New Zealand Pool Industry Association Inc, PO Box 170769 Greenlane 1546 – email executive@poolguild.org.nz

TEST PAPER 10

INSTALLING & MAINTAINING RESIDENTIAL SWIMMING POOL FILTRATION, PLUMBING AND POOL EQUIPMENT

Sign boxes in acknowledgement of reading and understanding of information and as being relevant at time of publication. E&OE SEPT 2021

Section 1.

☐ ***Designing pool filtration systems***

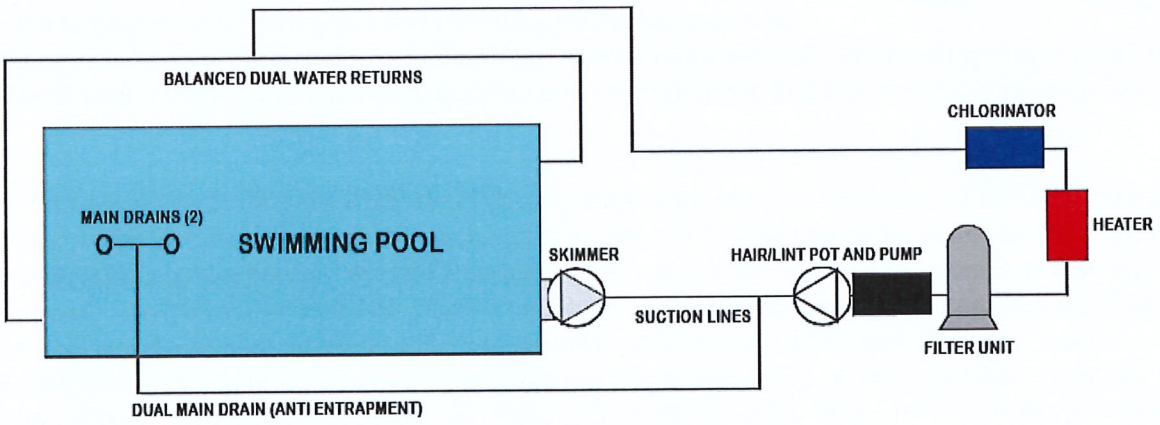
Pool equipment designs can vary from a basic design that includes just a pump and filter, skimmer & water return to elaborate designs incorporating a spa pool, solar heating collectors, various features such as waterfalls, shear descents, fountains, vanishing (aka Infinity) edges, and others. In this section of the course, we consider a simple design evaluating the basic requirements usually found in a residential swimming pool. A description of the major components in a filtration system is presented below with a diagram of the most common configuration. If you see 'aka' used it means 'also known as' and i.e. means "for example".

The diagram following presents the current thinking in basic residential pool plumbing, but of course you can add water features, a dedicated pool cleaner suction line, backflow preventer devices where required, and the pool may have features such as an infinity edge or scum gutters which may eliminate the need for skimmers.

☐ ***Note that if 'Main Drains' (aka bottom suction points) and other suction-line devices are to be installed; they should comply with NZ Standard AU/NZS4441:2008 regarding suction entrapment whereas no single suction line may be installed where an entrapment danger exists. The NZ Standard recommends a minimum of 1,200mm distance between any two suction points, whether on the pool floor or pool wall for drawing water for Solar Heating or any other reason. The pool skimmer must also protect from entrapment danger by being plumbed in series with the main drains or a main drain that is fitted with a spring-loaded hydrostatic valve which will open if the skimmer is blocked. All other features and all openings into the pool that are connected to the suction lines of the pool pump must be protected by durable anti-vortex covers or faceplates.***

Every single pool or spa has some basic pool plumbing elements. You need to know at least some things about them in order to be prepared in the case of needed repairs, so look at the most common features by tracing the path of water through the recirculation system. The typical 'ideal' system employed in New Zealand is one described as "Consecutive Dilution" whereas water is drawn from the main body of pool water, pressure fed through a filtration media of varying types, and returned to the pool, thus 'consecutively diluting it' with fresh water in the same manner a 'swimming hole' in a creek is kept fresh by new water being introduced continually.

Our sample system utilises a skimmer or skimmers, at least two main drains and varying types of plumbing. Water is drawn into the system through a surface skimmer, main drains on the floor or a combination of both. Filtered water is preferably returned though at least two 'eyeball' fittings by way of a balanced-length dual pipe setup so as to avoid differential pressure at the eyeballs (pool water re-entry area).



☐ This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

☐ Pools are usually piped in PVC or in some cases ABS or Copper. Pipe diameters used generally range from 40mm to 60mm, with 50mm pipe most commonly used for suction lines, and often 40mm used for return (pressure) lines. Some builders use 40mm pipe both directions (Suction & Pressure) and some use 50mm pipe in both directions. By using 50mm on the suction side and 40mm on the pressure side, some builders think that the velocity of the return water is higher due to the increase in pressure and this is viewed as a good thing.

The filtration plant is ideally located within 20 meters from the pool to giving 20m of suction and 20m of return pipe for the average residential pool. The accepted rule recommends maximum velocities in copper pipes of 2.5m/sec (meters per second) for copper suction and pressure piping to prevent corrosion while PVC piping should not exceed 3.6m/sec for pressure (return) and 2.2m/sec for suction lines. The supplier of the pool pump will usually be able to advise you on the correct pump to use for the pipe diameter and intended application. PVC fittings used in typical residential systems are generally 45° and 90° elbows and right angle 'T's.

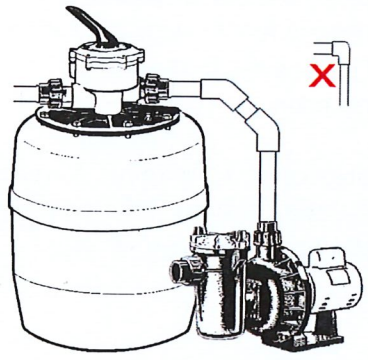
Note in the diagram that there is a required order of placement for the components in the pool filtration system that should always be followed. For example, in every case the final device in the system before returning to the swimming pool is the 'chlorination' device. This can variously be a saline chlorine generator, a chlorine tablet feeder, an ozone unit, or any in-line electronic device that ionises metals as a sterilising agent.

The correct order for the chain of equipment is always: Skimmer, (shut-off valve), (back-flow valve), hair & lint pot (aka hair & lint strainer), pool pump, (multiport valve aka MPV), pool filter containing media (sand, septum elements, glass, quartz, diatomaceous earth, etc) the pool heating device (inc Solar), the sterilisation device, the pool Eyeballs. Items in (brackets) are optional extras or not necessarily found on some filtration units.

☐ **Hi-Rate Sand filters**

Residential swimming pool filters are available commercially in three basic types:

(1.) Hi-Rate Sand Filter, (2.) Cartridge filter, and D.E. filter



High-Rate sand filters earned their name by having a 'higher rate' of filtration than the original 'rapid sand' filter. Rapid Sand filters are still being used in some places today, but not commonly in New Zealand. They typically consist of a large (1.0m square x 1.20 deep) concrete tank built in conjunction with the swimming pool, so close so they can be connected by a balance pipe located at the bottom which connects into the pool at the same depth. Water is drawn from the pool and 'poured" into the rapid sand tank, which typically is filled with progressively finer filtration media. As the water percolates down through the media by gravity, it is cleaned of debris, thus the water finally reaching the pool is "filtered water". You won't find many of these still in operation, as being a chore to clean out (dig out the media and dump it) they were outclassed by 'back-washable' Hi-Rate filters in the 1950's.

High-Rate Sand filters direct pressure-fed pool water through a dispersal device mounted under the MPV body and through a (typically) sand bed of graded sand. The water is stripped of contaminants, and redirected back through the MPV and back to the swimming pool. Other filter media available include crushed pumice, crushed quartz rock, and recycled glass (crushed and graded) beer bottles. The filter media is refreshed by a process of reversing the water flow – called 'back washing' which is the directed through the MPV to waste. In most of New Zealand this would be the Septic Sewer system, as backwashing into the stormwater system would not be ecologically sound due to any remaining chlorine in the water being detrimental to ocean life (where the stormwater usually ends up)

Cartridge filters

Usually found on Spa Pools, using the same principle of reticulating the pool water through the filter, the difference here is that the media is replaced with a '50 square foot' synthetic polypropylene microfiber septum – hence the common term C50 for these filters. These normally do not have backwashing facilities, as the microfiber is so fine that water pressure from the pool pump would be insufficient to thoroughly clean the septum. It is necessary to dismantle the filter – usually one large knurled knob on the top lid does the trick – take the septum to a nearby garden hose for a through hosing down, and replacing it. For residential swimming pools, it is more usual to see these filters where a backwash line is not feasible, water is short (the hose would use less than the pool pump would discharge over three or four minutes, several times a season), or Council objections to conventional filters being used. In these cases it is common to see two or more C50 filters in tandem.

