

Scottish Curling-Ice Group

ESSENTIALS OF CURLING ICE

Overview

Experienced curling-ice technicians have refined their knowledge over many years and will usually continue doing so, using every opportunity to learn, discuss, analyse and even argue. The subject of curling ice is a complex one with many apparent contradictions, which fortunately become much clearer when the science is understood. Detailed information and scientific support can be found in *Curling Ice Explained* (WCF), dealing with all relevant aspects of curling ice, and the information will not be repeated here. This report is primarily an overview for the benefit of ice technicians who are not yet sufficiently experienced to fully evaluate what the science tells us, yet in desperate need of at least some guidance.

It is true: the more perfect you become, the more obvious the mistakes. This is especially true of curling ice, where the parameters are refined within a given venue until perfection is achieved, at times. Then something happens to mess it up, and it is not always possible to understand what has happened. The experts will know, simply because they have the experience and have dealt with the essentials, thereby reducing the possible causes of a mistake and being able to deal with the few possible ones that remain. They know too that, in curling ice, some rules cannot be broken without risking disaster, and by learning the science they have established the essentials that will be their safeguard. Never mind the science, stick to the essentials, and the science will gradually become clearer.

Level

The concept of level is dealt with in the report on *Level*. How level an ice surface has to be for curling is open to some interpretation, because a stone with an aggressive running band will be more forgiving than a stone with a very smooth running band. The SCIG believe that a level within 0.05mm over 5m is sufficiently safe for any stone not to find an irregularity in level, and this is the standard they strive to achieve.

The floor of any curling rink is not that level, and some are more level than others. Within 5mm over an area of 1000m² is probably as good as it will get, while 50mm variation over the same area is not uncommon. Then there are the pipes carrying the secondary refrigerant through the floor, which ideally should be level too, but they are not, and they are not even in sight. Add to that the problem of heaving, where the subsoil freezes and lifts parts of the floor in an unpredictable manner, and this can happen to any floor if proper precautions are not in place. Even if it were easy to create a perfectly level ice surface by using the properties of water, it is not easy to keep it that way.

It is important to know both the composition of the floor and its relief. By opening the header trenches it will be possible to see what size the pipes are, how far apart, and how deep below the surface. In a sand floor it will be possible to dig up areas for study or to improve the levels, while a concrete floor will be a fixed entity. With a laser level or theodolite the surface can be mapped by taking a series of readings and transferring these to a computer, and for a concrete floor these should remain stable from year to year. A sand floor is best mapped twice a year – once after the ice has thawed and the surface dried (to check for changes during the previous season due to heaving), and once prior to installation to ensure that the pipes and the surface are as level as can be achieved.

For a sand floor it is very important to ensure that water has been soaked to reach to the bottom of the pipes before freezing, or it will need many additional floods to overcome uneven movement of the sand during the unequal freezing process. Using the relief map, the lower areas can be flooded first as soon as the surface has been properly sealed. Much time will be saved through the reverse-flood method, and a better level will be established very quickly (see CIE). Once the lower areas have been eliminated normal flooding can begin until the entire floor is evenly flooded, but it will not yet be level. It will look level, feel level, said to be level and believed to be level, but it will not be level.

As soon as everything is safely covered by flooding, the surface can be cut between floods, using an old blade – impurities will blunt the blade very quickly. The cutting will help remove higher spots and irregularities, and will reduce the salt content if raw water is used, both of which will help to create a better level and a cleaner result in less time.

Consistency during flooding is extremely important. The flow rate, walking speed, water temperature, width of ice taken, air movement, etc. all need to be consistent, or a level will not be achieved. It helps to have an in-line flow meter, a decent hose, a proper flooding pipe and stick and a good hose man, with a stopwatch in his hand. It also helps to have the time needed to do the job right, or it will not be right. Again, all the detail can be found in CIE.

Temperatures are important too. Freezing the water too fast or too slowly will affect the level, while too warm a surface will allow paint to migrate and too cold a surface will have freezing leading edges and possible cracks. Always return to the same temperature after freezing as to before flooding, to ensure that the lamination of layers are consistent with all the stresses dissipated. Freeze gently rather than aggressively, allowing each flood about six hours to freeze. For most rinks two floods per day will be the norm, while some might only manage one in the heat of August.

