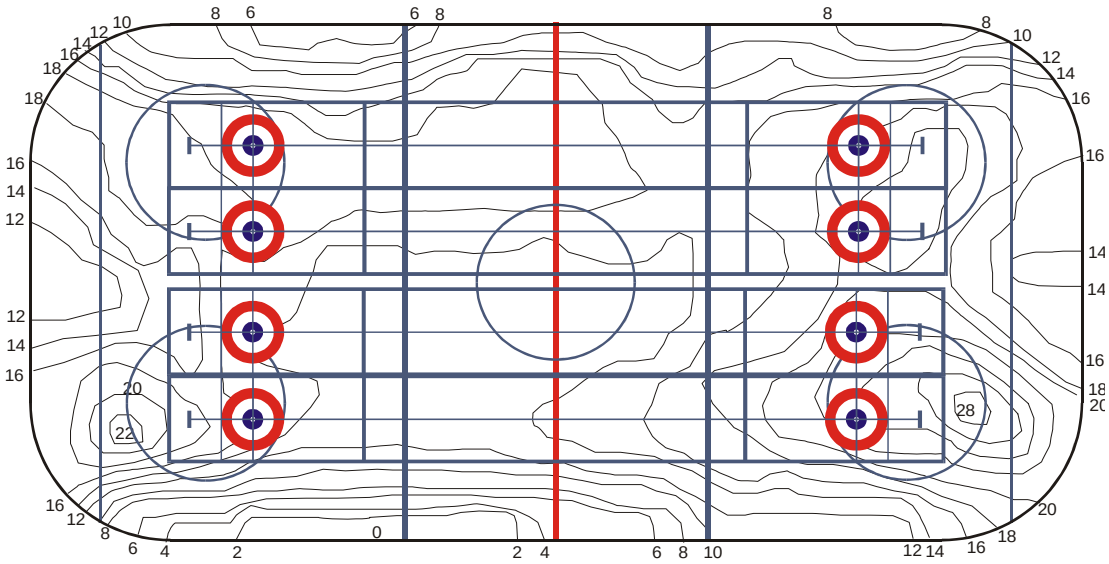
The machine runs quite fast over the ice, normally down the length of the rink, and when it reaches the end of the run it has to slow down to turn around. With the same amount of water still being applied at the rear it is obvious that more water will be delivered at every turn, and it would be impossible to achieve a level flood with the machine because one flood will overlap another at some stage. The skaters and ice-hockey players will also wear down the ice and this will inevitably be in the middle area of the rink and, combined with the Zamboni, create a level which is high at the shorter ends and along the sides. Other complications are players emptying their water bottles outside the players' stalls, creating a high area, or where the machine is driven onto and off the ice there could be a low area, or when technicians mill down the sides along the boards they could create a low strip there.

The level of the pad in hockey arenas can vary greatly, and more so if there is continuous skating over a long period. Most ice-hockey pads measured with a theodolite or laser level will show a difference in level of some 30mm, but where the concrete floor is uneven the difference in ice thickness could be as high as 150mm. A typical arena not maintained for curling will give the result shown below.



Contour lines in 2mm (the lowest spot is 0)

The next time the technician in the same arena had prepared the ice better towards curling because he knew what to do, and the result of his efforts can be seen below.



Contour lines in 2mm (the lowest spot is 0)

This clearly illustrates that, while arena technicians can significantly improve the level with successive floods, it will generally take much more than a few floods to level a skating pad sufficiently to provide a basis for the making of good curling ice.

Every arena technician must have clear objectives, and a clear understanding of what he has at his disposal to achieve those objectives. The most important component of the solution to his problem will be co-operation between himself and the curlers, or the curling club, or the curling-ice technicians provided by the organisers of a competition to help him. Without this co-operation it would be very difficult to make good curling ice. In the case of a club, it would be wise for the club to select a suitable individual to liaise with the arena technicians and provide the necessary information of their requirements. To allow every curler in the club to have their say would be disastrous, because too many cooks will spoil the broth (and the subject is complicated enough!). The most suitable person would of course be someone qualified in the making of curling ice and his contribution will make a significant difference.

As for the objectives, the different types of curling ice will play the most important role.