D.E. filters

These are similar in principal to cartridge filters, except the septum is coated with a very fine filtration media called D.E. – which stands for Diatomaceous Earth as it is composed of 'Diatoms'. This material is the natural remains of a type of ocean reef hard shell algae called a diatom that existed millions of years ago. It is not commonly found anywhere on Earth other than Europe (Germany, Czech Republic) and the western USA (Nevada and Colorado).

DE Filters were frowned on in New Zealand for many years due to opposition from the Territorial Authorities to having the used DE material being dumped down the sewer system, as it was very good at blocking up the system, so they are not commonly used.

A typical pool pump with attached Hair & Lint Strainer and a typical dual 45° PVC bend setup is shown in the graphic at left.

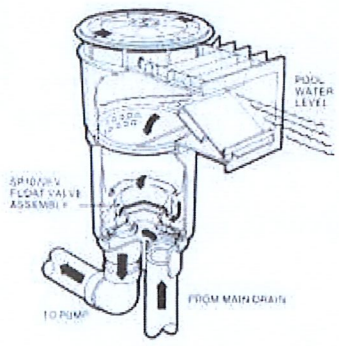
Note that although this setup is not as efficient as a single 'large radius' 40mm or 50mm PVC bend, these bends are not generally available commercially, so unless you can make them yourself, it's better to use two 45° bends than one 90° bend.

Later in this discussion you will find a google link to someone showing how easy it is to bend PVC pipe if it is suitably heated.

Another option is to use flexible 40° or 50° PVC tube which is commonly used on Spa pools and is available from your PVC pipe supplier. This produces a professional-looking job.

Surface Skimmers

☐ Surface Skimmers are mounted in the pool wall to intercept the pool water about the mid-way point of their frontal aperture, and 'skim' the pool water into the filtration system from the pool surface. By using an accelerated flow action created by a floating weir and 'waterfall' effect, skimmers are very effective in attracting floating debris into their entrapment area – the 'skimmer basket'.



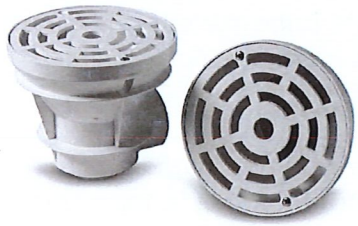
Inside the skimmer body is a round 'well' which contains the 'Skimmer Basket" whose function is the primary 'large object' trap, intended to stop leaves and other large scale debris entering the pump and blocking the impellor.

The weir's function is to stop trapped debris 'floating back' when the water flow (suction) stops due to the pump being switched off (possibly by an automatic timing device) The skimmer will remove surface dirt, leaves and other floating debris before it can sink to the bottom of the pool.

☐ This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

Skimmers come equipped with a circular shaped 'suction plate' (aka Vac Plate) which offers (usually) a 40mm suction point (a cone-shaped protrusion which the vacuum cuff on the end of the vac hose slides over) for vacuuming the pool using the provided ancillary cleaning equipment, the "Pool Vacuum Kit" which comprises an extendable Vac Pole, a Vac Hose several meters long, a Vac Plate that fits the skimmer, and Vac Head Brush the other end of the vac hose attached to. Skimmers contain a removable primary leaf basket to trap floating debris and can be checked for capacity through a removable plastic lid on the skimmer top although there are some that are accessed from the front through the pool side.

Entrapment issues with skimmers
Entrapment issues in the United States have forced skimmer manufacturers to add a number of stainless steel screws holding the lid in place. This makes checking (and emptying) the skimmer basket a difficult proposition. This is not a requirement in NZ but is being considered in some Australian States at this time.



☐ **Main Drains**

Main drains consist of one (refer to the next paragraph regarding using only one main drain) or two or more interlinked suction points. NZS4441:2008 recommends at least 1,200mm between two main drains, as an anti-entrapment protection.

The use of Main suction drains in New Zealand pools has diminished in popularity with pool builders in recent years, but almost all pools will have a hydrostatic valve of some type fitted in the deepest part of the pool. This device is to reduce (or eliminate) the potential for under-pool ground water hydrostatic pressure lifting (aka 'floating) the pool, which in most cases will destroy it.

Some pool builders install a combination spring-operated Main Drain/Hydrostatic device which changes the requirement to have two drains fitted, as – should any unfortunate entrapment of a swimmer occur - in theory the spring-loaded hydro valve should open, thus releasing the trapped swimmer. Another type of hydrostatic valve is simply an open-ended pot with a tightly fitting lid which the builder fills with pool plaster to hold it down. The theory with this type of valve is that any hydrostatic water pressure strong enough to damage the pool will 'pop' the lid off – thus releasing the pressure build-up. One issue with this type of hydro valve is that – should it 'pop', the chance of it returning to its original position when the water pressure drops is remote, so when the water pressure does abate, the pool empties out through the ill-fitting lid.

☐ **Hair & lint Strainer**

A Hair and Lint strainer (aka hair and lint pot) is the *secondary* 'large item of debris' strainer after the 'skimmer basket' located in the skimmer body. These two items are designed to remove large floating objects from the pool water before the pump as they are transported on the flow of water created in the pool's filtration recirculation system.

As with all devices that are designed to trap debris and fragments of leaves, they must be inspected regularly and – when full – emptied. Failing to empty either of these two devices can severely affect the water flow through the system, thus reducing the effectiveness of the filtration cycle, and possibly damaging the pool pump through overheating.

Skimmer baskets may split open if left full with the pump struggling to draw water through them, resulting in the debris ending up at the secondary basket in the hair and lint strainer.

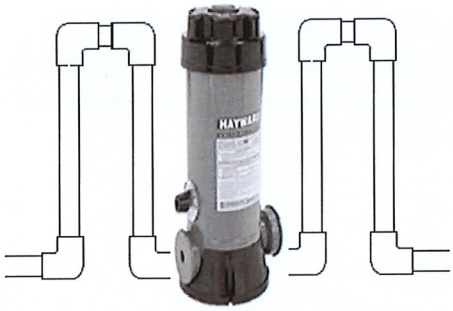
☐ This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

☐ **Automatic Chlorination systems and other sterilisation methods**

In the simplest example, a tablet feeder containing Tri Chlor (Trichloroisocyanuric Acid) tablets may be placed in a cheap floating device and placed in the pool so that the pool water erodes the tables and 'chlorinates' the swimming pool. These are extensively used in low-cost above ground pools such as Paradise, Sterns, Para and others, but are not usually considered as 'automatic devices'.

The entry level of actual 'automatic devices' whereas the device is filled, then carries on doing its job until it need refilling, is the in-line type erosion tablet feeder. Some examples of these are the 'Rainbow' and 'Hayward' model (at left). These erosion feeders are plumbed into the return line (pressure line) and must always be the last item in the filtration setup, so as the highly charged chlorinated pool water does not damage the expensive pool equipment in the system. This is such a problem that it is advisable to use a traditional "Hartman Loop" in the system, as when the pool pump shuts down for the day, highly chlorinated water – being of a higher specific gravity than pure water (i.e. 'heavier')- the water will find its way down to the return eyeball and out into the pool where it will sink to the bottom of the pool right in front of the eyeball!

If the pool has a coloured interior such as black-tinted plaster, or a plastic interior such as a fibreglass pool or a pool fitted with a coloured vinyl liner, there is a good chance the overchlorination that takes place will bleach the colour out of the pool surface.



Any device that creates a concentration of chlorine should have a "Hartman Loop" (see illustration at left) fitted with highest point protruding above the water level, as it stops acidic water from going anywhere. Hartman Loops are to protect the pool interior and easily constructed from PVC pipework, as shown, but are not great at allowing the free flow of pool water, due to the large number of elbows used. You need to weigh up the alternative of potentially ruining your customer's pool interior against making the pump work harder.

Saline Chlorinators

☐ Saline devices (aka Salt Chlorinators) have been available in New Zealand since 1973 when the first units were developed locally and sold as Aquatech IG450 Chlorinators. Using low voltage transformers (240v-12v) to power an electrode located in-line in the pool water return line, electrolysis separates sodium hypochlorite and sodium hydroxide from common salt dissolved in the pool water (plus hydrogen gas), thus generating 'chlorine' in the pool. Sodium hypochlorite is commonly referred to as 'liquid chlorine' and sodium hydroxide as 'caustic soda'. Sodium hypochlorite has a pH of 11.0 and sodium hydroxide is 'base' – it has a pH of 14 (as high as the scale goes in alkalinity) so these generators always produce a high pH in the pool which is potentially destructive or can cause scaling in concrete pools, so the regular reduction of pH using acid (either hydrochloric acid liquid or sodium bisulphate granular acid) is essential. Maintenance of these devices is usually restricted to the electrodes wearing out, and replacement is a simple matter.

