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PAPER 1
BASIC POOL INFORMATION

Let's start by defining what we will be dealing with in these Papers:

We will begin the first Paper by assuming that you know what a "swimming pool" is, i.e., a water-retaining recreational structure, large enough for swimming, and hopefully be pleasing to look at and an asset to the owner's family, backyard, and property value - but firstly you must also be aware that there are a number of ways of creating the 'home swimming pool'. Each product must be treated accordingly, and this course will tell you how.

Therefore, as there are several types of water retaining structures that are commonly referred to as 'residential swimming pools' - you should at least have a basic awareness of these types that may vary in popularity - and market share - from country to country, and that generally there are three main pool types found in New Zealand.
'Descriptive Name': As time and construction methods have evolved over the years, a single 'one word' description may not suffice anymore, and several pool types may combine a number of different construction materials which 'blur' the description, but let it suffice that the 'Big Three' will do for this exercise.

Descriptive names

The "Big Three" – Concrete, Fiberglass and Vinyl - are the popular descriptive names indicating the variety of construction or major feature of pool types that have been built/installed in New Zealand for many decades since the 1960's, so it's probable that you will come across them all (or a sub-category variation on the descriptive type) at some stage – particularly if if your goal for achieving the Diploma is to work in the Pool Service sector of the New Zealand swimming pool industry.

1. Concrete pools:

The descriptive name (Concrete) refers to the basic material used in the construction of a basic pool shell, although "Steel-reinforced Concrete is a more accurate description, but as you will see, there are a number of different ways of manufacturing this end product, each with a further or additional description of the material or process employed.

1.1 Shotcrete pools: The descriptive indicates the main material used in the construction and are the most commonly constructed type of concrete pools in New Zealand. Steel 'deformed re-bar' reinforced cage, pneumatically sprayed high strength (25 mpa when sprayed, up to 45 mpa when cured) 100mm to 120mm thick concrete walls, thicker radii wall-to-floor, and typically with a 5mm to 10mm thick plaster interior finish, 200mm waterline mosaic tile-band and 250 x 250 x 50 copings (top edge stones) or something similar around the top perimeter.
Pools encountered are usually fitted with one or more 'Surface Skimmer' (pool water overflow weir devices) and single or multiple 'Eyeballs' (water return nozzles) and often a main drain suction point and/or hydrostatic valve (or combination of both) at the deepest part of the pool for complete water recirculation. The hydrostatic valve is normally included to reduce (or eliminate) any chance of the pool 'floating' should a build-up of external ground water pressure exerting upward lift which exceeds the total weight of the swimming pool, thus displacing it (it could "float like a boat") and will be found fitted to most in-ground pool types but particularly shotcrete and moulded fibreglass pools.

Extreme caution should be used if any pool fitted with this valve is to be emptied for any reason. Obviously, the valve "must work", and not be stuck down or inadvertently covered

over by the interior plaster – catastrophic damage may occur to the empty pool under certain circumstances, such as a sudden rainstorm which floods the pool area. Be cautious!

Under normal circumstances, shotcrete pools should easily last 50 years or more, although the interior plaster finish may need replacing periodically.

1.2 Gunite Pools: The introduction of shotcrete for swimming pools in the mid 1970's was a huge advance on the older style 'Gunite' concrete pool. Shotcrete slurry of liquefied concrete is delivered 'ready to be sprayed' by large Concrete Delivery trucks (with the large rotating snail-like Bowl on the back) and at the correct and predetermined water/materials mix (referred to as 'slump' whereas a cone of the mix is upended, and the amount of "slump" determines the water content of the mix) whereas the Gunite pool concrete slurry is produced 'at the nozzle' terminating the 150mm delivery hose that feeds the supply of the concrete's components of sand, cement, gravel of a determined diameter (i.e. for pools, a diameter of 10mm is common) and measured water. This system relies on the skills of the 'nozzle man' to ensure a strong mix with the correct 'slump' or viscosity of the resulting mass of concrete by adding or lessening the water supply via a manually operated valve.

Gunite pools are not often built in New Zealand anymore, but a properly constructed gunite pool should have lasted for many decades and so many examples from the 1950's still survive. The interior plaster finish life-span depends on a number of factors, but these pools can have the old 1" (25.4mm) interior plaster and tile-band removed and be refinished many times over in its lifetime.