Club ice

Club ice will be ice available for curling almost directly after skating, and will certainly be down to the art of the possible. Many clubs and their curlers will accept this kind of ice if it is all they can get, but it really isn't curling ice at all. When the ice is installed in autumn the level will be achieved through flooding, and with the proper technique the ice will be as level as anywhere else. Despite the problems caused by cutting and flooding with a Zamboni the level can still be maintained by flooding with hot water whenever possible, usually at night once the hockey has finished. In addition the technician can cut "dry" more often to keep the ice thin, and with a careful schedule of floods during the season the ice can be maintained sufficiently level for curling throughout the season. Although this will result in more work for the technician and higher costs to the club or owner, there is no simpler way to keep the ice level. Bear in mind that level ice is only one requirement for curling, because the surface also has to be smooth and even, which involves the control of humidity and the temperatures of the ice surface, the air and the pebble water (see Section 13).

There are two broad scenarios for club ice after hockey:

1. Curling directly after hockey.

The ice has been cut and machine flooded during the whole day, and there will be courses from the cutting along the rink with the surface still rough after the last hockey game. If the previous overnight flooding had been done well the surface will be reasonably level, but the courses and roughness have to be removed. The simplest solution is to have four sheets of curling in the middle of the rink, which will leave some 5 metres of space along each side for the Zamboni to turn.

As a result the machine can work both lengthways and sideways and achieve a very good result, but of course the cutting will have to be gentle so as not to cause further courses which could affect the stones. Finishing touches can also be applied with an Ice King if time permits and a machine is available.

2. Curling first thing the next morning.
With curling first thing the next morning the overnight flood will give good conditions, and preparation of the ice will be the same as in a curling rink, with the usual pebbling and cutting. Although hand scrapers are still used, an Ice King or similar machine will make a much better – and easier! – job of it. The cutting is primarily to remove the salts and impurities from the surface of the ice, which will adversely affect the pebble (see Section 9).

Formula ice (Bonspiel ice)

Formula ice, or bonspiel ice, will be what an experienced arena technician has developed as the best he can do within the time available, and obviously there will be more time spent on the ice than with club ice. Many technicians have become masters of this art of change-over ice and their skill must be admired.
In the worst scenario, where there has been a long period of skating and the ice has to be prepared for an important bonspiel, it is best to start some two weeks in advance with the task of levelling the surface. The level will first be checked with a theodolite or laser level and mapped out as above (see Section 5), a process which will take about two hours, and the result will give a good indication of the problems to be solved.

Once the high spots are known, the technicians can scrape away at these during the two weeks and, combined with overnight floods, soon achieve a satisfactory result. (Using the differences in level the number of floods required can easily be calculated and scheduled accordingly, while the cutting will reduce the number of floods needed.) Every 2-3mm cut off from the highest spot will save a flood, while cutting down a high of 10mm will save more than three floods – time is the biggest problem for any ice technician preparing curling ice from skating ice.
Depending on time, manpower, plant, etc., the finishing work can start as late as the day before the bonspiel on the surface last flooded the night before. By doing the measuring and painting in the morning, which will take some 6 to 8 hours before everything is sealed in, it will still be possible to flood twice and have sufficient time for the pebbling and cutting. It is important to be able to keep cutting until the snow has become white to remove all the impurities, which would otherwise find a way into the playing pebble with poor consequences. Again a powered cutter such as the Ice King will make quick work of this, and with careful planning the tight schedule is feasible.
For both the above it is important not to forget about the hacks and stones. Removable hack plates in aluminium are now preferred for ease of use and these should be ready to be put in place before the last floods. The stones will need to be cooled in advance and, before they can be put directly onto the ice, will need to be as cold as the ice surface itself. In arenas there will be the corners outside the rink where stone cupboards can be installed, otherwise a purpose-built stone cooler will have to be built somewhere within reasonable access. The stones cannot be put directly onto the ice to be cooled down because they will melt the ice, and if humidity enters the granite it will increase the pitting process. If the ice has to be used for cooling down the stones, they have to be put on a form of hard plastic that won't allow water through, or on plastic beer-draining mats. Warm stones have to be cooled some 24 hours in advance.
It is sometimes the case that there is nowhere to leave stones in a cold environment sufficiently near the rink, but that there is a suitable area some distance away. Carrying a number of curling stones to this location is hard work, and if this is repeated twice to and fro every week it becomes a burden on volunteers or staff. To overcome the problem heavy-duty trolleys can be constructed that will carry two sets (sixteen) stones each to be moved to a suitably cool place. In this way the stones can be kept quite cool and will acclimatise within an hour or so when returned to the ice on plastic mats.