Magnesium and Potassium electrolysis devices

☐ Much like any saline chlorination unit, these electrolysis devices affect Magnesium Chloride to generate pool water sterilisation in much the same manner as a saline machine, and the potassium may reduce any environmental issues in the backwashed pool water.

Ozone Generators

Ozone is a very powerful and natural sterilising agent which is formed by passing pool water close to an Ultra Violet (U.V.) source – typically a fluorescent bulb, but also by a "Dual" UV - Corona discharge (aka CD) electrode system. CD devices are more commonly used in commercial installations, and commonly UV devices are being used in spa pools and recently re-designed and marketed for use in home swimming pools. Quality UV Tubes (which are fundamentally a light source, like any light bulb) have a useful life Any maintenance is usually restricted to replacing the UV source or the CD electrode. Ozone will kill 100% of all known virus & bacteria (Chlorine is good for 65%) and will kill Cryptosporidium, Guardia and even Covid-19 Viruses)

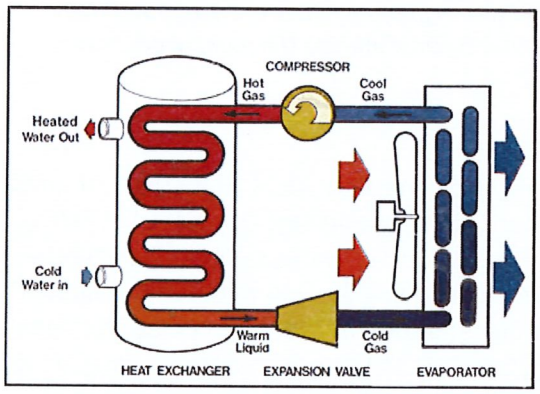
Ionic devices

Other than the less expensive 'floating' devices. around since the 1980's the in-line devices 'ionise' silver or copper so that metal particles are released into the pool water return flow. Some devices float on the pool surface and are powered by Solar Cells on the top of the unit.

The above devices come in various styles, but they all have in common that they are intended to be plumbed 'in-line' into the filtration system, and all must be positioned as the 'last in line' in the chain of equipment.

Heating devices commonly used in residential swimming pool installations

A very important choice you need to make is what type of pool heater to suggest that your customer installs. The most common choice in New Zealand is an electric Heat Pump, followed by Natural Gas (and propane) then a reasonable number of Solar Panel pool heaters. If gas is preferred, and there is no natural gas supply to the customer's home, propane tanks can be installed – providing there is a delivery service available.



Heat Pumps

Heat Pumps operate very efficiently by compressing gas to create heat, which is then forced through a 'heat exchanger' which transfers the heat to the pool water. A thermal pool cover is recommended in all cases when the heat pump is operating, as the heat input is incremental and quite low (compared to gas heating) and must be retained in the pool with a suitable thermal cover otherwise the pool surface area will radiate the heat outwards.

The efficiency of a Heat Pump is quantified by a ratio of 'in and out' i.e. a typical home pool of 40 m2 would used a heat pump with the output rating of 12 – 15 Kw.

This unit would typically use 2.6 Kw to 3.2 Kw which can be calculated as a ratio. Say the 'average' output of 12-15 is 13.5 and 'input average' of 2.6 and 3.2 is 2.9, the COP (co-efficient of performance) would be 13.5/2.9 (13.5 divide by 2.9) or 4.655 or in other words the output value is more than four & a half times the input cost.

This is why Heat Pumps are so popular, as at less than $0.30c per Kw/Hr (Check current charges) the average Heat Pump costs less than 90c per hour (not including the power company's "daily charges" etc). It is calculable that if a pool is heated by a heat pump for 6 months (180 days between November to April) At an average of 4 hours per day, the cost of a 28^0 pool for the entire season would be less than $800.00 (plus Power Company's 'other charges')

Heat pumps are generally very reliable, and usually carry a warranty ranging from 2 years to 5 years. Maintenance is generally on the compressor pump motor and the heat exchanger unit. Cheap units may have corrosion issues.

They are almost exclusively manufactured in China, or the parts are imported from China and assembled in New Zealand or Australia. Some Heat Pumps available are assembled in the Philippines from Japanese components.

☐ ***Gas Heaters***

Contemporary Natural Gas pool heaters are highly efficient and will only consume as much gas as you want the pool to temperature to be . They are controlled by a thermostat, and this means that you simply cannot forget they are running – which was a problem in the early days when gas heaters were left on 'High' and 'forgotten' for several weeks resulting in huge gas bills. The cheaper models may not have thermostat control.

Early model Gas Heaters will typically have an on/off switch, a water pressure switch, a gas valve and different high limit switches in safety circuitry, based on model and size. Gas Heaters will require special attention to location and chimney and need to be professionally connected to the Gas Supply by a Certified Gas Fitter and vented correctly so it does not introduce a safety hazard. The swimming pool plumbing connections are usually undertaken by the Pool Installer.

☐ ***Fixing Gas Heater Problems?***

The most common Service problems are related to the pilot not lighting (a high-voltage spark is produced by a device similar to an automotive spark plug can give trouble). In most cases the cause is low gas pressure, improper venting or an inadequate air supply. Check that the gas is turned on and if using propane, make sure the tank has a sufficient supply of gas. Make sure there's no blockages in the gas plumbing system i.e. pool water flow to operate the Flow Switch.

Another problem might be that the water will not reach the needed temperature. In this case check if the thermostat is not set too low. Also, if there is heat loss greater than heat input you can get the same problem. This happens when the outside temperature is just too low, the heater does not have a proper gas supply or it might just be too small for the job at hand.

A thermal heat retention pool cover should always be installed to slow heat loss and if you have a faulty high limit switch you should shut off the heater or more problems can appear. If you see that the heater cycle goes off before the desired temperature is reached the water flow might not be adequate, because of a closed valve, dirty filter, reversed water connections, faulty pressure switch or an external bypass. The thermostat must also be checked for possible faulty calibration.

☐ ***Solar Heating***

The idea of Solar Heating always appeals to customers, as the perceived pool heating is "Free Heat" from sunlight. This is not always the case, due to a number of factors (one being the low latitude location of New Zealand in relationship to direct sunlight – also known as 'the declination of the sun' which describes the position of the sun – and radiation waves warming the molecules of the atmosphere and pool water - in relation to earth (NZ ranges from about 30° to 65° attitude angle) which allows for a decent sunstrike in our Swimming Season .

Nevertheless, there is a thriving Solar industry that provides numerous installations each year. Solar Panels are generally maintenance free and located on a roof or other high location. Preferably arranged to catch the appropriate season's sun position, the 'angle of attack' from the sun's rays must be considered. This varies from wanting more solar capture in Spring & Autumn (Solar Panels arranged more vertically) to summer (Panels laying flatter, pointing at right angles to the sun position in Summer)

Most maintenance issues with Solar installations relate to the plumbing and (if fitted) the booster pump and temperature differential assessment. (A temperature differential assessment is necessary to switch the booster pump ON when the pool water has a lower temperature than the Solar Panel water, and OFF when the opposite occurs – otherwise the Solar Panels would radiate the heated pool water and cool the pool down)

Section 2.
Swimming Pool plumbing.

☐ **PVC pipe used for plumbing residential swimming pool filtration systems**

Large diameter PVC pipe arrived on the New Zealand plumbing scene in the 1950's and by the 1970's in diameters suitable for pool use (40 mm – 80 mm) were used as a preferred method for pool plumbing (replacing 32mm Class E ABS, Copper and Galvanised Steel) for residential water in Class D (40 mm and 50 mm Pressure pipe) as ideal plumbing for residential swimming pool filtration systems. Since the 1970's, a variety of styles of PVC pipe and fittings have been developed for the residential swimming pool industry, and in New Zealand it is sourced mostly from China, and you can find them in most pool supply company's inventory. Although in common use, special care should be taken to not become complacent when plumbing with PVC pipe and special attention given to protecting the pipe when buried underground.

PVC pipe is a 'poly vinyl' (i.e. multi-chemical) product Poly-Vinyl-Chloride, which is a combination of propylene plastic and vinyl. This substance is used in a wide number of rigid, semi-rigid and flexible plastic products, as it is appreciated for its durability, longevity, and resistance to wear and tear, corrosion and premature disintegration. Its use varies from hard plastic pipe to flexible covers - and 'vinyl' swimming pool interiors.