As soon as even flooding is possible, use the 1441 technique. This refers to a four-sheet rink (could be 1661 or 1881), where the first flood starts at the home end of sheet 1, the next flood on the away end of sheet 4, then the home end of sheet 4, then the away end of sheet 1 – it is simply a diagonal approach to doing the opposite. The difference that this makes to the eventual level ice surface will be astonishing, but of course there should be sufficient hose to reach all four corners in comfort.

It is important to learn how the water behaves once the even flooding begins. Variations in level of 5mm or more will be normal, with some water flowing off the higher areas into the lower areas as it tries to find its level. During the freezing process the water will expand about 9%, with the deeper areas expanding more than the thinner layers, so the high areas could become the lower areas while the low areas could become the higher areas. As the floods progress the floor becomes more and more level until no discrepancies are visible, and this will show when the surface is cut. It is here that the first real skill of an ice technician is developed, over years, until he becomes competent and fully able to read the signs as his work progresses. Then, when all looks well, he will still add a flood or two simply to be absolutely certain that it is level, because no-one is perfect. A well-flooded floor that has been properly finished with careful finishing floods will be as smooth and even as glass, and a good blade will not leave a single mark anywhere.

The use of warmer water during flooding is gaining popularity, where the flooding water is heated from the usual 10-15°C to 25-35°C. There are advantages, especially during the finishing stages, but it is a specialist technique that requires flooding experience of a high degree. It can be very risky if done at the wrong stages and can easily make things worse instead of better.

In the case of a level concrete floor it is sometimes accepted that 20mm of ice will be sufficient for curling. Perhaps it will be, or perhaps it won't. It will depend on the size and spacing of the pipes, the speed of refrigeration, the skill of the technician, the painting and lines, and everything else that goes on in an ice floor. The general consensus is that the ice should be about 35mm thick on a concrete floor with modern piping, and about 50mm for an older floor or a sand floor where the pipes will be larger and further apart. The ice surface should be level enough to cut and paint after about ten floods, while it will take at least three further floods to install the lines and markings. Installing ice to a good level ready for the job of curling will take at least fourteen floods over about ten days.

Installing ice to a good level is extremely important. Level ice can be maintained level, while flaws cannot easily be cut level. Install the ice level and it is very easy to keep it level (if all the other rules are obeyed!), while it is just about impossible to maintain a pad that is not level. It might look level, but the stones will soon find the flaws and after a week or two the flooding will have to be resumed to try and repair the surface.

The days of opening the tap and going for a cup of coffee while water "finds its level" over the entire floor are long gone. Installing level ice for curling is work of a high calibre that has to be taken seriously. A chef does not throw a few things in the pot and put his feet up for a rest, and a mechanic does not throw his spanners at an engine in the hope that the work will get done. The work of a curling-ice technician is specialised and becoming ever more technical, and to achieve a level surface takes more than opening a tap.

The essentials:

- Map the floor and record all data, from start to finish.
- Use the right equipment in good working order.
- Plan and prepare carefully, and leave nothing to chance.
- Seal the floor well, and for sand be sure to soak to a depth just below the bottom of the pipes.
- Fill the lower areas first, using the map as guidance.
- Flood evenly and consistently, allowing ample time for freezing.
- Remove salts between floods whenever possible.
- Control temperatures and humidity as carefully as possible, and log the data.
- After painting, seal the paint in properly before proceeding.
- Once the lines are installed, be sure they will not move during flooding.
- Allow sufficient installation time to have time in hand for extra floods.
- The ice has to be level, an uneven ice pad is not fit for modern curling.
- Once the flooding is complete, pebble-cut until the snow is absolutely white.
- Once the pad is level and clean, keep it that way.

Water

Obvious, isn't it. Water is essential. Unfortunately the stuff that comes out the tap is not water any longer, it is a contaminated water full of many chemicals, residues, organic particles, gases and minerals. The report on *Water In A Curling Rink* deals with most of the known problems, while the one on *Pebble Salts* focuses on the effects of tap water. No reliable data exists to prove that all salts in the water are bad or that some may be good for curling, but it is certainly clear that the cleaner the water, the better.

To flood with tap water is not the worst thing in a curling rink, because deionisation is expensive when dealing with a few thousand litres of water. It is also possible to remove virtually all the salts through the process of pebble-cutting and then work only with purified water for the actual curling. CIE deals with these problems in ample detail. The problem will however be exaggerated for a skating arena that has to convert to curling at regular intervals, where there is simply insufficient time to remove the salts of a raw-water flood. Here the only advice must be to install a method of purification to deal with the salts and impurities before it reaches the ice floor, the simplest of which will be deionisation.