Competition ice

Competition ice, or championship ice, needs much more time. It will seldom be attempted in the normal running of an ice rink but mostly in an arena for the purpose of a specific event, and as the ice has to be as near perfect as possible the technicians will need several days to do their work.
It is extremely difficult to put down on paper everything that is involved in the making of championship ice. If the competition is held at a rink where the ice technician is suitably competent, he will do it his way and that will be as good as any other way. But if the competition is in an arena not normally used for curling, the job will usually be given to one of a handful of experts who have proved their worth in previous years at similar events. These masters of curling ice are exceptional technicians who travel many

thousands of miles every year to deliver perfection on schedule, and it would be unrealistic to think that this manual could hope to teach them much.
However, the contents of this manual will help to teach any technician the technical requirements of their craft, and with experience many will become sufficiently expert to make the ice for the World Curling Championships. The secret to success for any technician remains that he should never be afraid to learn more, and by learning from the masters he will become a master technician himself and make excellent competition ice.

Championship-ice schedules

Here a detailed listing is included as an aid to producing championship ice in an arena, which will invariably have been used for ice hockey and will therefore have "old" hockey ice on its floor.

Technical aspects

It is essential to investigate all technical aspects of the facility in as much detail as is possible. The more that is known, the better the ice and the better the competition.

1. How many compressors are there and what is their capacity.
2. What is the cooling system (an indirect-brine system or a direct-expansion system).
3. The construction of the floor from subsoil upwards.
4. The pipework in the floor, including the sizes, spacing between pipes and the direction in which they were laid.
5. The refrigeration steering system (e.g. to adjust the brine temperature, manually or by computer).
6. The dehumidification systems, their capacity and steering system.
7. The air-conditioning system, its capacity and steering system.
8. Any constant air flow over any area of the ice surface that might affect the ice.
9. The quality of lighting, or if temporary lighting will be installed and their type and location.
10. The mains water quality from the tap to be used (obtain a test result from the authorities).
11. Any known floor movements or other peculiarities.
12. The availability of hot water for flooding, ideally at a rate of 2.5m³/hour.
13. How well is the building constructed, especially air and moisture entering through walls, the roof or openings of any kind.
14. What equipment is available for use on site, and its condition.
15. What help is available and when.

Compressor duty

It is surprisingly frequent that a problem occurs with the compressors, causing the ice to melt at the worst possible time. It is essential that a system is in place, either manual or computerised with backup, that will ensure that the compressors are monitored at all hours. Normally arenas have alarm systems and a twenty-four hour call-up facility, and these must be switched on and monitored as a failsafe at regular intervals. When changing from automatic steering to manual steering, remember (and have a back-up reminder!) to switch back to automatic when leaving the building.

Paintwork

Ice paint for the surface and the houses (see Section 5) must be specially formulated for ice use.
Brushes and spraying equipment, with a boom fitted with non-drip nozzles.
A router scribe to define the circles will give the best result.

Backboards

By fitting backboards behind the hacks (see Appendix 1 for layout) the area of ice surface can be reduced by some 20%. This will save on flooding/freezing time and reduce energy costs for hot water and freezing. The boards will also be used to mark out the sheets.

Dividers

Dividers will also separate the sheets. Foam dividers are used and they will be installed when there are no more than five floods to be done.

Layout

The width and positioning of the sheets, usually five, must be decided, planned and drawn on paper. The line positions are then marked on the backboards and sides. See Section 5 and the Appendix for the measurements of the lines.

Lines

Wool is very good to use for lines in the ice. The lines can be single or double, and the hogline can be painted between two lines of wool with relative ease.

Logos

Competitions have sponsors and they have logos to be installed into the ice. Plastic and ice are not very compatible, and it is wise to ensure that logos are produced from a material suited to the purpose. Fibre sheet or paper is best for printed logos, while very large logos can either be printed in sections or painted by hand onto the surface. See Section 5 for the technique.