1.3 **Concrete Block pools**: Popular with do-it-yourself people, this pool type is fraught with the possibility of cracking between the block grouting in unstable or earthquake areas, and must be steel reinforced and solid poured for the best result. The blocks are not inherently waterproof so must include an internal (or external) waterproofing layer. Simply marble plastering a block pool may not guarantee its watertightness. You may find these pools finished with a fiberglass or vinyl liner interior, and occasionally a plaster finish that has been painted with waterproof rubber-based paint. The pool shells should last up to 50 years without any problems but are susceptible to cracking on the event of earth movements.

1.4 "**Other" concrete pools**: These include 'Tilt Slab' pools whereas a pool floor is poured from a ready-mix concrete source (a batching plant), with a groove or channel around the perimeter. Pool wall 'slabs' are then poured into formers on the floor, and when cured these are raised 90° to a vertical position slotted into the perimeter groove with a suitable sealant creating a waterproof bond between the wall slabs and the floor (and each other).

Many School pools were constructed in the 1970's using this method, so you might come across them occasionally. The biggest problem was keeping them waterproof as the sealant gradually aged and disintegrated. These pools typically had an outdated filtration system called 'rapid sand' which is a suitably sized chamber built conjoined to the outside pool wall, filled with varying grades of filter media - from coarse gravel to fine sand - into which the pool water was pumped at the top level with a connecting pipe at the bottom which joins into the main pool. The theory was that as the 'dirty' pool water percolated down through the media mixture, the water-bound particulates would be trapped in layers for later removal.

1.5 Another pool in this category is a 'box and pour' vibrated concrete pool with a variety of interior finishes whereby a hollow timber (150mm wide) structure forming the pool shape is erected onto a pre-poured steel reinforced floor slab incorporating vertical 'starters' of re-bar steel encases high density pumped concrete, so that when the timber 'boxing' is 'stripped (removed), a smooth concrete wall remains. Various interior finishes may be employed (as previously described). When done correctly, these pools should last as long as

the shotcrete pools.

All Concrete pools may not necessarily have a plaster-mix interior finish, although popular finishes using cement additives include colour tints and crushed quartz in various colours. Other interior finishes may include paint, fiberglass and vinyl liners.

1.6 Finally, a common 'concrete' pool type you may encounter is purpose-built galvanised-steel pool shell wall formers producing the desired pool shape.

These may be simple flat steel panels forming the pool, or more sophisticated hollow wall panels of galvanised steel incorporating insulation foam into which high density 25 mpa concrete is pumped, filling the tubular wall strengtheners which connect the floor with the coping receptors. Concrete is pumped into these receptors, walls and the pool center, with steel-float finishing forming an 80mm to 100mm plastered pool floor, creating the pool "Shell" which – under the correct conditions – may potentially last up to 50 years or more.

A close-fitting vinyl liner may be fitted – often by a vacuum forming operation. A Durable .77mm vinyl liner can last as long as 30+ years depending on the manufacturing brand and (as with all pool interiors) the appropriate treatment received from the pool owner. Other interior finishing – such as fiberglass or sprayed thermal-polymer may be encountered.

2. Fiberglass pools:

These are a Chlorinated Poly-Vinyl-Chloride Thermoset product: The descriptive name applies to the base product that forms part of the shell construction. The most common perception of a fibreglass pool is a 'one piece' moulded shell that is ready to drop into an excavation on the pool buyer's home site.

There have been many developments in the history of these pools, the current thoughts lean towards NPG gel coated pools (Neopentyl-Glycol Isophthalic resins embedding hollow glass 'fibers' or strands) and new 'fade free' guarantees. Some of these pools are manufactured in New Zealand, but the majority (as this is being written) is imported from West Australia and the Eastern coast states of Australia.
Despite being restricted to around 4.3m in width due to transportation issues, they are generally very popular because of three factors: (1.) They look good in the showroom or display center ("What you see is what you get"), (2.) They may generally cost less than a shotcrete sprayed pool, and (3.) they can be installed (in the pre-excavated hole) in one or two days – depending on your understanding of "installed". Life expectancy is generally 30+ years but varies with the manufacturer and UV resistance. Once they have reached their 'design life' the Council may require them to be removed, as refurbishment is a difficult option.

