BUILDING THE ICE PAD

There was a time when a curling area with a roof over it was new, and very much a luxury. With cold outside temperatures the surface could be flooded and frozen, and eventually curled on. Make no mistake, this was not easy, because it was so cold that the water in the hoses would have frozen before it reached the floor! So why not use the structure that held the roof up and build some walls, to control the temperatures a little better, with shutters high and low to provide for the introduction of cold air as needed, both for curling and to keep the relative humidity down. This also didn't work so well, so the floor was artificially frozen, the air was heated to hold more moisture and suddenly life was a great deal easier and more comfortable. Those were the days, because even those facilities that still exist are now obsolete and well behind the times.

A modern curling facility needs to produce and provide modern curling ice to specification, within very small margins. It is a fact that very few such facilities have been properly designed or equipped, and therefore the job of curling ice remains a challenge. It is the purpose of these files to help technicians and players understand that there is no longer much of an excuse for poor ice, as long as they learn how to overcome the problems and have the support of the entire curling community to do their work, in the right conditions with adequate essential equipment. The most important single aspect of this work is building the ice pad, from the beginning, until this meets the first requirements of level and consistency.

In the first file, *STRATEGY*, the subject of level and measurement has been dealt with in some detail. The more level the floor is to begin with, the easier it will be to build a decent ice pad. There is however one small problem: water does not really behave as it should, and if these anomalies are not understood and taken into account, no decent ice pad can be built. In the case of a sand floor it is even more difficult, because the floor will absorb water at different rates in different areas, and if the sand is not evenly frozen to just below the pipes there will be problems developing throughout the season. Add to this the matter of frost heave under and in the sand and the last few months of the season will be a real nightmare. Fortunately, if the preparation has been properly done in every respect, even a sand floor can provide an excellent ice pad – to the full credit of the technician – while both a sand and a concrete floor can provide a surface level within 0.05mm over the width of every sheet.

During our earlier research we realised that much of the information we were being given was based on presumption. I was fortunate to be given a description of a fairly crude device that a precision engineer had made to check the level of the ice surface, and I quickly found a precision engineer nearby to make me such an instrument, but one of precision. We call it the IcePOD (Precision Overhead Device), which stretches a cable across the ice sheet so tightly that a precision dial gauge can be hung from it and not distort the cable. The whole thing comes apart and fits into a suitcase, and so successful is the result that I can confidently say that it cannot lie – it measures within 0.01mm anywhere along the cable and what it says is what it is. It is the IcePOD that gave us the confidence to say what is wrong, and helped us learn why, and how to overcome the problem. There are a few more photos with some detail on Facebook:
http://www.facebook.com/groups/32568586828/#!/groups/32568586828/photos/
or here:
http://s681.photobucket.com/albums/vv174/JohnMinnaar/IcePOD/

To believe that water "finds its own level" is a fallacy. It will find a level within certain margins, which could be in meters on the oceans or in millimetres on a large floor, and this will depend on a number of influences such as wind, temperature, flow rate, gravitational force and water quality, not to mention the quantity of water being used. For the purpose of building a decent ice pad water does not find its own level, it has to be helped and made to do so. To achieve this, a thorough understanding of the complexities of water is essential and a good starting point is our report on *Water In A Curling Rink*. There is also considerable specific information in the section on *Flooding* in *Curling Ice Explained*, available from the WCF.

1. Viscosity

Generally, the colder the water, the more viscous it becomes, until it will flow no further than thick paint will. Obviously the thicker the layer, the longer it will hold it's temperature, and the more level it will become, until it takes so long to freeze that it will lift the paint and lines of the curling floor. To understand this better, take a warm sheet of glass and level it with a small spirit level. Now pour a little warm water onto it in a small puddle and lift one side of the glass until the water starts moving. Try the same thing with a cold sheet of glass and cold water and compare the result – it is likely that the cold test will hold twice the amount of water before it flows at the same slope.