Hacks

Sufficient hacks must be in good condition and ready to be installed. See Section 5.

Blades

The cutting blades are vital. Four blades should have been reground at the factory and must be tested for flaws and finished before the competition starts.

Water quality

If the test result of the water is unsatisfactory, equipment will be needed to clean the water. The most common method is deionisation.

Flooding water

A thermometer and flow meter must be fitted after the warm-cold mixer to be able to constantly read and adjust the temperature and flow rate for a uniform heat and flow.

Pebble water

Even with good mains water it is better to use deionised water for pebbling, because mains water will never be as clean as deionised water. There are small deionisers on the market that will supply water in sufficient quantity.

Water heater

An electric urn fitted with a thermostat will heat the pebble water to the right temperature and keep it there, with no need to mix hot with cold. Because deionised water is more aggressive, it is best for the "kettle" to be made of plastic or stainless steel.

Temperature monitors

The following is essential for adjustments to be made, because it is impossible to be accurate by working blind:

1. Control sheets for recording the data at regular intervals (see below).
2. Thermometers on the flow and return of the brine.
3. A probe in the floor for the controller.
4. Thermometer probes at different heights for the air temperatures.
5. Meters for the dew point, inside and outside.
6. An accurate means of measuring the ice-surface temperature – fixed infrared laser that can be calibrated and logged.

See Section 13 for more information on temperatures.

Lighting

It is often the case that the lighting in an arena is insufficient for television recording. If the lux level in the arena is too low temporary lights will need to be installed, and some lights are better than others. Check with the television company what type of lighting they intend to use and find out what effect these will have on the ice. See Section 16.

Stones

Often the stones used will be a set that has been tested and is delivered to the venue. Even so it is always wise to test the stones on the ice to see how they behave, and with the help of a few good curlers (who would no doubt enjoy the practice!) much can be learned. If there is time it is always a good idea to see how well stones are matched and to match them again if needed.

Sample log sheet

Most experienced technicians will have their own log sheet, designed to record all the information they need to install ice in an arena setting. Below is a sample as a guide, which is easy to design and maintain on a computer or on paper.

Day	Time	Set temp/ temp	Surface ice temp IR 1	Surface ice temp IR 2	Ice temp probe 1	Ice temp probe 2	Air temp 1.5 m	Air temp 3.0 m	Air temp 10 m	Brine temp out	Brine temp in	Dew point inside	Dew point outside	Temp outside	Air condition supply temp

Material and equipment
The list here is not exhaustive and is in alphabetical order for simple reference.

Adhesive tape for repairs (Duck tape)
Allen keys for stone handles
Backboards (60m of 100x50mm wood or similar)
Battery-powered drill/screwdriver
Blowtorch, hand-held with spare gas
Brooms, coconut hair or stiff, wide, 2pcs
Circle scribe, router type
Computer for temperature-control system
Cotton lines/yarn/wool, enough for all the lines
Cotton mop and bucket for ice use only
Coupling with valve and thermometer
Couplings
Curling stones
Cutting blades 4pcs
Cutting machines, ideally two battery-powered units, with chargers
Deionising unit for flooding and pebbling water
Dustbins
Dustpan and brush
Flooding hose to flood from both ends
Flooding stick with valve
Flow meter
Foam dividers 100mm² (400m for single sheets, 320m if outer sheets are paired)
Hand scraper
Hand spray can for the lines
Honing kit and stones
Hose clips
Hose, extra length to flood from both ends
Hygrometer to measure relative humidity
Ice paint, red and blue
Ice paint, white
Ice-surface thermometer (fixed probe)
Ice-surface thermometer (infrared laser)
Ice-surface thermometer (hand-held thermo-couple probe)
Insulation tape for repairs
Laser level or theodolite
Levelling team
Levelling map
Logos printed on textile fibre
Marco hacks complete with flooding cups mounted on aluminium plate.
Mats to cover hacks, 10pcs
Measuring jug (for snow after nipping)
Measuring tape, long
Measuring tape, short
Mop and bucket for floors
Nipper
Paint brushes and/or rollers
Paint brushes for the houses, 6-8pcs (old curling brooms)
Paint roller (for logos)
Paint scraper, stainless steel
Paint table or cardboard boxes, 4-6pcs
Pebble cans, 2pcs
Pebble heads
Racks, for racking/moving stones
Screws (for marking lines)
Plugs (for marking centres)
Small cans for paint
Snow bins, 2pcs
Snow shovels, 2pcs (plastic corn shovels)
Speedfit couplings
Spirit pens
Spray bottle for repairs
Spray gun or nozzle for sealing with hose
Spraying equipment (boom) for white paint
Sticks to stir paint
Stopwatch
Sweeper, 2pcs (with string mops and four spares)
Tee centres
Temperature gauge for urn water
Temperature-analyses software
Thermo-hygrometer for dew point
Thread tape, 2 rolls
Tool kit for emergency use, hack repairs, blade changing, etc
Towelling and cloths
Urn for heating and storing pebble water, 2pcs
Warm water (40ºC) to flood the arena three or four times a day at 50l/min (11gall/min)
See also Section 10 for items normally available at venues.