Thermoplastics ABS - chemical name Acrylonitrile Butadiene-Styrene (whew!) and PVC pipe are commonly used for sewer lines, water systems and most underground plumbing these days, and ABS pipes – being more suited to larger diameters - are common in earthquake-prone areas because they are resistant to movement fractures. Both ABS and PVC pipe is impermeable to harmful bacteria and manufactures boast that correctly made and installed PVC pipe can last more than 100 years.

PVC piping is generally considered easy to cut and use, and can be joined by solvent melding (a combination of melting and welding), which involves applying a solvent to both the pipe end and pipe fitting to soften them, then melding them together. PVC pipe is typically white, although it also is sold in clear and grey varieties. Most New Zealand Territorial Authorities allow the use of PVC pipe in pool plumbing, but check the local by-laws to be sure.

When using PVC pressure pipe for a swimming pool application, be ABSolutely certain that the fittings you use match the pipe in both gauge and quality. Pool pipe and fittings found in New Zealand are generally manufactured in China or other Asian sources and sold in a variety of thickness and diameters so be aware and alert. You might end up with mismatched pipe/fittings that may ultimately fracture and leak, or 'hydraulic apart' under water pressure.

If you intend to Flame Heat the PVC pipe (as in order to produce bends) be aware that harmful components used in the manufacture of PVC pipe can be released and emitted under heat from a flame, and these fumes have been linked to carcinogens.

☐ ***PVC (Poly-Vinyl Chloride) is the most commonly used pool pipe & fittings material***

PVC is the most common material used in pool plumbing elements. Lengths of PVC 40mm and 50mm pipe can be joined by using a larger diameter sleeve (aka joiner) that the pipe fits into each side, or the pipe itself may have an enlarged section on one end that accepts the standard diameter of the other end of the pipe. The pipes then act as 'males' which are glued into the 'female' openings on the plumbing fittings.

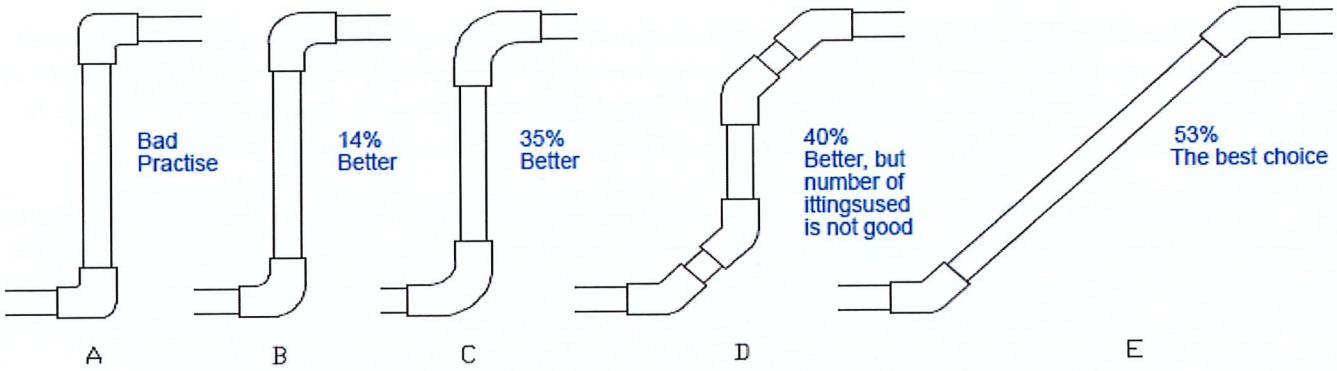
Copper plumbing was also common in the past, so you may still find this on maintenance jobs you attend, but it is more difficult to repair and install, and can also be quite expensive. Older copper plumbing found on refurbishment jobs is commonly replaced with PVC, mainly because copper will corrode and lose its strength as time passes. You may also encounter galvanised iron pipes (electroplated with zinc – aka Galvanised plumbing). Whatever the type of plumbing you may encounter, they all use the same basic installation procedures.

☐ To summarise, basic pool plumbing elements consist of skimmers or main drains and a pipe system that reticulates the pool water. Although plumbing up a swimming pool in PVC pipe seems a simple task, attention is needed to ensure that the system will hold water! Many builders have experienced the same issue: the pool is all nicely plumbed up and ready to start up. The switch is thrown and ... oops, there is water squiring out of a pipe join (comments like "I was sure I glued that joint!" are quite common in the pool industry!)

In many countries, it is mandatory to use coloured pipe solvent (Blue and Green are common colours) In this way, it is a simple job to check if the joint has been glued: you can see the coloured solvent around the join.

Many builders, however, don't like the look of the pool plumbing if it has colour solvent dripping all over the place, and refuse to use it - particularly in the filter shed. Fair enough, and any leaks here can be easily fixed, but remember that the rest of the plumbing may end up under 100mm or more of poured concrete paving – and you don't want to have to dig that up, do you?

☐ Think about your use of elbows and bends in PVC pipes
They affect the flow – so use appropriately to minimum loss of efficiency in the system



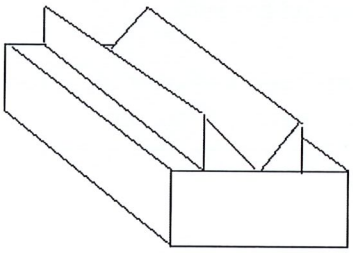
A – B – C = Bad practise, D has some saving effect, but uses more components, look untidy, and increases the possibility of unwanted leaks due to the large number of glued joints. Use only on the Pump/Filter connection. E is preferable, but difficult to integrate into pool system.

☐ When compared to the hard 90° elbows, the short and long radius elbows show 14% and 35% reduction in head respectively, but by using two 45's to form a 90° bend yields very little extra savings (another 5%) and raises quality issues as it doubles the number of glue joints that may potentially fail at some future time. The use of two 45° elbows spaced apart (as in 'E') in place of a single 90° yields a 53% reduction in head loss, but cost and space means that this design is infrequently used throughout a pool filtration recirculation system.

Cutting PVC Pipe
PVC Pipe is easily cut using a number of various hand-held sawing tools, ranging from a simple hacksaw, to a woodworking fine-tooth cross cut saw or a Tenon saw (see picture) more importantly it is knowing how to hold the

☐ pipe securely while you are cutting it improves the cut.
Many installers use whatever is handy (even their knees) to hold the pipe securely in place, but this is risky, and an un-even cut will often result. As it is most important to make all cuts precisely at 90° so that the maximum amount of pipe surface area is available to meld into the intended fitting, a simple wooden tool can be quickly made up out of some off-cut 100mm x 50mm timber and 'no more nails' adhesive as shown here. It is a simple device that works with all the pipe diameters you are likely to encounter on a residential swimming pool installation and will securely hold the pipe in place while you cut.

One option that is often used on-site by pool professionals is the electric 'cut off saw'. This device is intended for bench use, but the 'home handyman' size saw is easily portable and by swapping the 'Rip' sawblade with a finer tooth version, you will (with care) produce some real professional-looking pipe cuts. Once the cut is made, use a Stanley Knife to scrape the 'dags' off the inside and outside of the cut then sandpaper the area of the pipe that will be in contact with each other.

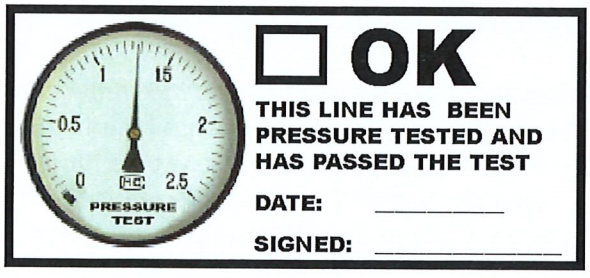


☐ The MOST IMPORTANT thing you need to know about turning out a professional-looking plumbing job is the VISUAL aspect of the installation - and THINKING before you cut & glue!

If using a hand-saw, use a Cutting Block (easily made from timber) to hold the pipe straight and get a straight 90° cut every time! The finished job should look professional, visually lined up parallel with obvious house features, proper right angles, using the appropriate number of bends and fittings that you can to encourage good water flow, don't use up pipe offcuts joined together as a 'straight' piece ***anywhere it can be seen by the customer*** (if at all!), support the pipes with the correct clamps where necessary, and finally - wipe off any joints dripping glue!

☐ MEASURE TWICE – CUT ONCE is a good rule to remember. Using a pen and paper, plan your total pool plumbing before you cut any pipe. Draw a schematic of what you hope to achieve, then measure the pipe runs and mark them down on your schematic. This should be kept, along with your customer's details, as you may need to come back at some future date and dig up a faulty joint – it pays to know where they were installed!