Once I had a high spot on the ice and decided to do an experiment with the IcePOD. I measured the level of that area and learnt that the high spot was some 3.6mm higher than its surrounds. So I flooded over it as normal and measured the frozen surface again – the high spot was still 3.2mm higher than its surrounds. I then flooded but put no water on the high spot, then a further flood also over the high spot – it had disappeared. The only reason there can be is viscosity, because the water was too viscous to flow off the high spot before it froze. The second flood was quite heavy, probably about 3mm thick, cancelling out the discrepancy – the assumption here is that a normal flood is about 2.5mm thick.

The problem with viscosity is that it is virtually impossible to see or measure in a curling rink. Had it not been for my knowledge of it, I would not have been able to approach the problem in a constructive way. Having learnt this new skill, I applied it the following year using the laser to map the concrete floor and identifying all the high and low spots. I then started filling the low spots first, taking care to work with no more than 5mm of water at any time, until it was clear that these were now level with their surrounds. I avoided flooding the high areas until they too appeared level with their surrounds. This is not difficult, the map shows the differences in millimetres and if a flood is 3mm thick, then it is easy to calculate how many floods are needed to reach the high spots. The prize for my efforts was two days saved in installation and an excellent result in level, and after that the whole process became second nature. Viscosity can be beaten.

2. Temperatures

It is likely that all technicians are sick of the subject. Temperatures are difficult to measure without the right equipment, then there's Fahrenheit versus Celsius, this man says this and that man says that. In my experience, and learning from very skilled experts, buy the equipment and ensure it is calibrated to the temperatures that matter.

For the IST (ice-surface temperature) a Fluke or Raytek (much the same handheld thing) infrared laser is invaluable for ice-surface readings if it is acclimatised for half an hour and carefully calibrated – sadly I have found discrepancies of 2ºC between similar models despite all our efforts to get the same reading, so these units cannot be trusted for absolute accuracy and will only serve as a measure of up or down compared to its surrounds. Instruments like Microtherma, where a probe is placed on the ice, are much more accurate, but cannot really be used during curling because the stones or players will trash them. The solution to that is very simple: once the ice is installed, place a wire probe (where the tips of two wires are soldered together) in the ice wherever you want it to be, just below the surface where the blade cannot harm it. The cable can be as long as you want, simply cut a groove in the ice and freeze it into the groove – under the hogline is fine, but the tip must be in white ice. At the other end of the cable is the connection that plugs into the unit, and an accurate reading is provided whenever you switch the thing on. Although I have found that it can take a day or two for the tip to settle down and properly bond with the ice, this is the best way I have to measure the IST and how it changes, and it gives accurate readings within 0.1ºC. For my units I found a simple gadget that plugs into each unit and calibrates it accurately to – 4ºC just like that, and these units are not very expensive.

For the AT (air temperature) the consensus is to measure at 1.5m (exactly) above the ice surface, because the air temperatures can vary very quickly from rink to rink or as the height increases. Nowadays there are many very economical and accurate thermohygrometers available that will provide both the temperature and relative humidity, and this is all I use. Some have wireless transmitters and base units which are bliss to measure the AT all the way to the roof, but a ladder will be needed every few months to replace the batteries. Search the internet, or ask Hans Wuthrich who has considerable experience of these.