Technicians who have many years of experience installing ice with tap water will know that, whatever they do, at the end of the flooding stage there will be some very hard work. They will pebble and cut almost endlessly to remove the salts and smooth the surface, which could be done in a day or so, but the result is seldom satisfactory in less than a week. They will therefore use every opportunity during the flooding stage to remove salts as they go, after every flood, as soon as the surface is sufficiently level to cut. Then, when it comes to the last flood, the salt content will be so low that they can finish the surface within a day. It pays very well to cut between floods, simply by running the used blade over the surface without even applying pebble. If there is time, then pebble and cut again, because even more salts will be lifted into the pebble and removed.

As will be explained below, pebble is a risky business. The pebble has to be even and consistent and, where possible, should be cut down to the pad, with only the lower areas remaining relatively uncut. The pebble also has to be with purified water to have the best effect. The object is not to use the pebble to level the surface, but to remove salts. It is therefore a good idea to use a small pebble rather than a large one, because it will cut off easier and so save time. Heating the pebble water to about 40°C helps too, as it will be easier to apply and will melt the ice surface more on contact to lift more salts. Heating the water more than that will cause the pebble to flatten into a larger blob, which is more difficult to cut off.

After the flooding process, with installation more or less complete, the surface will not be smooth and even. This will be due to surface tension, impurities, small differences in temperature and even poor technique. The best way to finish the surface is through pebbling and cutting, and so also remove salts in the surface at the same time. Again a small, warm pebble will work best. Some technicians will do this at least twenty times, others less – the most skilled technicians will have purified water, no salts to cut, a smooth and even finish and nothing much to do. Dream on.

Up to this point the unique properties of water have been used to create a level and clean surface, and in an ideal world it will be perfectly level and perfectly clean. It looks beautiful and, considering the intimate experience and hard work of some ten days, it is tempting to think of it as water in its frozen state. It really is no longer that, because it is only a level and clean surface that will be used to produce a curling surface. This curling surface will be created by sprinkling drops of water all over the surface in a specific way, upon which the stones and players can move in a predictable manner with an ease and grace that is the essence of curling. The water that is now used **MUST** be clean (see *Pebble*), or there will be no control and no enduring pebble. Having cleaned the surface of the pad so carefully, every single drop of water applied to its surface must be clean, or all that work has been a waste of time. Even hot tap water used for hot mopping behind the hacks will leave salts on the surface, which the stones will collect and distribute to contaminate the entire floor.

It is worth considering the alternatives to purified water for pebbling, here meaning through deionisation or reverse osmosis. Distilled water is a common alternative, and the best source of clean water in many curling rinks will be from mechanical dehumidifiers, where near-distilled water is continuously delivered through a pipe down the nearest drain. Catch it, bottle it, filter it and keep it clean, and it will be fine for pebble – allow it to accumulate fibres from the air and the pebble heads will be blocked within a few paces of pebbling.

The essentials:

- If the rink can afford it, install purification.
- Remove unwanted salts through cutting between floods, and when finishing the surface.
- With mechanical dehumidifiers, collect the distilled water in clean containers for pebbling.
- Only use clean water afterwards, and only pebble with clean water.

Pebble

A level pad has now been installed with the surface as clean and even as can be, but no-one can curl on it without pebble. Although this job of pebbling only takes a few minutes, it is the most important aspect of a curling-ice technician's job, which he will do for every day of curling and often several times a day.

Therein lies the problem. In order to maintain his level surface, he will have to remove most of the pebble, if not all of it, before he can apply fresh pebble. If he pebbles unevenly, say more to the sides than the middle, he can remove the inconsistency by cutting all the pebble off. If he can't cut all the pebble off the sides will gradually become higher, until he will have to cut the sides more than the middle to compensate. He will not know how much more he will have to cut and will have to guess, and within a few days his ice pad will no longer be level. Is there any point in creating a perfectly level surface, only to ruin it within a few days? None.

Pebbling is a great skill and requires much practice, until the drops can be distributed so evenly and consistently that a pad can be kept level for months on end. One small discrepancy a day becomes a hundred after three months, which is a real problem. Every morning the pebble will be cut off to avoid this accumulation, and often the day's pebbles will be cut off again before the evening games. It pays to cut and it pays to control the level surface. Consensus is to cut after every two games, which means a double pebble for the first game and a single pebble for the second game, making three pebbles in total. A fourth can even be tolerated. But the more pebble there is, the more difficult it will be to cut it off, and problems will accumulate.