☐ Think carefully when installing underground PCV pipes. Protect them from 'other trades' who might be working on the site – especially machinery operators and poured concrete subcontractors who will be using hardfill and compactors over your plumbing work. It's essential to backfill the pipe trenches with a suitable width and depth of a buffering material, such as scoria, finely ground pumice rock, or even sand – which is better than nothing. An untidy plumbing job is a dead giveaway of the lack of skills of an amateur pool builder!



Pressure-test your swimming pool plumbing

☐ Pressure Testing you swimming pool plumbing can be done with an actual tool called a "Pressure Tester"(Duh!), and there is an Auckland company that has been making pressure testers for some time in New Zealand – Aquatech Industries Auckland (09 636 9921)

Aquatech Pressure testers have been a common tool on most swimming pool repair Techies trucks for many years, and are a relatively cheap – but useful – device.

☐ This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

The Aquatech pressure tester connect to one end of the swimming pool plumbing lines and the other end of the lines will be plugged with commonly available Para Pipe Plugs available in several diameters

☐ The Aquatech pressure tester allows you to hook up household 1.0 Kpa water using a standard garden hose.

How to pressure test the pool plumbing

1. Gets your pressure testing equipment all together and ready, including your Aquatech pressure tester, test plugs, hand tools and water line (Garden Hose).

2. Depending on what plumbing lines you are testing for leaks on your swimming pool will decide on what you need to plug. If you are testing your returns for leaks then you will want to remove the eyeballs from the returns and use a test plug to plug the lines. If you were testing the skimmers you would plug the skimmers.

3. Once you have plugged one end of the pipe(s) that are being tested, attach the Aquatech pressure tester to the other end of the pipe. You may have to cut the pipe if access is not readily available, so if you do, rejoin the cut portion with a Mac Union so you don't have to cut the line again at some future date.

4. If you are testing the skimmer line and you have just plugged up the skimmer end, find the skimmer line that connects to the pool pump near the pool filter. Often the skimmer line will be connected to an 'on/off' valve on the suction side of the pump. If a Mac Union is already fitted at this location, disconnect it and attach the Aquatech pressure tester to the union.

5. Now that you have the pressure tester hooked up to your swimming pool plumbing lines you can use water pressure from the household system to test for leaks.

6. Once the pipe has between 1.0 to 2.0 Kpa (kilopascals) of pressure, close the Aquatech tester tap to stop adding water, and then watch the pressure gauge on the tester unit. If you see that the gauge indicates that the pressure is falling, this means that the pipes not holding pressure and that you have a leak somewhere within the line.

   If you have added 1.0 to 2.0 Kpa of pressure and the pressure gauge is holding steady and not losing any pressure at all after fifteen minutes, this will mean that your swimming pool lines are good and do not have any leaks.

VIDEO: how to soften PVC pipe to form bends

http://www.youtube.com/**watch?v=2Qs-PILTCbw** **(Select text, copy and paste into your Internet Browser)**

Plumbing an inground swimming pool with Class D Pressure Pipe is going to be a bit different than the normal PVC piping work you would do with DWV pipe (aka Class E 32mm Waste Pipe) used for drain, waste or vent pipe.

☐ ***Swimming Pool Plumbing: Rigid PVC vs. Flexible PVC, Which is better?***

One of the most frustrating experiences a pool serviceman can have is finding, fixing, and not to mention charging the customer for a mystery leak that would make anyone want to pull their hair out!

Needless to say, a pool builder needs to use the best installation methods and building materials available to prevent leaks along with all the consequences that may follow. The most fundamental component of a pool's plumbing is Polyvinyl Chloride tubing (aka PVC pipe). There are two primary types of PVC pipe used in residential inground pool construction today: ***Rigid*** PVC pipe and ***Flexible*** PVC pipe. Compare these subterranean tubes to determine which you would rather have buried for twenty years or more under your customers' pool surround.

What Rigid PVC and Flexible PVC have in common:
Rigid PVC and Flexible PVC pipes both have essentially the same chemical make-up
Both are cut and glued using solvents and the same tools – but different solvents must be used
They are joined together using the same PVC fittings

What pool piping to use? Read this section

What makes Rigid PVC pipe different from Flexible PVC pipe?
Rigid pipe, just as its name implies, doesn't bend on its own. This means whenever a direction change in the pipe is needed, the installer either has to cut the pipe and install a fitting or 'heat bend' the pipe to get around the turn. Both take time and varying degrees of skill.

Flexible PVC is made with plasticisers that make it soft and highly flexible. When a turn in flexible PVC is needed the installer simply forms the pipe around the bend and keeps on rolling. This method of installation is much quicker and easier than using rigid PVC pipe.

☐ Basically, there is a choice between a pipe that is stronger and more difficult to install verses one that is weaker and easier to install.

Flexible PVC pipe is easier to install, but should it be used on an inground swimming pool?

1.) Several years ago at a Seminar on inground pool plumbing the instructor passed a small section of pipe around the room. It was a piece of 50mm flexible PVC pipe with dozens of tiny holes in it. Those in attendance were asked their opinion of what caused the damage. No-one had any idea, and then the instructor said one word "Termites!" (Aka Woodworm or NZ Borer) Flexible PVC pipe is simply not suitable for underground use, because it is susceptible to attack by insects!

☐

A Distributor of Japanese flexible PVC pool pipe (the kind available in New Zealand) stated:

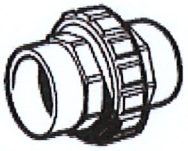
"Pool Hose (flexible PVC pipe) can be damaged by rodents or insects, including termites. Spa Hose should not be used underground in areas infested by termites. Our warranty does not cover damages caused by them...This product warning shall be given to every purchaser of Pool & Spa Hose Pipe"

2.) Flexible PVC pipe is much easier to puncture or crush than rigid PVC pipe. It's not as strong, and considering all the pressures exerted on underground pipe, strength is a necessary asset. "Flex pipe" can be crushed and punctured both during construction or while working in a customer's backyard with existing pipe in the ground. Digging in a backyard needs caution, but it would be much more comfortable digging in a backyard that has rigid pipe versus flex pipe.

Why would a pool builder take the chance on burying this underground for decades?

Why is Flexible PVC used on Inground Pools?
Although the swimming pool contractors that use flexible PVC on inground pools are in the minority, they are out there, perhaps because they don't know any better. There's no doubt that it saves time, and time is money, but is it worth the risk? The last thing we need is to waste our time finding and fixing leaks caused by the insects in the environment!

☐ ***The Difference between Pipe types:***
Swimming Pools use pumps and filters to circulate and clean the water in the pool. These systems run on a pressure system that requires the pipe to be able to handle anywhere from 1.0 Kpa to 2.5 Kpa (15-40 psi of pressure) and that is why regular 32mm Class E 'waste' PVC pipe is not suitable for swimming pool use, and Class D 50 Kpa (90 psi) pressure pipe is normally used.



The Difference between the Fittings:
PVC pipe Fittings are different than DWV Fittings, so don't mix them up. The PVC fittings that you will use with Class D pipe will be "pressure fittings" that are different in two ways. The first way is that they are thicker than the normal Class E fitting. The second is that the surface area where the fitting accepts the pipe has twice the surface area which allows the creation of more of a high pressure and durable bond.

Gluing or Melding Fittings:
The next issue is the Solvent (aka 'glue') you will be using. PVC glue (sometimes labelled "PVC Cement") is typically the same for both types of pipe as long as you are using a rigid pipe and not a flex pipe. Flexible PVC pipe will require a different type of cement for the bonding application.

VIDEO: Preparing PVC pipe for jointing
http://www.youtube.com/**watch?v=Zirp8vqApQc**

Some important advice in using PVC pipe for swimming pools
Pool equipment items that may need removal for servicing should always be connected with Mac Unions (See left illustration) They cost more but are better that having or cut and re-join pipes – sometimes more than once. CLEAN ALL JOINERS THOROUGHLY before gluing – sandpaper the joins that touch each other with Fine "wet and dry" grade (150 to 180) : Even the smallest amount of water, dirt or other contamination in the joints to be glued can make your PVC pipe joint fail – with the consequent of a leak, so make sure all the jointing areas are primed using the separate Primer Liquid supplied, and cleaned well before you go ahead and bond the pipe & fitting together. Experienced pool professionals will thoroughly scuff up all the areas that will be in contact with each other once the solvent is added. It is good practise to do as the top professionals do!

Why do you not quote the internal diameter (bore) of the PVC pipe and ABS pipe?
Almost all plastic pipes are extruded in the same way as PVC pipe and ABS pipe. The outside diameter of the pipe is the controlled measurement as this is what is used to fit into pipe sockets.