3. Flow rate

This means the amount of water actually passing through the pipe and all the taps and fittings along the way to exit through the end of the flooding stick or pipe. The simplest way to measure it is to have a container of known quantity, even a bucket will do, and measure the time it takes to deliver say 20 litres. Please note, we work in metric units because it is far easier and simpler than Imperial units, especially when British and American gallons are not the same! Let's say it takes 29 seconds to supply 20 litres, the flow rate is just over 41 litres/min, which equates to 2460 litres per hour, or nearly 2.5 cubic metres per hour (2.5 m^3/hr). That is the flow rate, but it is only the flow rate at the time of testing, and it can change if someone should open another tap somewhere in the building. Experienced technicians will know how to compensate for this by flooding at a slower rate until the pressure returns and the flow rate is restored, but it is now all guess work. A better way is to install an in-line flow meter (see http://www.kytola.com/ and look for Model HV, which measures the flow rate in m^3). This tells the flow rate continuously and also by how much it rises or falls. Add to this a large tank supplied by the mains as needed (1m^3 will do) and a small pump for supply to your pipes and the flow rate can be stabilised for the entire flood simply by a valve somewhere. Now the flow rate will be constant throughout the flood, and the bonus is, with a larger tank, that the water in the tank can also be heated in advance (more on this later). The same system can also be used to supply the spray boom, with or without paint, at the volume and pressure required.
It could easily be argued that the flow rate doesn't matter, because you have to use what comes out the tap off the mains and you can't change it. In my own experience it does matter, because a large flow rate off a pressurised main supply can introduce a large amount of air in the form of bubbles, many of which do not reach the surface and remain frozen into the ice for the season. On the other hand, a very low supply will certainly result in freezing edges along the flood lines if the pad is very cold. The best guideline for an ideal flow rate is about 2.2 m^3/hr, which will result in a normal flood of a four sheeter in around 50 minutes, around 460 litres per sheet.

4. Water quality

The measurement, and so the definition, of the quality of water is expressed in two ways: TDS (Total Dissolved Solids) and conductivity. TDS can be measured by taking a litre of water and evaporating the water, and the weighing the residue to give a result of milligrams of solids in one litre of water (mg/l). This takes time and even under laboratory conditions is not all that easy, but ironically the evaporated water can be condensed and distilled to give us what we want, the clean water. A simpler way to measure TDS is through conductivity, which is the inverted value of the electrical resistance of the water, or the amount of electricity the water can conduct, or, conductivity measures the amount of salts dissolved in the water. This is measured in milliSiemens per meter (mS/M) or microSiemens per centimetre (µS/cm) and can be roughly converted to TDS by multiplying by six. Purified water will have a conductivity somewhere below 2 mS/m, while tap water will be well over 20 mS/m, and although conductivity can have an error margin of 10%, it remains the most practical and cost-effective way of measuring the quality of water.
To give an idea of how dirty water can be, we did several tests on the snow collected from cutting, which we melted and bottled in sterile containers for testing. We did our own conductivity tests and then sent the bottles to a laboratory for verification, but by the time the bottles were opened at the laboratory some were exploding. This was tap water off the mains in the ice, and it is filthy, for making ice. But does it matter? If we take steel, for example, iron is melted essentially to remove carbon from the ore to the correct amount, which is less than 2%. Remember distillation? Same thing, really, and then they add other elements to it to give them what they want in terms of strength, corrosion and so on. We have no data or evidence that either pure or impure water is better for curling, except for the pebble itself, as long as the salts can be removed from the slab prior to pebbling.
Clean water can be produced through filtering, condensation/distillation, reverse osmosis, deionisation or a combination of any of these. None of them can be considered cheap, but at times it can be worth it. Having the job of producing curling ice in an arena for the World Championships in one week flat will challenge any technician, and deionised water gives him the edge because he won't have to remove the salts, which will take another week. Having your own deioniser setup means you can flood overnight, cut and pebble and the curlers can curl, because you are not adding any salts to the pad. However, it doesn't matter how clean the water is, if you cannot produce a perfectly level surface from any water it will still be an inferior surface.
Removing the salts is quite simple, but it does mean some hard work. As soon as the flooded surface is fairly even and level, start cutting with an old blade (the salts will ruin a sharp edge!). Cut the surface once with a level pattern (see the report on *Cutting Technique*), then pebble with a warm, fairly small pebble, cut that off, do it again, then do the next flood. Keep going till after the final flood, then pebble-cut until the snow is as white as fresh snow. What happens is quite simple: the salts will mostly be in the surface, finding a very unsafe haven in the last bit of liquid water before it freezes. The pebble melts the surface and lifts the salts