There are still many technicians who believe in applying a considerable amount of water as pebble, in case the pebble "goes flat". Our tests have shown, consistently, that there is no need. Use a fine or even an extra-fine pebble as the norm, double for the first game and singles to follow as needed, and as long as the essentials are controlled the pebble will last. In fact, competent technicians will know their ice so well that they will confidently play two full games of club curling on one double-fine pebble, with no complaints from the curlers. The less pebble, the less cutting, the more control – but don't break the rules of clean water and correct parameters (see below).

Many clubs have a volunteer system where several people can pebble – or try to pebble, because most of them are not very good at it. It will pay handsomely to invite the volunteers along during the flooding stages to practise their pebbling between floods, when it will be very easy to see how the drops are distributed and when little real damage can be done. They will soon understand what they should try to achieve and can go and practise in the car park before the next opportunity, until they develop the smooth and rhythmic action that works so well.

Tests have shown that small pebbles are higher and easier to cut off, while large pebbles are flatter and very difficult to cut off. Many technicians say they only have pebble heads with large holes, the small holes block too easily, the pebble won't last and so on. We have not yet found any evidence to support these objections, good pebble heads are now available and the small holes work very well. See the report on *Pebble* for more detail.

There is still considerable controversy regarding the temperature of pebble water. Some insist on heating the water to 60°C, while others leave it at 15°C. Within the SCIG the consensus is that everything works best if the water is heated to somewhere between 30°C and 40°C, and the actual temperature will depend on humidity, IST and so on. This is the temperature of the water in the urn, before it goes into the can, and the water is used before it goes cold again. The heating primarily reduces the amount of free oxygen in the water to provide a stronger pebble that will freeze quickly, without losing its shape too much. Simply hold a hand against the urn and if it feels comfortably warm, that's it; if it is cold, wait; if it burns the hand, take it away! And then add a little cold water to cool it down while filling the pebble can.

Of course, only use clean water. Keep the pebble heads clean. Have a good pebble can (see *Pebble Can Tests*). Heat the water to about 35°C. Always do the opposite. If at all possible, run the stones over the pebble before the games or use a Nipper.

A good pebble is magic to play on, while a poor pebble will ruin your reputation.

The essentials:

- Pebble only when needed, using as small a pebble as possible.
- Pebble evenly and consistently.
- Only use clean water at the correct temperature.
- Cut the pebble off before problems can accumulate.
- Rack or nip after pebbling, the curlers will thank you for it.
- Develop a system to suit the curling and stick to it.
- Organise the curling to allow for sufficient ice time, both morning and evening.

Parameters

For modern curling ice the parameters are extremely important, and have to be controlled as carefully as possible. In a good building with the necessary equipment it will not be too difficult, while a poor building or a lack of equipment will be an endless battle of ingenuity against the elements. The following abbreviations have been adopted as standard by the SCIG for ease of reference:

BT	Brine temperature (in and out)
FT	Floor temperature (usually beneath the ice, and displayed on the controller)
IST	Ice-surface temperature (taken either by infra-red laser, or fixed probe)
AT	Air temperature at 1.5m above the ice surface
RT	Roof temperature (of the air, just below the roof, say at 5m)
OT	Outside temperature at 1.5m
DPT	Dewpoint temperature at 1.5m above the ice surface
RH	Relative humidity at 1.5m above the ice surface
ORH	Outside relative humidity at 1.5m

Generally speaking, refrigeration in a curling rink is quite simple. The brine is chilled by the plant and pumped out to the rink, and the BT out will be around -9°C . If there is a probe in the floor the controller will display a FT of about -6°C , because of the heat being transferred from the ice above the floor. The IST will be around -4°C , because the air above it is warmer than that, while the AT will be around 7°C . The RT can be as high as 25°C or more in a poor building, or as low as 10°C in a well controlled environment. If the OT is very low, and it colder areas it could be -20°C , the RT could also be much lower, depending on how much heating is introduced into the building. In the scenario discussed here the OT would be say 10°C . It is clear that heat from the air, the roof space, the players and the heating has to be extracted through the floor into the brine and removed by the refrigeration plant, and the BT into the plant will be warmer because of this at say -7°C (the BT will be different from building to building, this is for illustration only). Surplus heat will need more work by the plant and a lack of heat will mean less.