Preparation

As the two diagrams show at the beginning of this section, old hockey ice typically varies in level by about 30mm or more. The time schedules below are based on a reasonable work effort by the ice technicians. The timescale can be shortened if they work around the clock, but this is not really good practice. The flooding in particular needs time to freeze, and it is good for the tension in the new ice to dissipate during the night and the strains to equalise, which will help prevent cracks in the ice. This also gives impurities time to work their way to the surface of the ice.

A week in advance of curling-ice operations

Check the level. With the help of the arena staff the floor should be mapped and high spots identified, and they can then work away at lowering the level with the Zamboni and remove the high spots to reduce the thickness of ice as much as the floor will allow.

Day 0 late evening

The first job upon arriving at the arena is to check the level of the old ice once more. It is essential to know as much as possible about the floor to prevent unforeseen problems at a stage too late for repairs. See above for a sample, and the Appendices.

Day 1 (see detailed schedule below)

1. The high spots identified the previous evening can be cut down with the Zamboni first thing in the morning. Every 2-3 mm that can be cut down off the higher spots will save one flood, which equals to around 5 hours in time. Saving time is now important, as the competition is approaching at relentless speed.
2. When the high spots have been scraped down as much as possible, spray the whole surface with water to produce a smooth surface to paint the white onto. It is a good idea to use the spray boom, which will also test its operation. The white paint will cover all the hockey lines and provide a good base for the curling ice. See Section 5.
3. When the white paint is satisfactory, seal it in carefully with the spray boom. At the same time measure the location of the backboards and freeze them down in place across the rink. Along the hockey boards the measuring of the different lines across are marked, and on the backboards the sheets are measured and marked. It is advisable to use the measurement sheet and have the planned width of the rinks at hand.
4. Put a screw in line with the teeline at the boards and the middle of the rinks on the backboards. Stretch strings between these screws and, where the strings cross, drill holes into the ice for the centres of the houses.
5. Scribe the houses with the router scriber. Then paint the houses twice, sealing with water between coats for a good result. When all painting is finished seal in the houses, first with a light spray and later heavier sprays. Finish by using the boom to have a good sprayed surface for the lines and the logos.
6. With the help of volunteers this whole process will take a full day.

Day 2 (see detailed schedule below)

1. Start with the lines and the logos first in the morning. Know where the logos should be located before installing the lines, because the centreline often passes through a logo and it is important to know beforehand whether the lines go beneath or above the logos. For details see Section 5.
2. All the sealing of the painting, lines and logos must be done before the end of day two, and hopefully a light flood or two.

Day 3 until the finish (see detailed schedule for 10 floods below)

1. Flooding towards a level surface begins on day 3, for detail see Section 7.
2. There are three floods every day, which will give the ice time to relax and return to the same temperature as before each flood. If a flood is applied as soon as the ice is dry (0ºC), shrink tension will be built into the ice which will cause cracks – this tension is released when the day's floods of some 10mm are cooled to – 4ºC overnight (see Section 21).
   It is of course possible to work around the clock if necessary, but the ice technicians must not fall victim to the time and must instead ask in advance for the time needed. Day-and-night work will create tired ice technicians who will make mistakes.
3. Once the ice pad is in good level, the foam dividers can be installed, after which the sheets are flooded separately.

During this preparation period, which is scheduled below, a different number of people will be involved. The schedule can be squeezed by working around the clock, and note that the number of personnel on this list does not include the head and assistant ice technicians.