The internal diameter of all such pipe types will vary a little – depending on the pressure rating and size of the pipe – but enough to warrant the internal diameter of the pipe to not be stated. We can advise on the likely internal diameter of a pipe, but we cannot guarantee it. Also different pressure ratings require different wall thicknesses of pipe and as the external diameter is the controlled diameter of the pipe, the internal bore varies with the wall thickness.

How smooth is the inside of a rigid PVC pipe and ABS pipe?
The inside of a PVC pipe and ABS pipe is nearly as smooth as the outside – note above internal diameter information – there is sometimes a slight, almost indiscernible change in the pipe wall thickness – this goes for ALL manufacturers of PVC pipe.

What are the temperature ratings of PVC pipe and ABS pipe?
The recommended temperature ratings of PVC pipe is 0.0^0C to 60.0^0C which is suitable for most areas of New Zealand (remember the majority of pool pipes will be underground, and insulated by the surrounding backfill). The pressure rating of the pipe will reduce as temperature increases and all pressure ratings quoted for PVC pipe and ABS pipe in literature are those at 20^0C.

***What are the recommended distances for supporting PVC pipe pipes*?**
This is a common mistake made when installing PVC pipe. Insufficient support will cause the pipe to sag and may reduce the working pressure or, under extreme circumstances, cause excess strain on joints and affect the integrity of the pipe system.

The table below gives pipe support distances for different sizes of pipe.

Distance between supports	@ 20°C	@40°C
40 mm	1,100 m	0,900 m
50 mm	1,200 m	1,000 m
60 mm	1,300 m	1,800 m

Section 3.
Troubleshooting Leaks

Air leaks (suction issues) and water leaks (pressure side issues)
Read complete section

One of the most common problems in swimming pool filter systems complained about by customers is air in the system or the "bubbles" that you see coming from your swimming pool returns. (Aka "Jets" or "Eyeballs – because they swivel around like an eye does"). Providing that the system does not have an Ozone Generator fitted – because ozone units inject air into the recirculation system – then you may have an air leak problem.

The bubbles you see coming into the pool via the returns, or the air that you see through the clear Hair & Lint pol lid is caused by air being drawn in through the suction line. Many people think that the air is forming on the pressure side of the return line but what is really happening is air is being drawn in through the system and then being pushed out though the return eyeballs. Any leaking on the pressure side of the system would squirt water OUT not suck air IN.

Pumps would rather suck air than push water, because it's easier for vacuum pressure to pull no-weight air than heavier water. If you were drinking a liquid though a straw and poked a hole in the side of the straw, what would happen? Air would come through the straw before the liquid - and that is what happens when a pump has air leaks on the suction or vacuum side.

Suction leaks often occur in the vicinity of the pool pump and can be easily identified, however sometimes the leaks or breaks in the pipes can appear underground and might require some extra work or a professional leak detector device for the job.

Check all the Mac Unions: Typically these are only hand-tightened on initial installation – it is unwise to use plumbing tools such as a 'multi-grip pliers' to tighten them, as the annular ring is too easily over-tightened and may suffer internal stress that will cause it to crack - usually after you have left the site. Always position the male side of the MAC on the 'passive' side of the installation - i.e. the part that 'stays in place' as opposed to the 'active' part that may need to be removed at some stage i.e. where the suction line meets the pool pump, the MAC Male (annular ring side) stays put and the pump side (the female side) can be removed. This is also true of the MPV MAC unions. Although MAC unions may be used as either 'active' or 'passive' components, it's better to leave the annular ring side 'on – site' where it can't get lost if you have to transport the unit being investigated back to your depot, during which 'O' rings etc. can fall out and get lost, creating a problem in refitting the piece back on site.

Hand pressure is generally enough, but this always needs revisiting after the system has been in operation for a while, due to temperature differences, etc. Mac union joints are generally solvent welded onto the Multi-Port Valve (aka MPV) wherever a plumbing connection is made and also the front of the Hair & Lint Pol on the suction side of the pump. The reason for these Mac unions, is to easily enable the pump or filter top plate to be removed for servicing – without having to 'cut and replace' solid pipe connections.

Especially when first installed, the pool pump might run slightly hot and the threaded 'female' section of the Mac union connected to the Hair & Lint Pot could swell and the fitting will become loose and lose its air tight capability. If this happens, unscrew the annular ring (male side) and re-tape the thread with P.T.F.E. tape (Poly-Tetra-Flouro-Ethylene), then re-thread the fitting back onto the female side closest to the pool pump.

Check the "Hair & Lint Pot lid seal" this rubber o-ring or gasket fits in between the lint pot lid and water receptacle. Resealing the O ring with a smear of petroleum jelly (Vaseline is commonly used) often cures this leak, or if the O ring looks worn or damaged in any way, replace it.

Check the drain plug(s) on the pump housing, as vibration of the pump may loosen these drain plugs, resulting in leaking and/or sucking air into the pump body. Unthread the drain plugs and re-tape the with P.T.F.E. tape. Note that some drain plugs will have O rings that might need replacing.

If the filtration unit is fitted with an MPV (Multi Port Valve), air leaks may be introduced when the system shuts down because of a worn 'Spider Valve Gasket' (see illustration) allowing air to be drawn in due to vacuum-pressure suction caused by gravity draining water in the lines back into the pool - although this is not likely in a new pool filter installation.

A typical indication of a leaking spider valve is the pool water leaking down the backwash line while the system is running. As the gasket deteriorates, water seeps past the seal and the only exit place is the backwash line, so a quick visual check of the termination end of the backwash line will determine if pool water is leaking out. Some filter installations include a clear section of PVC backwash pipe at the MPV end, and some MPV valves have a clear glass 'sight glass' which indicate any leak, so check these areas first.

Spider gaskets are often 'super glued' in place during the factory assembly of the MPV, which is a good idea until you come to replace it! You will need a Phillips-head screwdriver to remove the MPV top and a special scraper tool to remove all of the deteriorated material from the lower part of the disassembled MPV valve body.

Using a bench grinder and small-blade, long-shaft screwdriver, grind the width of the blade to the required width (about 3mm), and you can produce a suitable scraping device for this job and your tool box.

Carefully scraping the valve body – being careful not to gouge the plastic – to remove all the remaining debris of the failed spider gasket, super-glue the replacement carefully back in the correct position. When the valve top is replaced, the spring pressure from the variable top part will press the gasket firmly down. Don't restart the filtration for at least fifteen minutes to allow the glue to cure sufficiently.

If the above still does not fix the air leaks in your system, then there might be a leak in the suction line underground at fractured (or improperly done) joints near the pool wall fittings or elsewhere in the line somewhere, or commonly the PVC pipe might have fracture splits in it, and you would have to locate that leak using an Aquatech Pressure test device and a sonic microphone setup as a more sophisticated method. This is mentioned elsewhere in this Paper.

There are many types of leaks that your swimming pool plumbing can give you. Most leaks are caused by human error rather than the pipe itself going bad, but in some cases it simply is the pipe or the fitting that goes bad

Leak Detection using electronic devices
Apart from the Aquatech Pressure Tester, there are a number of electronic Leak Detection devices available on the internet: simply google "swimming pool leak detection" for a number of options. Cut and paste the following link into your internet Browser, it takes you to one US supplier (Leaktronics), and will give you an idea of what you "hear" when using the underwater hydrophone (waterproof microphone) system:

http://www.youtube.com/watch?v=eypc5BKj8YE&rel=0

Common Causes of Leaks
Poor installation practises or lack of maintenance
severe weather or ground conditions
Incorrect or mismatched materials including past-dated solvents used
Unprofessional repairs by untrained or unlicensed service contractors

Pool Chlorine Tablet Feeders
There are a few most common areas that a swimming pool chlorine erosion feeder will leak from no matter which brand you have. Whether it's a basic Chinese manufactured chlorine tablet feeder, or an imported US Rainbow chlorine tablet feeder, they mostly have the same parts and generally leak from the same places. Here are some things that commonly leak

Top Cover O-ring
Drain nut on Chlorine Feeder tank
Unions or threaded fittings connecting the feed to the plumbing
Compression Nuts (Offline Chlorine Feeders)

Replacing the O-ring
The most common leak is the O-ring on that sits inside the cap of the chlorine feeder, this gets worn out from the cover being removed over time and can easily be fixed by replacing the O-ring. In order to do so just remove the old o-ring and replace it with a new one and then grease the threads on the housing itself with some Vaseline or other brand pipe lubricant.

Drain Plug leak Repair
The drain plug on the bottom of the tank usually has a rubber washer or an O-ring that completes the seal when the drain nut is tightened. Over time the washer gets worn from the removal and re-installation of the plug from the

winterisation and the summer start-up of the pool. Un-thread the drain plug and replace the washer that sits on the nut, then lube the threads with some swimming pool pipe lubricant and thread the drain plug back into place. Be careful not to overtighten.