For the humidity there will be many scenarios, due to variations in climate, equipment and buildings. Here we'll assume that the ORH is about 80% (it is a rainy day), and thanks to a good dehumidifier the RH inside is 55%. This will give us a DPT of -1.25°C , which is not too bad for a game of curling.

The environment within a curling rink is a complex one, and it will help to study the report on *Water In A Curling Rink*. The relationship between the stones and the ice is equally complex, and studying *Why Do Curling Stones Curl* will help too. The essence of both these reports is that the IST has to be at the correct level to do the job, while all the other parameters will, in some way, affect where the IST is to be set and maintained. If the AT is as high as say 12°C the IST will have to be lower, say at -5°C , for the pebble to last a game. But if the RH is at 55% this will give a DPT of 3.25°C , an additional 4.5 degrees of frost, and this frost will accumulate on the ice surface and quickly affect the behaviour of the stones. To prevent this the RH will have to be lowered to below 40%, if the equipment can do it, and suddenly there will be a real danger that the ice surface will gradually sublime into the air space above. Do this for a week or so and the ice pad will no longer be level.

Every curling-ice technician, aspiring or experienced, will have to deal with these parameters and the many continuous changes in the environment. The only way to learn about them is to have metering equipment of some kind that can be logged at intervals to reflect the changes small adjustments to the equipment will cause. It is not difficult and does not need to be expensive, but without such a system it will be impossible to learn anything. Unfortunately the cheaper end of the market sacrifices absolute accuracy of the instruments, while accurate instruments are expensive and beyond most curling rinks. This is however not too much of a problem, as long as the instruments are consistent in their inaccuracy, because it will be changes in the parameters that will be more important than absolute accuracy.

The most important parameters to record will be the RT, AT, IST, RH and DPT. Having tested many items over the years the equipment has been tracked down through the internet, and the cost is reasonable. The links below will serve as a starting point and does not necessarily include a recommendation, and it pays to spend a little more rather than to buy the cheapest models:

RT & AT	Wireless weather station from www.oregonscientific.com Order BAR628 with two extra transmitters (one for OT) THGR122NX
IST	Search for digital thermometers that use a K-type thermocouple probe Search for laser infrared thermometer (expensive!)
RH, AT & DPT	Search for a thermohygrometer with dewpoint calculator (or use BAR628)

It is very difficult to read the actual IST as an absolute temperature without expensive equipment. The best systems will use a laser infrared beam from above, which will be calibrated and connected to a computer. This is a luxury for most but will, in time, probably become the norm. The best system that is quite reliable is the digital thermometer with a K-type wire probe – the wire is buried a short distance into the ice with its tip just beneath the surface about 20cm from the sideboard, with an extension to where the instrument is kept. A typical reading that works for curling will be around -3.8°C from this probe, which is not the actual temperature but simply a reference which to adjust to. Installing the probe takes time and patience and, once the tip is safely frozen into position, it is best left overnight to settle down – by the morning it should be giving a constant reading.

Without a consistent reading of the IST, AT and RH it will be very difficult to make meaningful adjustments. The heat from thirty-two curlers will be enough to affect the IST, as will their movement and so the turbulence in the air. Depending on the amount of surplus heat in the roof, the IST can change by 1°C within minutes and with serious consequences. Many technicians routinely run the ice colder than needed to avoid this problem, or they have no surplus heat and the ice is colder anyway, which causes the stones to behave very differently. Suddenly the stones will not draw as they should and the ice will play keener, and without surplus moisture this will stay the same through the game. Now they resort to sanding of the running bands, a dangerous thing to do, or they spend thousands to have the stones refurbished every year. This will suit the stone manufacturers very well, but a better result can be obtained by tweaking the IST with considerably less expense.

There are too many variables involved to provide definitive answers to the parameters, but the advice given here regarding the essentials of curling ice has been tested in many different rinks and environments, with many different stones, and has been found valid in all cases.

The essentials:

- Measure and log the IST, AT and RH.
- Learn what can be adjusted and what effects this will have.
- Only adjust one thing at a time and note the effects over a period of time.
- Gradually work towards the most suitable IST for the building and the stones.

Stones

There are many thousands of curling stones in the world, and in some way they will all be different. Naturally matured stones will behave much the same, while artificially matured stones will vary considerably. From the above it is clear that, if the IST and other parameters are properly controlled, a given set of stones will behave quite consistently, and by manipulating the parameters they can be made to draw more or less.