Other fiberglass pools: Another fairly major pool type originated in the mid 1970's and consisted originally of a formed wall structure (variously timber and "Hardiplank™" - formerly Fibrolite - and latterly concrete block and other media) a plastered concrete floor and an on-site application of blue-tinted resin-impregnated fiberglass matting.

Extreme care must be observed when emptying these pools as some were installed without stabilised backfill and the walls may be under undue stress – leading to internal collapse of the backfill into the pool interior. Due to the number of years these pools have been constructed in New Zealand, there may be many thousands of them still in service, so you are bound to encounter them from time to time. Due to the latest fiberglass sprayed interior construction method being employed, it is probable that the fiberglass interior may be re-sprayed, thus extending the life of the pool indefinitely.

3. Vinyl Pools:

Unlike the other Description names (above) this name describes the interior waterproofing membrane other than the shell structure (which can vary considerably). These liners are technically a Chlorinated Poly-Vinyl-Chloride Thermoflex product: The descriptive name applies to the interior finish (the primary waterproofing membrane) which for some reason has been adopted as the generic descriptive for this pool type whereas the other descriptive types apply to the primary construction method.

Vinyl Liner swimming - and splashing - pools are very common, due mainly to the low cost "kiddy" pools available in department stores, ranging to the use of Vinyl as a waterproofing agent for a concrete structure. Here are a few examples:

1. **Department Store Splashers** Usually imported from Asia with a low quality .20 - 30 mm vinyl liner, these pools make up many pools sold in New Zealand, mainly because they are very low cost, and can be erected in a few hours by the home handy-man. They are of little interest to this Course but are included here for your general information.

Generally these cheaper pools are termed 'Splasher' pools because you shouldn't swim, jump (or dive) into them. They are not expected to 'last forever'.

Some have simple liner-support frames, while other have a blow-up air pillow that surrounds the water area and creates a catchment area for the pool water. Because of their shallow depths (less than 400 mm) they do not require a pool fence.

These pools do not normally have any chlorination or filtration system, and when they reach their 'use by' date it is not economical to repair them, so they are generally discarded.

2. **Above-Ground Pools:** More substantial vinyl liner pools with .40 mm to .50 mm liners are the next step up the pool ladder, and usually physics of water containment require that they are formed from a circle or oval of wall material (painted steel, plastic) that is 1,200 mm high thus not needing a pool fence - provided the access ladder is removed when the pool is not in use.

These pools are somewhat permanent, and many see ten to fifteen years of family use without may major problems. The liners may be easily repaired on site or replaced by a similar gauge vinyl to extend the usability lifetime, although wall corrosion could be an issue with some brands. Usually equipped with a small cartridge or sand filer and a 500w pool pump the typical sterilisation method is a chlorination device known as a 'floating device'. These pools can be quite large - and deep - often as large as 3.6m x 9.0m or more

3. **In-ground Vinyl pools**: There are many thousand existing examples of one Auckland manufacturer's brand of the Vinyl Pool type which were introduced into New Zealand in the early 1970's and continue today as a FRESHWATER hybrid-concrete shell purpose-built to contain a .77mm vacuum-formed tightly fitting vinyl pool liner.

These predominately chlorine-free concrete pools have a shell life expectancy of fifty plus years and the vinyl interiors 25 years or more. The liners can be removed and replaced easily in a day with a similar replacement product for another 25 years of use by the owners.

A variation on the purpose-built in-ground vinyl pools may involve different wall systems – such as prefabricated concrete slabs forming the pool walls – but the basic process is the same: a pool shell forming a pool, which is then fitted with a vinyl liner.

4. You may find some 'Above Ground' vinyl liner pools that have been installed 'below ground'. As the wall structure of the AG pool is not designed to withstand the 'loading' of backfilled sand (or plain dirt) these pools may be at risk if ever emptied, so be cautious with emptying them for repair or otherwise or you might find yourself on the wrong end of a law suit for replacement of the pool. There have been a few other styles of above-ground vinyl liner pools adapted for in-ground installation from a few other manufacturers, but apart from only one or two manufacturers generally these offshoot vinyl pool companies have not remained in business for the long term.