into the tops, where it can be cut off. Using a coarse pebble will work too, but these will be flatter, offer more resistance to the blade and take longer to remove. In our experience it will take about a week to remove all the salts possible, but a day's hard work will at least make the surface playable.
The reason why these salts have to be removed is also quite simple. Salts will require additional cooling to freeze the ice surface (2% salts in the surface will need an additional 1ºC), which costs money. The behaviour of a surface filled with salts will be very different under the mass and velocity of a curling stone and sliding sweepers – if the ice is just a little to warm it will be slippery, and the stones will certainly not travel as far. Therefore, once the salts have been removed, simply use clean water for the pebble and all will be well.
For information, I believe the best water to use for building the ice pad is rain water. It is cheap (or free, once the system is in place) and relatively clean. Unfortunately installation is usually done in summer when rainfall can be in short supply, so the water will have to be caught off the roof and stored in sufficient quantity to build the pad. Tanks of 25m³ are commercially available, but they are not cheap, and ultraviolet filters will have to deal with the risk of Legionella. See the next subsection on temperature.

5. Water temperature

The temperature of the water used for flooding does not at first seem to matter much, but science says that it matters because of three reasons: viscosity, oxygen content and surface tension. What is clear from pebbling is that it pays to heat the water to say 40ºC, which will provide a stronger pebble partly because of the oxygen content but mostly because the droplets take a little longer to freeze. This is simply because the hydrogen bonding of the molecules have the time to arrange themselves properly to create a stronger lattice, and because there is little free oxygen trapped in the lattice the ice is even stronger. This does not mean it is harder and more brittle, but it can withstand tremendous thumping from stones and will seldom crack, while hard and brittle ice will crack very easily.
There is a dilemma here. Water from the mains can vary from very cold, say 5ºC, to quite warm, say 15ºC, and the temperature of the surface being flooded can be as cold as – 4.5ºC to perhaps – 2.5ºC. It is the combination of the two temperatures that will create the difference between strong ice and hard ice, and then there is surface tension to take into account as well as viscosity. Colder temperature will lead to higher surface tension and also freezing leading edges too fast, and viscosity can prevent the flood from finding its optimum level. If the water is at 10ºC, I would never consider having the surface colder than – 3.5ºC unless the lines or paint are in danger, and I would always allow the surface tension to dissipate overnight before the next flood.
Water is an element that, like iron smelting, responds to temperatures at very exact and often critical stages. It can easily be argued that water is alive and has a mind all of its own, force it and lose, caress it and win. This is more true when the temperatures are manipulated beyond the limits in order to save time. Freeze a flood to – 5ºC and it will explode, but freeze it gently to – 4ºC and it will look like a sheet of glass with not a line on it.
Flooding with warmer water has advantages and does not cost much. If the plant has been fitted with a heat exchanger and a heat-storage tank, it will cost very little, because the rain water from the large storage tank can pass through the heat-storage tank and be delivered to the end of the hose at say 25ºC. If the hose is of good quality and reasonably insulated (see below) it can still slide on the ice and won't need ten people to keep it in the air, as long as one person can keep it sliding – usually there is such an assistant anyway. The advantages are slower (and more gentle) freezing with less surface tension, less free oxygen in the water and later the ice, and less viscosity. Flooding with warm water, especially during the finishing floods, does pay, and does make a very large difference.