Manufacturers, for commercial reasons, will not provide details of what they do to stones and to the running bands in particular, and it is impossible to provide specific advice without studying the stones very carefully. What is clear is that a new set of stones will have aggressive running bands of a given profile and will draw or curl well under modern specifications, but after a few months they will lose some draw and gradually mature. Usually, to prevent excessive draw of eight foot or more, technicians will run the ice a little colder to straighten them, and then gradually warm the surface again as they mature during the first few months.

Fortunately every curling rink will normally only use one set of stones and get used to them, and after a few trials and errors will find what works for the stones and stick to it. Changes in humidity and temperature will affect their behaviour, but the changes should appear on the log and can be adapted to without much difficulty.

It is important that the stones of any rink should be matched in sets and in pairs, and should be numbered on their handles for identification. This takes time and must be done on very good pebble, but once done there is usually very little change. This enables curlers at least to be able to play their shots with two stones that behave the same, and will eliminate most complaints about poor ice or poor stones. There is no point in having a set of stones refurbished simply because they have not been properly matched, and a newly refurbished set of stones will have to be matched several times in the first year or two before they have "settled down". The best advice is to have a schedule that allows for all the stones to be matched on freshly prepared ice over a period of days and, for the more fortunate, have the help of very good curlers and statisticians.

The running bands of stones will acquire a certain amount of dirt during normal play, usually of a slightly greasy nature, probably from players' hands during cleaning. In time this deposit will affect the stones' behaviour. It helps to give the bands a good clean about once a week with a gentle solvent (methylated spirits works well and evaporates quickly, simply moisten a bit of paper towel and wipe the band carefully). It's not a fun job and can be hard on the knees, but it pays good dividends.

For a variety of reasons many technicians run their ice colder than needed. Some have no choice because of the cold temperatures they work in, while others try to save their pebble from excessive wear – or they can't be bothered controlling the parameters. Many use tap water for pebble or have too much heat in the air, and many simply know no better and do what others have done before. The invariable result is that the stones will not curl very well, so they resort to sanding of the running bands.

Please note: this is a dangerous exercise only to be undertaken by experts, preferably during a process of proper refurbishment. This is NOT for DIY technicians, many of whom have ruined a set of stones that cost thousands to repair. It is not easy and it is not really necessary, unless the stones are in need of full refurbishment, in which case the manufacturers are sufficiently competent to do the work. A good curling-ice technician should not have any need to sand his stones.

The essentials:

- Match the stones and number the handles.
- Clean the running bands once a week.
- Take good care of the stones and teach curlers the same.
- Don't mess with sandpaper.

Maintenance and equipment

During the installation and pebbling liquid water was being used, and the behaviour of liquid water can be challenging at the best of times. Now the water is in a solid state and much more predictable, but the level surface and cleanliness have to be maintained. The simplest is to use a powered cutter with a sharp blade to remove the pebble, and to address the surface in such a way that the level is maintained. Get it wrong and liquid water will be needed again for a flood or two, yet more work with no real guarantees; get it right and the curling can continue, uninterrupted by unnecessary flooding, for many months. In fact, a properly maintained ice surface can last all season.

In the report on *Cutting Technique* (and in CIE) every attempt has been made to explain and illustrate what happens during the cutting routines, and careful study will hopefully bring the knowledge across to technicians. Essentially every sheet is cut with level patterns (where the overlap is insufficient to cut any area twice), with extra passes only where needed. These will be down the centre area and, in the case of uneven pebbling, along the four-foot lines. At the worst end, where there has been several pebbles during a competition without cutting, the eighteen-pass pattern will be used on the following morning to remove as much of the pebble as possible. At the best end the eight-pass flat pattern will be used on a daily or twice-daily basis.

What happens here is simply this: there is a straight-blade pass down the centre at the beginning and end of each of these patterns. At the end of the pass the snow can be studied to see if the centre is becoming higher, showing as more snow in a slight mound. Of course the first pass will not tell much because there is a lot of pebble to shift, but the last pass will. By now the cutting on that sheet is over, but an extra single pass can easily be added if it seems important, or make a note to cut the centres harder for the next cutting session. On the other hand, if the last pass shows no rise in the centre, then the next cutting session will omit the final single pass and become the seven-pass flat pattern. In this way the sheets can be worked to perfection, but only by regular daily cutting and careful observation. It soon becomes second nature, and it is very, very accurate.