5. One last type of vinyl liner pool is the nylon reinforced vinyl which has been very successful in School and other Public pools, whereby the pool shell is constructed in modular formed stainless-steel panels, a 100mm poured meshed concrete floor and a nylon-strand reinforced 1.2mm or 1.8mm vinyl interior which is heat-welded on-site in long runs of 1,400mm material.
This type of interior is very popular in Europe, but there are only a few in New Zealand, so it's appropriate that you are at least informed of them in this paper.

You now have a basic knowledge of the types of pools you are likely to encounter in your swimming pool career.

Let's move onto the Course now .....

REASONS AND PURPOSES FOR POOL TREATMENT

Our aim will be to gain the necessary knowledge to maintain and keep a pool sparkling clean and healthy, with a minimum of fuss and expense to the owner.

Contrary to popular belief, we will NOT need a Pilot's license, a Degree in Chemistry, or a gigabyte Computer to accomplish our aim, although as you happen to possess the last of these items it may be of some assistance. We will, however, assume nothing of your current level of knowledge, and will start from the beginning. Please excuse us if it seems a little basic at times, but there will be at least one reader who will benefit from us starting with the assumption that you know nothing! The vast array of new terminology etc., we have to learn will be covered more fully in the next PAPER. From there the Course will move on to Equipment, Chemistry, Maintenance, problems etc.

REASONS FOR POOL WATER TREATMENT

When swimming in pool water it should be safe and enjoyable, without any of the complaints we often hear about, such as, sore eyes, irritations to the skin, nose or throat and sore or bleeding toes from sandpaper like finishes – or premature deterioration of internal finishes and equipment due to incorrect – or no – correct maintenance procedures!. We must remember that pool water is like any other water, that if it is not treated it will soon become stagnant and or contaminated by such things as windblown dirt and leaves, pollutants from body discharges like seat and urine, hair, dirt carried into the pool on swimmers' feet and bodies etc.

If we do not treat bacteria in organisms in the pool water and then remove them by an efficient form of filtration, we will soon end up with a 'pea and ham coloured soup', which most people would consider to be injurious to your health, this could be because of viral diseases such as infectious Hepatitis, Mumps, Poliomyelitis and others which are known to be transmitted in water. There are also bacterial diseases like Typhoid, Dysentery, Gastro-enteritis, plus the organism that causes Cholera. Some of these organisms can remain alive

for up to one week in untreated water. To add to this list we can also be infected by parasites such as, the human roundworm and amoebic Dysentery, which can enter the human intestine through water.

We should also record the fact that several cases of drowning have been attributed to swimmers getting into difficulty, sinking to the bottom of a murky pool and then not being visible to the fellow swimmers. (Would you let *your kids* swim in a pool like that?).

The majority of the above organisms float at or near the surface of the pool water, where the body fats and oils accumulate, while the "heavies" like dirt, grass and leaves, sink to the bottom, where they then encourage the growth of slime and algae, which in turn are very slippery and therefore very hazardous. Anyone who has walked across ocean rocks at low tide will know what I mean.

To achieve our aim of safe and enjoyable swimming pool water, we need to destroy these "nasties", the organisms that are introduced to the water. We do this by oxidisation or disinfection, usually by adding chlorine in one form or another or introducing Ozone to the pool water. Although the use (or production) of chlorine is more widespread in residential swimming pools, Ozone is the most powerful Oxidant available, and has the ability to destroy algae and bacteria, inactive viruses and to oxidize many organics and inorganic contaminants which are present in the water. Ozone has a short half life in aqueous solution, but this Ozonised water can be recycled in Swimming Pools without fear of building high concentration of dissolved Chemicals.

There are some other not so popular ways, which will be covered later in the Chemistry part of this Course. Once the organisms are destroyed, the "last remains" and other solids, need to be removed from the water and this is done by passing the whole of the pool water through an approved form of filtration, by means of a recirculation system, run by a pool pump.