6. Water physics

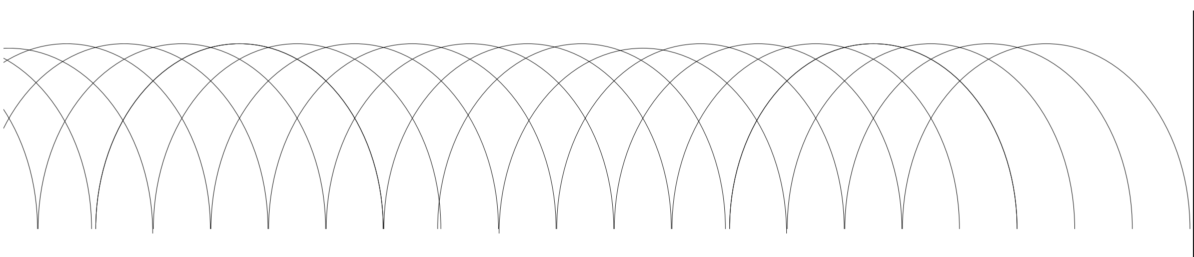
When water freezes, it expands by just over 9%. Where deep low areas have been flooded along with the rest of the floor, they will expand 9% more than the rest and become high areas. When they have been built up slowly until they are level with the remainder, this will obviously not happen. Very experienced technicians can deal with this, or so they claim, but if the topography of the floor is known and systematically dealt with there will be only one reward: the perfect level, by guarantee.
The energy needed to freeze a flood from say 15ºC to – 3.5ºC can be better understood with the 1:2:3 formula – for every hour needed to reduce the temperature to 0ºC, it will need two hours to freeze this water, still at 0ºC, and another three hours to lower the temperature to – 3.5ºC. It goes without saying that different refrigeration systems and settings will change this, but these figure mean for me that it takes twelve hours to apply a flood and freeze it gently to the stage where I can apply another flood. Even then I have to be patient and sometimes only do one flood a day, but when the pressure is on the 1:2:3 formula works safely for me and always provides a reliable result.

7. Flooding equipment

Having used many different kinds of hose, there is only one that I can recommend. It is sold as Tricoflex Irrigation Hose, and for any facility a hundred-metre roll should be sufficient. It has woven polyester-fibre reinforcement, a two-layer smooth black inner tube and an exterior covering in ultra UV-resistant PVC, usually yellow. It is very light, does not kink easily and slides extremely well on the ice. The best size is their 19mm I/D, which connects well to 22mm copper and fittings, and pieces of it can also be used for pebbling with excellent results. Whether it is stored on a reel or not depends on intelligence – for me it is part of the process to achieve precision and I bought a very expensive fire-hose reel for storage without any regrets. The route of the water on my system is from the mains to a valve, and then the in-line flow meter and pressure gauge. These are fitted to the side of the hose reel and connect to the hose. At the end of the hose is another valve (of plastic, so it can be closed and placed on the ice without fear of melting the surface as I often flooded on my own), and then the flooding pipe or stick are of 25mm I/D, using Speedfit tubing and couplings. The whole lot is on wheels and fits in the back of the van for mobility. The flooding pipe (because it has the shape of a smoker's pipe!) delivers water in such a way that the leading edges can be watched, and I use it for all the low spots. The flooding stick has a kink near the end but not as much as a hockey stick, and the enlargement of the pipes allows the water to relax before exit and not blast everything before it. All of it is really light and very easy to use, with no metal able to touch or scar the ice.

8. The Andy Shuffle

The sketch below aims to illustrate as simply as possible what happens to the water during flooding with a stick. The water leaves the stick at 90º to the floodline and flows into it, creating a seemingly endless wave as it disturbs and mixes with previous lines. At the right-hand side there is a line representing the sideboard. Because the technician cannot walk further than the sideboard the continuous wave will become confused and less water will be delivered as he turns to flood in the opposite direction. The water at the sideboard will splash and splutter as best it can until the new wave is established.



Note: This is the single biggest mistake any technician can make during flooding – the areas next to the sideboards will be low and every excuse in the book will be offered to explain this. It is vital that the same amount of water is delivered along the sideboards as over the rest of the floodlines, and the way to do this is to pull back on the stick when reaching the sideboard for about a foot or so, which is the width of the floodline. This takes the pressure off the trapped water and will not cause splashing. Then push the stick forward into the floodline again, in a gentle shuffle, to add more water to the area, before proceeding to the next floodline. Call it a pause of perhaps two seconds, or a delay in movement – we call it the Andy Shuffle after the man who showed it to me.
The same applies at the end of a flood, when the last line of water is up against the backboard and additional water is not added. In my case, I would turn sideways after the backline to finish in the corner, and then continue adding water in that corner for a few seconds while standing on the walkway. It works for me.