Without a good, true blade that has been ground to perfection and honed to maintain its edge, all this cutting is really a waste of time. Just plough the pebble off and go home, and a blunt blade can probably do that all right. The cutting blade is a precision instrument to maintain a precision level, and by shaving off the pebble in a gentle, accurate and controlled manner the level can and will be maintained. That is why some ice technicians are very good at what they do, while others struggle. Learn to look after the blade and use it properly, and become a very good curling-ice technician.

The other reason for frequent use of the cutter is to remove dirt. Pushing a fleece or string mop over the sheets after a game will remove some of the fibres deposited by curlers, but not nearly all, and the remainder will be ground into or simply frozen to the surface. The cutter will remove this dirt, before it becomes embedded in the ice pad. And yes, an ice pad can be kept clean for eight months through regular cutting and removal of the pebble, it will usually be the end strips behind the hacks that will become an embarrassment because these might not have been cut every day. Using the cutter behind the hacks is also perhaps not the best idea, because most the grit will end up here and quickly blunt the cutting edge – use the hand scraper instead, or hot mop the strip, or both. Then keep the walkways clean, and the walls, and the ceiling, and everything that can be cleaned, and the dirt will simply become less and less until the entire ice pad can be kept as clean as is humanly possible. It is all part of the job and the maintenance routine.

No proper maintenance can be done without the proper equipment in good working order. As with flooding, using the proper equipment is easier and better in every way. The simple change from a cable machine to battery power has made an enormous change in powered cutting, and continuous improvements in battery technology takes this still further. The grinding of blades too has improved, and modern curling ice now demands that a blade is precision ground, mounted to its box, and usually by someone who has considerable experience. Even then there must be a brace at hand to true the blade to perfection, simply due to changes in temperature between the workshop and the ice hall. Then there is the humble broom – several, in fact, because there are different applications and surfaces to deal with. For clearing snow, find a soft-haired broom about three foot wide (usually coconut hair) that will not scatter the snow all over the place, with a plastic corn or snow shovel and bin, and a dedicated dustpan and soft brush for ice work with a small scraper to loosen snow frozen to the pad. For cleaning loose snow off the blade find another soft broom, a foot wide, and fit two clips on the cutting machine for it so the broom will always be at hand. For snow frozen to the blade have a small hand brush with stiff bristles, usually only needed at the end of the cutting. For the plant room and smooth walkways find another broom with soft hair, about a foot wide, and a dustpan and brush – never use an ice broom on other surfaces or vice versa. For the rest buy a good vacuum cleaner, and all the mops and buckets that will be needed.

By attending to the problem with careful thought and gradually acquiring the right equipment and keeping this equipment in good order, maintenance becomes a pleasure. In fact, it becomes an undertaking of professional application, which it is and should be. See CIE for more information.

The essentials:

- Cut regularly and accurately, and keep a record of the patterns.
- Keep everything in good working order and suitably oiled.
- Only use sharp, true blades and look after them.
- Never use ice equipment on other surfaces or dirty equipment on the ice surface.
- The total cost of all the equipment needed to install and maintain an ice pad will be less than 1% of the cost of building a curling rink. Don't hesitate in spending the money on the right equipment.

Summary

Experienced curling-ice technicians will be able to maintain their ice to a reasonable standard, because they will have developed the working routines to deal with the work. But not all experienced technicians will produce excellent curling ice, because they became set on their ways many years ago and find it easier to stick to what they know.

Modern curling ice is, by and large, a product of science, through the application of science and all that experience. Yes, it can seem daunting and quite frightening, but once mastered it is sheer bliss. It has been proved time and again that making curling ice of the highest standard is not difficult, and maintaining it is much, much easier than working with a pad that is not level and with uneven pebble in an environment that is uncontrollable.

Curling-ice technicians young and old are urged to obtain a copy of *Curling Ice Explained* from the WCF, which now forms the basis of all our work. Without it modern curling ice would not exist today in as many places as it does, and the information within it will remain valid for a very long time.

The essentials of curling ice:

- Establish a level, clean surface and maintain it properly.
- Understand the properties and behaviour of water.
- Pebble evenly with clean water and don't allow pebble to accumulate.
- Study and control the parameters.
- Match the stones and look after them.
- Use good equipment and look after it.
- Clean everything and keep it clean.
- Have a copy of CIE for continual reference and study.