Fixing the plumbing connection

Inline chlorinators are connected in line with the plumbing of the filter system in two ways. One way are Mac unions and the other being hard-wired into the plumbing. If the chlorine feeder is using Mac unions as a way to connect to the filter system, then simple undo the unions and replace the O-rings that are inside. These O-rings over time become flattened or cracked or dry rotted from age or weather conditions and a simple replacement will solve your leaks. If you chlorine feeder is hard-wired, you will have to cut, replace the O rings and re-join as required.

Fixing Leaks On Compression Nuts (Offline Chlorinators)

The reason they call an off line chlorine feeder off line is because it's not directly piped into the filter system, and it uses flexible lines with compression nuts to connect to the fittings or saddle clamp fittings on the PVC pipe. The most common problem with these connections is that the flexible pipe is cut on an angle. These lines must be cut with a clean straight cut or they will leak.

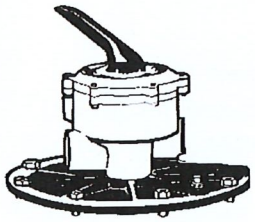
How to decide if it's time for a new chlorine feeder

If you have tried all the above and any part was damaged or if before you started to make a repair above and you noticed a major crack, or your feeder is very old then you might want to think about just buying a replacement chlorine tablet feeder.

Multi-Port valves (aka MPV)

An MPV is a multiple-port valve that is located or attached somewhere to your swimming pool filter - usually on the top, but sometimes at 'waist level' on the side. This valve allows you to control the water flow direction or the port that you want to direct the water flowing out of the pump.

Most pool filter manufactures encountered in New Zealand have their own proprietary valve, and some use a generic valve (i.e. Midas) the repair or the replacement for these types of multiports are quite simply performed with the right tools. The basic unit is generally quite robust, and the areas that may need attention over time are typically the Rotation Handle (it can be snapped off) the internal Main Spring (may lose its power and stop closing the valve tightly enough) and the spider gasket.



The tools you will need to service an MPV are pliers, P.T.F.E. Teflon tape, and Phillips & flat-head screwdrivers.

Section 5.

Simple maintenance tasks for the pool serviceman

Replacing the Multiport Valve

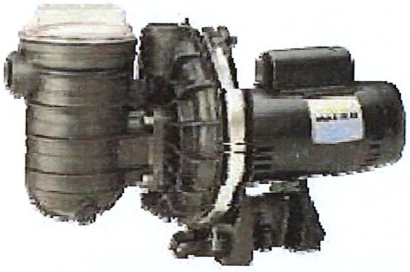
. Switch off the pump and isolate the power by pulling the power lead to the pump motor
. Loosen all the Mac unions on the incoming pipes connecting to the multiport.

This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

. Loosen the retention nuts that connect the multiport valve to the plate on top of the filter tank
. Carefully lift the entire top filter plate and MPV off the filter top. Notice the location of the vertical pipe sticking up through the sand media in the filter body itself. Take notice of any gasket or large O ring that might be a seal of the plate to the filter top. If there is one, careful clean it and put it back on the filter top so you don't misplace it.
.Now that the multiport & filter plate is disconnected from the filter, undo the nut holding it.
.Discard the old MPV in a nearby place where it can be seen by the customer (proof of replacement)
.Remove the new multiport valve from the box it came in.
.Reattach the new MPV to the filter top plate, being careful to make the joint water-tight
.Refit the top plate carefully to the filter tank, being sure (a) that the ports align correctly with their correct counterparts, and (b) you insert the vertical pipe into the MPV and the gasket or any waterproofing device is correctly reinstalled to ensure a watertight joint.
.Connect the Mac unions from the pipes that you previously disconnected
.Wrap the existing Mac union female threads with P.T.F.E. Teflon tape and re-thread back into the new MPV disconnected when removing the old multiport

Turn on your filter system and check for leaks around all the fittings and the joints of the filter tank, if you notice any leaks or drips make sure you shut down the filter system and redo the process above.

Finding out the 'power rating' of the pool pump
To find out what the power of your pump is you simply have to look on the sticker that is on the motor itself. The motor is the driving part of the pump located towards the rear, and you will see wires hooked to the motor as well. Once you see the sticker just look for the wattage label and that will let you know if you have a 550w (3/4 hp), 750 w (1.0 hp), 1,100w (1.5 hp), or 1,500w (2 hp). If you ever need to know, to convert watts into horsepower (as you might need if using US manufactured pool pumps) multiply the watts x 0.00135 for an approximate value. I.e. for a one kilowatt (1,000 w) pump the formula is 1,000 x 0.00135 = 1.35 (hp)



Getting Ready to install a new pool pump
Now that you have found out the power requirement of your new pump and have bought the replacement one to install, you will need a few tools as indicated (below)

Tools you will need to replace a pool pump
A pair of water pump 'Multigrip Pliers"
Flat Head screwdriver
P.T.F.E. Teflon Tape or thread sealant paste
20 litre bucket filled with water

Turn off the electric power to the unit and unplug the pump from the wall. If the pump is hardwired, take extra precaution to ensure the power is disconnected by pulling the fuse in the mail household switchboard. If you can't identify the correct fuse DO NOT PROCEED! You may have to ask an electrician to shut the power down for you.

Installing a new pool pump

Step One: Rechecking the power
The first step is to recheck that the power is completely shut down to the pool pump, make sure you double-check to make sure the power is off. You may need to remove a Fuse or find the Mains Power Board in the house and pull the fuse to the pool pump. If the pump is just connected to a wall power source in the Pool Shed, disable it by unplugging it from the power source.

☐ ***Step Two: Draining water from pump***

Ensure the power is turned off. Remove the drain plugs on the bottom of the pump housing, you will see one drain plug on the side of the pump on the bottom and the other drain plug on the front of the pump on the bottom of the water housing or 'wet end' as it is known in the trade. This will allow all the water to drain from the pump.

Step Three: Disconnecting the electric from hard-wired pump

Once the water is drained, if the pump is "hard wired" you will need to disconnect the electric source from two places, first (as in step one) find the outlet where the pump is plugged into.

If the system is hard wired (and you are positive you have ensured that the power is disconnected) remove the back cover of the pump using the flat head screwdriver to remove the two screws that hold back cover in place.

Once the back cover is off and you will see that the end of the power lead is either held on by 'slip connectors' that you can just slide of the posts, or you may have to use a screwdriver to loosen two screws that hold the wires on the motor. Once you have completed one of the two options you cord will now be removed from the pump. Do not discard the power lead as you will need this for the new pump – unless the new pump comes with a power lead.

Step Four: Disconnecting the Plumbing from the pump

Replacing a pump connected with Mac unions

Now that the electrics are disconnected, loosen the Mac unions by hand, or if they are jammed tight, use your ☐ Multigrip. There are normally two Mac unions, one on the suction side and one on the pressure (discharge) side. Once you have loosened the two Mac unions you can slide the pump away from the filter giving you more room to work. If don't find Mac unions connecting the pump, the next section (below) gives the method of how to remove a pump with no Mac unions.

Replacing a pump with no unions

If there are no Mac unions to disconnect the pump, will have to cut the incoming and discharge pipe with a saw to remove the pump. Think about what you do before you do it! There must be enough room left on the pipe after the cut to attach new Mac Unions (Best Practise workmanship – makes it simpler to come back at some future date) so plan ahead! If the existing pipe is not PVC this requires more thought being put into the process, and more knowledge of the type of removable (Mac) unions available if the material is being used.

Step Five: Removing the fittings and re-installing the pump

Rotate the fittings that are attached to the old pump housing out by spinning them anticlockwise. Reassembly is the same process in reverse. Just simply reverse these directions to re-install the pump.

1. Filter Sand Change:

Standard 14/24 *(UK standard for grading filtration media which will pass between a fine mesh of larger than 14 strands per 24mm and smaller than 24 strands per 24mm)* filter sand should be changed every five to seven years. The "sharp" sand gets rounded off by the passage of dirty water, and must be replaced.

Before starting this job, SUPERCHLORINATE THE POOL THROUGH THE SKIMMER so that bacteria in the filter tank are neutralised. USE RUBBER GLOVES - Most households have these disposable gloves for hand protection when manually washing dishes. If you don't have any, your Supermarket will have them. So purchase a box before you touch any filter sand.