9. Building the ice pad

As explained in *STRATEGY*, the sand floor has been sprayed and the first flood is frozen, ideally to just below the pipes. The concrete floor has been sprayed a few times to seal the paint. It now helps enormously to pebble the surface with a high XF pebble on which the hose can slide without being in contact with the pad itself. With the floor at – 4ºC, fill in the low areas adding no more than 5mm in thickness at a time, and wait for the water to return to – 4ºC before the next layer is added. This takes time, but it will save time later. Once the ice is reasonably level, lay down the first full flood of about 400 litres per sheet, avoiding the high spots if needed. At a flow rate of 2m³ per hour it will take just over fifteen minutes per sheet, moving quite slowly and with a floodline width of about eight inches. Wait for the flood to freeze to – 4ºC before continuing with the next flood.

The speed of walking is important. It takes some practice, but the best way is to learn to walk as fast forwards as backwards to avoid having to turn, and at a speed that is both comfortable and relaxed – the water too must be comfortable and relaxed, with no disturbance that can mix in air or burn into the surface previously established. Once normal flooding starts at 2.2m³ the floodline is wider and should be constant at about twelve inches, and it will take about twelve minutes per sheet. Some people use a stopwatch, but I have found that a wall clock will suffice to give me an idea once I reach a quarter, half or three quarters of the floor. The speed is not the most important thing here, some people walk faster than others, but the consistency is important. This is serious work, laying down water in a meticulous manner that will provide a perfectly level surface, and mistakes are difficult to cure.

Small undulations in the floor, less than say 5mm, will ruin the look of the first few floods. These cannot really be cured in advance, the best is to simply keep flooding until they disappear. Sometimes a high spot will show as a bright white patch during the freezing process (these usually freeze first) and it will pay to memorise them, or even to walk out there and scribe a line around the edges in the ice that will remain visible. These spots can then be avoided during the next flood and they will not cause much of a problem later on. If the preparation has been properly done the floor should be evenly smooth after about five floods, or even less, by which time the high spots too should be under ice.

If tap water has been used, the surface at – 4ºC will start feeling slippery, due to the gradual accumulation of salts. If all the high spots have been covered, the cutting can begin. Using an old blade (usually the one waiting to be sent for a regrind), cut the surface in a level pattern. Not much will come off, but small high spots will be removed and with these some of the salts. For the first cut pebble doesn't help much simply because the surface will not be sufficiently level to cut all the pebble. Another flood or two and things improve, the blade will be taking more off and pebbling becomes an option. In my experience large, hot pebbles are a waste of time, they flatten out and are virtually impossible to cut with and old blade – the small pebbles, on the other hand, heated to about 30ºC, stand up high, lift a tremendous amount of salts and are easily cut. This, incidentally, is a very good time for novices to practise their pebbling technique.

Once the pad is level and the bulk of the salts have been removed, the surface can be sprayed white and sealed in with several sprays of water. For this phase it helps to cool the floor down to – 4.5ºC or even a little colder, and the first flood after spraying must not be too heavy to avoid lifting the paint. Another flood or two will make the paint safe, and the pebble-cutting can continue between floods. Next will be the installation of the circles and lines, using the same precautions. Of course, a painted concrete floor will simply have the lines to worry about, with their positions already marked by the screws on the sideboards and backboards. It helps tremendously to have a small rubber roller (used for the edges of wallpaper work) to roll the tapes or wool into the water sprayed onto them, which flattens the fibres and also pushes out trapped air. It's a bit of a fiddle to avoid moving the lines, but practice makes perfect. Spray the lines in well and flood carefully, anything not perfectly straight will be haunting every ice technician for the whole season.