To start this process, enough oxidant must be introduced to the pool, to quickly and effectively kill the "nasties" which are present in the pool water, plus enough left over to kill any future additions of bacteria that might be introduced to the pool. It is necessary to ensure that ANY bacteria are eliminated BEFORE it can do any harm.

In our Chemistry Papers we will also cover the pH value (Acid/Alkali balance) of the pool water, so that the optimum kill rates may be achieved, whilst ensuring bather comfort, while ensuring the longevity of the pool surface and equipment.

You may think that this introduction is a little overdramatic, but it has been found in both University and NZ Health Department surveys that only 50% of pools chosen on a random basis for testing had a correct level of free available chlorine (FAC) in their pool. Only 25% had a correct pH balance and over 15% had no free chlorine present at all. Pool Builders can freely relate to this fact because of the large proportion of pool samples tested by them from "complaining customers" have had problems relating to 'insufficient oxidisers'.

It's hard to test pools for Ozone, and as far as I am aware the only commercial way is by iodometric titration and a photometer - and that's not available for pool users. There is no commercially available portable testing apparatus available, and the gas readily percolates out of the pool. As very small amounts of chlorine (.5ppm or so – often not enough to show up on the test strip or comparative color meter) must be used in conjunction with Ozone, the usual test for Pool Servicemen is visual – does the pool look "happy" and is there a visible "bubble stream" being produced? Residential pool Ozone generators are commonly "Fluorescent" types – the ozone being generated by a 30w fluorescent lamp past which the

pool water flows. Less commonly is the "Arcing" or "Corona Discharge" type generator that passes an electric current between two "electrodes" with a venturi in the water flow drawing air (O^2 oxygen) through the device. This latter type creates greater volumes of O^3 and due to the toxic nature of higher volumes the gas must be treated differently, so is not generally recommended for residential pools.

It must be remembered that swimming pool water should meet the same bacteriological and turbidity criteria as drinking water. Many of the pools tested showed substantial level of bacteria, (25 fecal coliform colonies or more per 100ml) which are far too high to be considered safe for drinking. It is these incorrectly maintained pools that are suspected of spreading many of the summertime "nasties" that we hear have from time to time.

So to summarise - remember there are three essential factors to be carried out correctly, if we are to keep the home pool free from bacteria, safe to swim in as well as clean and sparkling, and conducive to a long lasting interior surface.
These are:

1. Sterilisation,
2. pH control and
3. Filtration

- all of which will be covered in greater detail later.

WHAT ARE BACTERIA AND ALGAE?

You will probably know what Algae looks like. It is usually of microscopic size, which quickly spreads to become a slippery slime on the pool walls and steps, in some "worst case" scenarios becomes a floating mass near the surface of the pool, being a nuisance in many ways, causing staining and unsightly appearance to pool finishes.

Algae is a plant and is not harmful to humans, although we must remember that if there is Algae present in the pool water, it means there is not enough free Chlorine or oxidents present to kill it, and therefore there is not enough free Chlorine to kill the bacteria either. It could be that there is insufficient Chlorine or oxidents being added to the pool, or that the Chlorine or oxidents are not being distributed throughout the pool efficiently by the filtration system. Therefore, we must make sure there is sufficient oxidation of the whole pool to prevent any Algae developments.

The definition of algae is chlorophyll-containing plants, without true roots and without distinct leaves or stems and are a large and diverse group of eukaryotic (complex-celled) photosynthetic organisms. The green algae are primitive members of kingdom Plantae, though other types of algae are outside the kingdom entirely.

Land plants evolved from green algae about 500 million years ago. The algae are a paraphyletic group, meaning they did not descend from a common ancestor. Algal groups have independently evolved several times in life on Earth, representing a beneficial strategy adopted by parallel evolutionary paths. They enter a pool in a variety of ways although the spores are usually carried in by wind or rain. The spores thrive in hot and humid conditions (summer) and because of their rapid growth can cause damage to the pool lining and or clog up the filter if they are allowed to gain a foothold.
Algae can be very hard to remove once it is allowed to gain a foothold; particularly the thousands of them grow on top of each other and thus protect the ones underneath from most types of treatment. There are only a couple of algaecides that will completely kill these spots

without many attempts at vigorous brushing. More on this in the Chemistry section of the Course. Note! It is the thickness that makes this type of Algae appears black.