Day	Time	Action	Staff
Before		Everything to go on the ice should be in place.	
Days before	2 hours	Check the level of the ice.	Levelling team
Day 0	1800-2100	Check the level of the ice again.	Levelling team
Day 1	0800-1000	Cut down the high spots on the ice with the Zamboni. Control the level with an instrument during the process.	2
	1000-1200	Paint the ice white.	6
	1200-1300	Seal the paint with sprayed water.	6
	1300-1400	Freeze (lunch).	
	1400-1500	Install the backboards.	6
	1500-1600	Measure out the sheets.	6
	1630-1930	Cut the circles and paint the houses. Install logos.	6
	1930-2200	Seal the paint and apply a light flood.	6
Day 2	0800-1000	Install lines and hacks and remaining logos.	6
	1000-1100	Seal in all lines and logos.	6
	1100-1200	Cold flood.	6
	1200-1500	Freeze.	
	1500-1600	Warm flood.	6
	1600-1900	Freeze.	
	1900-2000	(Cut the ice) Warm flood.	6
Day 3	0800-0930	(Cut the ice) Warm flood.	6
	0930-1300	Freeze.	
	1300-1400	(Cut the ice) Warm flood.	6
	1400-1800	Freeze.	
	1800-1900	(Cut the ice) Warm flood.	6
Day 4	0800-0930	(Cut the ice) Warm flood.	6
	0930-1300	Freeze.	
	1300-1400	(Cut the ice)	6
	1400-1600	Install foam dividers, seal the foam, cold light flood.	6
	1600-1800	Freeze.	
	1800-1900	(Cut the ice) Warm flood.	6
Day 5	0800-0900	(Cut the ice) Warm flood.	6
	0900-1300	Freeze.	
	1300-1400	(Cut the ice) Warm flood.	6
	1400-1800	Freeze.	
	1800-1900	(Cut the ice) Warm flood if needed, otherwise cut the ice, clean, install hacks and centres.	6
Day 6	0800-1200	Ice preparation, cutting, pebbling (spare day for flood).	6
	1200-on	Test.	
Day 7	0800	Practice.	2 teams of 5
Day 8	0900	Competition starts.	2 teams of 5

Competition week

During the competition week ice maintenance begins 90 minutes before the competitors start their practice at 0800. The competition ends at about 2100 in the evening, which requires ice technicians on duty for about 15 hours a day. Two teams of 5 members each (without head and assistant) can split the days during the week, here called A1 and A2.

Day	Time	Action	Team
Day 7	0630-0800	Ice maintenance	A1 and A2
	0800-0915	**Practice session 1**	
	0915-1000	Ice maintenance	A1 and A2
	1000-1115	**Practice session 2**	
	1115-1200	Ice maintenance	A1 and A2
	1200-1315	**Practice session 3**	
	1315-1400	Ice maintenance	A1 and A2
	1400-1515	**Practice session 4**	
	1515-1545	Cleaning	A1 and A2
	1730-2000	Opening party and ceremonies	
Day 8	0630-0800	Ice maintenance	0630 – A1
	0800-0820	Practice	
	0820-0830	Cleaning	
	0830-1130	**Draw W1**	
	1130-1230	Ice maintenance	
	1230-1250	Practice	
	1250-1300	Cleaning	
	1300-1600	**Draw M1**	1400 – A2
	1600-1700	Ice maintenance	
	1700-1720	Practice	
	1720-1730	Cleaning	
	1730-2030	**Draw W2**	
	2030-2100	Cleaning	
	2100	End of the day	
Day 9	0630-0800	Ice maintenance	0630 – A2
	0800-0820	Practice	
	0820-0830	Cleaning	
	0830-1130	**DrawM2**	
	1130-1230	Ice maintenance	
	1230-1250	Practice	
	1250-1300	Cleaning	1400 – A1
	1300-1600	**Draw W3**	
	1600-1700	Ice maintenance	
	1700-1720	Practice	
	1720-1730	Cleaning	
	1730-2030	**Draw M3**	
	2030-2100	Cleaning	
	2100	End of the day	
Day 10	0630-0800	Ice maintenance	0630 – A1
	0800-0820	Practice	
	0820-0830	Cleaning	
	0830-1130	**DrawW4**	
	1130-1230	Ice maintenance	
	1230-1250	Practice	
	1250-1300	Cleaning	1400 – A2
	1300-1600	**Draw M4**	
	1600-1700	Ice maintenance	
	1700-1720	Practice	
	1720-1730	Cleaning	
	1730-2030	**Draw W5**	
	2030-2100	Cleaning	
	2100	End of the day	