By the time the lines are in and safely under solid ice, there will have been some ten floods for a concrete floor and perhaps twice that for a sand floor, with the ice pad somewhere between 25mm and 50mm thick. Considering that the optimum thickness on a good floor is said to be between 30mm and 40mm, there is still room for a few finishing floods. These are approached differently, simply because the floor is now so level that few problem areas remain. Having applied the previous floods the method has been refined, consistency has become second nature and somehow everything becomes a lot easier. To give the floods the maximum chance to level and bond properly, allow the floor to warm up to about – 3.5ºC, or even switch the plant off during the floods. After every flood, pebble and cut several times to remove more salts and fill in small imperfections. For the last flood or two, leave the plant off for as much as thirty minutes after the floods and ensure that there is no air movement in the ice hall. The last finishing flood will leave a surface that is truly as pretty as a picture.

It is important during flooding to have someone who looks after the hose. Yes, it possible to flood on your own and I have done it many times, but it is more difficult and does not give the same desired result in consistency. On the one hand learn to slide the hose and avoid banging it down on the ice, which can crack the surface, ensuring that the person who is flooding can concentrate on his job with sufficient hose in hand and the remainder out of his way. On the other hand look after the hose itself, either reeling it in as you go or laying the surplus on the walkway in a figure of eight, especially in a place where no-one can walk on it. The figure of eight prevents the hose from kinking when it is unrolled again, and any kink WILL become a weak spot where it will always want to kink again. The same will happen when a few heavy boots trample all over the hose.

Remember to periodically clean the outside of the hose. After a few floods it will have done much sliding through the salts on the surface and will become caked in it – why else would your hands and clothes become so dirty during flooding?

The best time to see if a newly-ground blade is cutting smoothly and evenly is during the finishing stages of flooding, and AFTER the salts have been removed. Now the pad is at it's most level and any flaws in the blades will immediately become apparent.

10. The opposite

It is an important aspect of all ice work that it is best to always do the opposite of what went before. When flooding, this can have its problems, usually to do with the hose, how long it is, where to store it after the flood and so on. For reverse flooding, starting at opposite ends and also from diagonal corners, the hose will have to be at least 90 metres long. There will have to be adequate space to coil the hose at every corner, and the assistant has to know exactly what is going on.
When I tried this first I couldn't really see the point, because there wasn't much to see. But then I realised that, if the flooding technique is of a high standard, it should not really be necessary. To be honest, even then I think I was wrong. The one year when I meticulously changed direction and ends in a predetermined plan, the result was quite fantastic, the ice levelled much sooner and the level was better than before, and better than EVER before. I can commend this to anyone, it is a little more work but it does give a very large return on the effort.

11. Summary

Building the ice pad to specification takes time and many skills, but it is certainly possible and it really does pay to do it properly. The fact of the matter is that the ice pad will be there for the duration of the season – get it right and it will work, but get it wrong and it will not work. Yes, it can be fixed with yet more flooding and little tricks here and there, but if it isn't level it will not work. If it is full of dirt it will not clean itself until the thaw. If it is inconsistent the stones will find the flaws. For those who think an ice pad will only stay level and clean for so long before it will need further floods I must say this: we did an experiment one season and, with the help of the IcePOD, we proved that it is possible to maintain a level ice pad for the full season of eight months, within 0.05mm across the width of every sheet. It was only possible because the ice pad was installed according to the information recorded in this file, and it was level.
There are undoubtedly curling-ice technicians in the world who can produce a level surface very quickly and say with confidence that it is level. They are few and far between, because it is impossible to tell how level a surface is simply by looking at it. There is also a huge difference between a pad that has to last for a single championship and a pad that has to last for eight months – the former relies on what a technician knows he can get away with, while the latter relies on certainty at every stage. Having had the pleasure of watching some experts at work it was always with some surprise that I discovered how crudely they go about the work of flooding, yet they knew the limits well enough to get away with it – in today's world of science and ever higher standards I am sure they would have to up their game to stay in business.

The next files will deal with creating the actual playing surface, which is on top of the ice pad, and how to maintain the surface to its optimum for the season.

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