PREVENTION IS BETTER THAN CURE!!

Chlorine is a fine algaecide so if your Chlorine levels are maintained correctly you should never get Algae problems.

Bacteria are microscopic in size; being measured in microns (1 micron = 1/1000 millimeter) yet these organisms can reproduce themselves by splitting their cell into two identical cells. Each organism can do this on average every twenty minutes, so in one day, a single bacteria organism can produce 1,999 million living, identical copies of itself. No wonder we need to be sure of adequate disinfecting of the pool water to be sure of killing the "nasties", particularly if the pool is being heavily used.

THE FILTRATION SYSTEM

Now that we have disinfected our pool, we must follow up by removing the "last remains" of the bacteria and other solids like dirt and plant material from the pool water. This is where the filtering system is introduced.

The system consists of a "pool pump " (water pump and electric motor), which usually draws contaminated water from a skimmer box, and/or main drain, through a network of P.V.C. plumbing, pumps the contaminated water through a filter, which usually consists of a tank containing a medium of one of the following:

i) a Polyester and cotton cartridge, which is similar in appearance to a car's air filter
ii) a Bed consisting of .300m to .600m fine graded river sand or proprietary media
iii) a D.E. (Diatomaceous Earth pronounced Die-a–tom–a-shus Earth) septum, which uses a plastic framework to support a porous material onto which the diatomaceous earth can be deposited in a layer, that is capable of trapping the fine pollutants from the water. (To be covered in greater detail later.)

As the water leaves the filter it is returned to the pool via the P.V.C. plumbing to the outlets, which are adjustable by means of an eyeball fitting.

The number of skimmer boxes and return outlets are determined by factors such as size, shape, pump and filter size as well as the desired flow pattern.

THE SKIMMER BOX

The usual type skimmer box is designed to fit into the wall of the pool at the water level. It is usually placed at the end of the pool perpendicular to the prevailing wind or should be situated on the sidewall that the prevailing winds are most likely to blow the surface debris, as this will enhance the operation of the weir as it is skimming the surface of the pool. Where a main drain has been fitted, it can be hooked up to the skimmer box with a minimum of pipework.

Note: Main Drains can be hazardous and create an entrapment risk for swimmers – particularly girls with long hair. For this reason there are safety regulations relating to the use of main drains, which must be connected in tandem so that one – on its own – cannot channel the entire suction vacuum of the pool pump. For the same reason, multiple skimmers should

be connected in tandem, and any suction lines in the pool walls must be located a minimum of 1,2m apart and connected in tandem.

When the pump is operating, the floating weir (the flap) floats about 10mm below the surface of the pool water, thus making sure that the surface debris is removed before it has a chance to sink. We should note that if the wind were blowing in the opposite direction then there would be no chance to skim the surface debris properly. When the pump is not operating the weir will float slightly above the surface of the pool water and will prevent the caught debris from escaping back into the pool.

Inside the skimmer box and before the actual suction point, is a leaf basket which is designed to trap the larger debris that might be caught in the plumbing lines or the pump. The basket should also be situated below the entry point of the main drain line. Note: Some skimmers incorporate the main drain entry point into the basket. This is so that any debris that might be sucked in from the bottom of the pool will also get caught in the basket. One other skimmer type used in New Zealand (the Aquagenie) incorporates both the suction and return within the skimmer body, also including a moulded chamber which accepts a child-proof cartridge (designed to contain Quadrachlor Tabs) which is flooded by a takeoff tube from the the return water which then drips into the main skimmer body, thus adding chlorine to the pool water on the suction side.

Regardless of the skimmer type, to vacuum the pool, an especially designed plate, the vacuum plate, is fitted above the basket, blocking off the main drain line, enabling all the water to enter the suction line through vacuum hose, attached to the vacuum head, filled with water and placed under the surface of the water is then positioned into the vacuum plate. The suction end (Vacuum Brush) must not be brought above the pool water surface, or the pump will de-prime and suction will be lost.