Day 11	0630-0800 0800-0820 0820-0830 **0830-1130** 1130-1230 1230-1250 1250-1300 **1300-1600** 1600-1700 1700-1720 1720-1730 **1730-2030** 2030-2100 2100	Ice maintenance Practice Cleaning **Draw M5** Ice maintenance Practice Cleaning **Draw W6** Ice maintenance Practice Cleaning **Draw M6** Cleaning End of the day	0630 – A2 1400 – A1
Day 12	0630-0800 0800-0820 0820-0830 **0830-1130** 1130-1230 1230-1250 1250-1300 **1300-1600** 1600-1700 1700-1720 1720-1730 **1730-2030** 2030-2100 2100	Ice maintenance Practice Cleaning **Draw W7** Ice maintenance Practice Cleaning **Draw M7** Ice maintenance Practice Cleaning **Draw W8** Cleaning End of the day	0630 – A1 1400 – A2
Day 13	0630-0800 0800-0820 0820-0830 **0830-1130** 1130-1230 1230-1250 1250-1300 **1300-1600** 1600-1700 1700-1720 1720-1730 **1730-2030** 2030-2100 2100	Ice maintenance Practice Cleaning **Draw M8** Ice maintenance Practice Cleaning **Draw W9** Ice maintenance Practice Cleaning **Draw M9** Cleaning End of the day	0630 – A2 1400 – A1
Day 14	0630-0800 0800-0820 0820-0830 **0830-1130** 1130-1230 1230-1250 1250-1300 **1300-1600** 1600-1700 1700-1720 1720-1730 **1730-2030** 2030-2100 2100	Ice maintenance Practice Cleaning **DrawW10** Ice maintenance Practice Cleaning **Draw M10** Ice maintenance Practice Cleaning **Draw W11** Cleaning End of the day	0630 – A1 1400 – A2

Day 15	0600-0730 0730-0750 0750-0800 **0800-1100** 1100-1130 1130-1150 1150-1200 **1200-1500** 1500-1530 1530-1550 1550-1600 **1600-1900** 1900-1930 1930-1950 1950-2000 **2000-2300** 2300-2330 2330	Ice maintenance Practice Cleaning **Draw M11** Ice maintenance Practice Cleaning **Draw W12** Ice maintenance Practice Cleaning **Draw M12** Ice maintenance Practice Cleaning **Tie Breakers (if necessary)** Cleaning End of the day	0600 – A2 1400 – A1
Day 16	0630-0800 0800-0820 0820-0830 **0830-1130** 1130-1230 1230-1250 1250-1300 **1300-1600** 1600-1700 1700-1720 1720-1730 **1730-2030** 2030-2100 2100	Ice maintenance Practice Cleaning **Tie Breakers (if necessary**) Ice maintenance Practice Cleaning **Tie Breakers (if necessary)** Ice maintenance (2 sheets) Practice Cleaning **Women's semi-finals** Cleaning End of day	0630 – A2 (if tiebreakers) 1400 – A1 (if tiebreakers) Else 16.00
Day 17	1100-1230 1230-1250 1250-1300 **1300-1600** 1600-1630 1630-1650 1650-1700 **1700-2000** 2000-2030 2030-2100 2230	Ice maintenance (3 sheets) Practice Cleaning **Women's Bronze medal/Men's semi-finals** Ice maintenance (1 sheet) Practice Cleaning **Women's final** Ceremony Cleaning End of the day	1100 – A2 1600 – A1
Day 18	07.30-08.30 08.30-08.50 08.50-09.00 **09.00-12.00** 12.00-12.30 12.30-12.50 12.50-13.00 **13.00-16.00** End	Ice maintenance 1 sheet Practice Cleaning **Men's Bronze medal game** Ice maintenance 1 sheet Practice Cleaning **Men's final**	0730 – A1 1200 – A2