Tools that will/may be required:
300mm (12") Stillson Wrench for undoing stubborn or over tight MAC Unions,
300mm (12") Crescent Wrench for undoing Older Type filter top plate studs,
200mm (8") Cresent or Medium size Screwdriver for undoing Clamp Type filter tops,
Old tin can for scooping sand out,
Bucket to contain scooped sand for disposal.
Wet & Dry vacuum (if you have one handy)
Rubber Gloves for bacteria protection against cuts or abrasions from inside the tank

Materials required
Up to 7 bags filter sand or glass media (Check with filter tank supplier) 14/24 Filter Sand (0.4 & 0.9mm)
Vaseline for lubricating "O" rings
Masking Tape or cloth to make a bung to protect 40mm return tube in tank,
O ring for MPV plate to filter tank seal

Older pools:
FPI "Contractor" filters (1975 - 1999) If the filter top has a MPV (Multi Port Valve) that is attached to a black aluminium or other metal plate, which is in turn bolted onto the top of a white fibreglass filter tank, you should dowse the protruding studs (bolts) and nuts or crown nuts thoroughly with a penetrating type oil, as the nuts may be "oxidised" onto the protruding studs by corrosion. DO NOT USE EXCESSIVE FORCE on the nuts for fear of breaking the stud off in the fibreglass tank. This is BAD NEWS and will mean a replacement tank at a cost of $350 - $500

Newer pools:
Newer pools have various different attachment methods (not studs and nuts as above) so the top part holding the MPV is easily removed, after disconnecting the PVC pipework. These are normally connected by MAC UNIONS which are a type of connector that easily comes apart (NOTE: Never use a TOOL to tighten MAC unions, just HAND PRESSURE is sufficient, as long as there are no drips afterwards)

After removing the Top Plate with MPV you will see a 40mm PVC pipe sticking up through the sand (and water). Put your GLOVES on BEFORE touching the sand and water in the filter tank. Using your tin can, empty the sand and water from the tank into your disposal bucket, checking that the media you are removing IS filter sand and not the bottom GRAVEL media. You will evacuate several buckets' full depending on the filter size. Once you hit the GRAVEL at the bottom of the tank, it is time to stop the emptying process. Although the gravel does not normally require replacement, is not uncommon to find it 'ground down' into useless size lumps, so replace it. Modern filters do not require this first layer of gravel, so check with the filter supplier and get the correct replacement media from them.

You may have a "Wet & Dry" vacuum unit which could assist in this process. Check that your unit is suited for this task before sucking any water through it.

Use the cloth or tape to protect the 40mm upstanding pipe (which should be held in position by the remaining gravel in the tank) so that the new sand media does not go down it to the wrong side of the bottom septum (which is the collection point for the filtered water to be returned up this tube and back to the pool) or in the case if adding filter media to a new filter tank, use the 'centering cap' that supplied.

Gradually tip or scoop the new sand media into the filter tank and spread evenly around the up stand pipe with your hands. USE GLOVES to avoid abrasions and possible infection. Sand should fill to approximately 150mm from the top. When all the sand is installed, gently refit the Top Plate, ensuring that the receptor aperture on the underside of the Top Plate fits neatly over the 40mm up stand, as this is when the filtered water re-enters the MPV to be diverted back to the pool. Also bear in mind the ORIGINAL POSITION of the MPV outlets, as they must line up exactly with the existing plumbing. This is not so hard with a bolted on top - as they will line up only one way - but more difficult if a

clamp system has been used, where it's better to leave it loosened until the plumbing is re-connected, AND THEN tighten the circular clamp.

Once all is re-connected, turn the MPV handle to BACKWASH, then start the pool pump. Backwash the filter for at least TWO MINUTES to remove all loose dust and debris that may have been included with the media. Check the pressure gauge, and note the new reading: this will be your new starting point for backwashing when it increases by 7 psi or 1/2 Kilopascal.

2. Change a pool quartz halogen (Aka QH) underwater pool light

☐ **Tools that will/may be required:**
Stubby Wide Blade flat head screwdriver
Medium size Screwdriver for undoing screws

Materials required
Waterproof Silicone Sealant
Vaseline for lubricating "O" ring
"O" ring for light seal
Replacement QH 100 or 150 watt headlight style lamp
Replacement QH bulb (touch sensitive)

NOTE: This procedure applies to the 100w Pool Quip type pool lights commonly used in many New Zealand pools. It does not apply to L.E.D. lights.

Before proceeding, ensure that the power to the light has been shut off.

Pool Quip lights are contained within a niche that protrudes through the pool wall.

The light fitting is held in the niche by two small toggle restraints. These are opposite each other on the outer bezel of the light fitting. Using a flat-head screwdriver, rotate each toggle 45o counter clockwise. This will release the light fitting and allow it to be brought up to the pool deck level. (There should be ample cable to do this)

The back side of the light fitting has a series of screws that - when removed - allow the two halves of the fitting to be split apart. When this is done, the bulb/reflector component can be disconnected from the power wire.

Remember the order in which the unit is separated - you have to re-assemble in the reverse order to disassembly! The wire must go through the outer half as before.

Replace the defective light with the replacement unit. Usually this is a one-piece integrated unit. If your light has a "bulb" that can be removed, you only need a replacement bulb, but these types were discontinued quite a few years ago, and separate bulbs may not be available.

☐ Reconnect the wires to the light/bulb and encase generously with waterproof silicone gel.

Clean the groove the "O" ring came out of, clean the "O" ring carefully, and add some Vaseline to aid in sealing the two halves - as they must be waterproof.

☐ When you are satisfied that the "O" ring is seated correctly, start replacing the screws loosely back. Don't tighten them yet.

When all the screws are in place, gently & slowly in turn tighten them slightly in a 1-3-5-7 rotation because the two halves must accurately fit with equal tension on the screws to ensure a tight and equal fit. If you fail to do this correctly, the first time you switch the light on the heat from the bulb will expel the trapped air unless the "O" ring is a perfect fit and contains the air pressure. (If this happens, when the light is turned off, the partial vacuum in the light fitting will suck the pool water in and short-circuit the light - so be ABSolutely sure you have done the procedure correctly)

Re coil up the wire, and replace the light fitting into the niche - ensuring that the lens is correctly aligned in a horizontal mode. (Rotate the fitting until it looks correctly lined up) then rotate the toggles back 45o clockwise to restrain the light in the niche.

Test the light for function. Does it light up? Congratulations, you have replaced a pool light!

3. Service a Salt Chlorinator Cell

Tools that will/may be required:
12" 300mm Stillson Wrench for undoing stubborn or over tight MAC Unions,
Bucket to contain used acid for disposal.
Suitable Soak container for cleaning process (A 1 litre PVC Milk container)
Rubber Gloves for acid protection
Safety glasses or goggles for eye protection
Gumboots to protect feet & lower legs against acid burns

Materials required
Hydrochloric Acid from Pool Shop
Glass disposal vessel for used Hydrochloric Acid Paper & Tape to wrap glass vessel
Take care - you are handling Hydrochloric Acid! Wear the recommended safety equipment!

1. After powering down the system and unplugging the saline generator, remove the saline electrode (in the clear glass tube) by unscrewing the large MAC Union nut on one end of the housing

2. Add water to soak container - 3/4 full

3. Carefully add approx 150 ml (two cupfuls) of Hydrochloric Acid to the water. Recap the Hydrochloric Acid immediately!

4. Place the electrode - plate end first - into the Soak container - the acid/water should cover all of the electrode's plates. Fizzing will instantly occur as the build-up of calcium contaminant is burned off

5. After the fizzing has ceased, remove the electrode from the mix and carefully hose down with clean water. There should be no calcium build-up left on the electrode plates at this point if you have left the electrode soaking for long enough.

6. Replace the electrode into the fixed clear glass housing and tighten the crox nut. Do not overtighten! Power up the pool system first and when satisfied all is well, switch on the Saline Generator. Check for leaks.

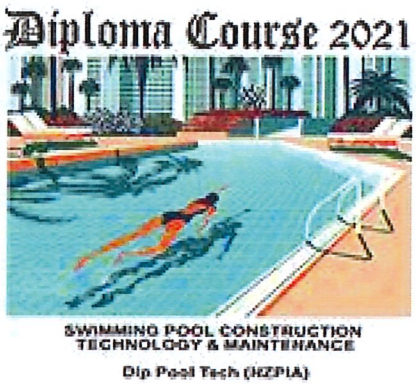
☐ This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.

7. Dispose of the remaining acid/water mix properly (OSH tell us to put the mix in a glass container and take to a disposal point - if you can find one near you) Remember - it is still a potent ACID mix that can harm you or damage your clothes.

Suggested additional reading:

NZS4441:2008
The Ultimate Pool Maintenance Manual – Tammy Temminem – IBN 0-07-136239-89 (www.amazon.com)

-- end –



This is an information page. Signify that you have read and understand this Paper by initialing the boxes and box at page bottom and return by email to executive@poolguild.org.nz Keep a copy for future reference.