To draw water from the main drain it is necessary to block off the vacuum hole and NOT the main drain line. This is so that the water can now only enter the skimmer box from the bottom of the pool. The purpose of this line is to allow for an easy drainage method of the pool. (It is NOT advised to empty ANY pool without recourse to the Pool Builder or the Pool Owner's Manual, as the risk of floatation is encountered. If still desired to empty the pool, it is essential that a well operating Hydrostatic Valve has been fitted and is fully operational BEFORE attempting to empty the pool. Catastrophic damage may occur – so be warned!) The main drain is very useful for sucking up loose debris when sweeping the pool, for use in conjunction with sweep type automatic cleaners, as an aid to good circulation of heated water and as an aid to mixing chemicals particularly acid which is heavier than water. Some skimmer boxes allow for a partial suction from both the main drain and the weir skimmer, which allows for a combination of the above purposes. It is suggested that the vacuum plate should not be left in the skimmer box in the vacuum position without the hose attached because when the water flow is reduced to the size of the hole in the vacuum plate there is likely to be a vortex created which in turn will allow air to enter the suction line damage to the pool pump is a possibility.

THE SUCTION LINE

The suction line in most privately owned swimming pools would be in 40mm or 50mm pressure P.V.C. pipe which carries the pool water from the bottom of the skimmer box, along the shortest possible route to the pump and filter. Wherever possible this line should be kept below water level to enable easy priming of the pump. Most self priming pumps are capable of handling up to a meter of air in the suction line but if there is more air than this it may be

necessary to install a check value back down the line from the pump at the approximate pool water level to enable the pump to be easily primed.

THE PUMP

All pool pumps should have a "hair and lint strainer" at the front to catch debris that might escape the skimmer leaf basket yet which might still cause a blockage of the pump impellor. The hair and lint strainer should have a clear lid to enable inspection of the strainer without having to remove the lid. If we remove the lid the strainer can be cleaned, and it is here that the pump should be primed. The ideal level for the pump is to be at the pool water level with the hair and lint strainer lid just above the water level so that it may be opened without having to shut off the water supply.

If the pump is below the pool water level then this is termed a flooded suction and if we are to open the lid without shutting off the water supply, water will flood out of the pump and lower the level of the pool to the level of the pump.
The obvious answer is to install shut-off valves to the plumbing lines, BUT be sure to open them again once the strainer lid is replaced! If the shut-off valves were to be left closed and the pump turned on the pump would starve for water and in a short time some damage would occur, and it would be *your fault!*

The pump should have a weatherproof cover and be positioned so that there is adequate drainage, preferably up off the ground, so that there is no possibility of the motor being flooded in a torrential type rain situation. Most motors are designed to be water resistant to showers of rain or water from the garden hose, but the pump motor manufacturers will not warranty a pump that has been submerged!

Similarly, a pump that has been allowed to "run dry" will overheat and distort the moulded plastic pump body, thus rendering it fit only for the rubbish! Ensure that neither of these situations can occur!

THE POOL FILTER

As the pool water circulates through the pump it is then forced under pressure of up to 1.0 to 1.5 bar through the filter media which may remove the contaminants down to a size as little as 2 microns (2/1,000 of a mm) in the case of diatomaceous (DE) or similar micro-media. Particles below 30 microns in size are not visible to the naked eye so all the three filters mentioned earlier will filter quite satisfactorily for a residential swimming pool. As a rough guide, sand filters will filter down to approximately 15 microns, cartridges down to 10 microns and DE down to 2 microns. Other media suppliers will be able to provide updated information on the filtration qualities of their products.

To clean the filters, we backwash in the case of DE and sand filters, which is done by reversing the flow of water through the filter which washes the dirt only in sand filters and the dirt along with the DE in DE filters. For this reason, DE Filters are not allowed in many places, as the contaminated DE constitutes a problem at Sewage Plants as the backwashed material is diverted to the nearest "gully trap" or waste water outlet (never the stormwater drain, as this is usually sent to the nearest ocean, and contaminated wastewater couyld be injurious to local sea life). When backwashing is completed the backwash valve must be returned to the filter position and in the case of DE filters a new layer of DE must be deposited onto the filter septum. Always switch the pool pump OFF when changing the Multi-Port Valve (MPV) or the effect of high speed water passing through can damage the unit (the "water hammer" effect)

To clean a cartridge, filter the polyester and cotton cartridge must be removed from the tank body and hosed down thoroughly to remove the dirt and debris.

RECIRCULATION AND TURNOVER OF POOL WATER

Home swimming pools in the 30,000 to 100,000 liters range that Pool Servicemen normally encounter are constructed by all kinds of "pool builders" – not necessarily professional Master Pool Builders or NZ Pool Industry Certified Builders - so there is little you can do if the "filtration system" provided by non-expert builders is inadequate, except "swap it out" for the correctly matched items.

Regardless of whether you are the "Pool Builder" or the "Pool Serviceman", ideally in summertime the recirculation system in a correctly sterilised (Chlorinated or Ozonated) pool should be able to recirculate the complete water volume three times per day, and four times if it is an Ozone pool. So … the choice of correctly sized pool pump, filter and sterilisation system is an essential consideration.

Regardless of whether chlorinated or ozonated residential pools - the filtration system should be operating for 12 hours per day during summer months and especially when the weather maintains continuous 28º Celsius sunny days.

Chlorine pools: In estimating "useful chlorine life" the reticulated water should travel the shortest possible distance from feeder to distribution in the pool and unfortunately - if we follow the above guideline, we will not get the most effective circulation required to keep the whole pool clean and algae free. Sunlight and wave action dissipate Chlorine at the pool surface (refer to "Cyanuric Acid" in Paper 2).

Sometimes there are dead spots in the pool due to poorly planned pool recirculation systems – and it is most important to have proper circulation to all corners of the pool. By retro-fitting either an effective distribution system for the retuning water, or the addition of an extra Pool return or two can counteract any dead spots. Should the plumbing system leave a lot to be desired then an automatic pool cleaner is one effective way to attain your circulation goal by removing algae or dirt from the dead spots.

It may become necessary to suggest to the Client the adding of and extra skimmer or extra return nozzles ("return eyeballs") to improve the circulation in dead spots, although chlorine is "hygroscopic" which means it readily absorbs water and travels quickly from the dosage point

This means that a sufficient dose of chlorine at one end of the pool will travel rapidly to all corners of the pool in an instant. Note I said "sufficient" as in a pool contaminated by nitrogenous matter, (i.e. skin flakes, urine, algae etc) the chlorine will readily be "sidetracked" on the way and used up.

If you are going to try tipping a bucket of warm, water mixed with a large cup of granular chlorine into the pool as an extra dose) so alternatively, simply increasing the daily chlorine dosage could resolve the issue (providing there are no side effects of adding a large quantity of what is in reality a Bleach into the pool.

However, to determine the correct turnover time required to filter the pool in swimming season, we need to calculate the volume of the pool and divide it by the average pump flow rate in liters per minute, times sixty.

$$\text{i.e. Turnover time (hours)} = \frac{\text{Pool volume in liters}}{\text{Average pump flow rate (L/min x 60)}}$$

e.g. The average home pool volume is approximately 40,000 liters, the average 750w (1 Horsepower) pump flow rate at 200 liters per minute (at 10 meters of Head i.e. Filter Pressure Gauge showing <1.0 Kp) is approximately therefore, to calculate the turnover time to filter this average pool, using your calculator we use the following formula

Enter the pool volume	40kl (40,000 L)
Divide volume by pump flow rate	/225 Lm
Divide answer by 60	/60 (Seconds in hour)
Time taken to filter full volume	2.96 hours per complete 40Kl

Three hours turnover times is considered satisfactory for light use in pre and post Summer but would not be satisfactory in high summer months if the pool was getting a regular heavy bathing load. It would then require a turnover time of not less than 12 hours running - or (in this example) would require a larger 1.5 Kw pump and filter capable of averaging a flow rate of approximately 300 L/min running for 8 hours per summer day.

It must be remembered that the pump flow rate can ONLY match the filtration recommended flow rate. If we were to try to pump too much water through too small a filter unit, the filter backpressure would rise drastically, and the filter flow rates would drop just as drastically.

We will be covering how to calculate the volume of a pool in the next PAPER and the pump flow rates should be obtainable from either the compliance plate on the motor or from a manufacturer's specification brochure, which should be readily available.

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