CGT TECHNICAL

VINYL POOL TECHNICAL MANUAL

Poolside by CGT

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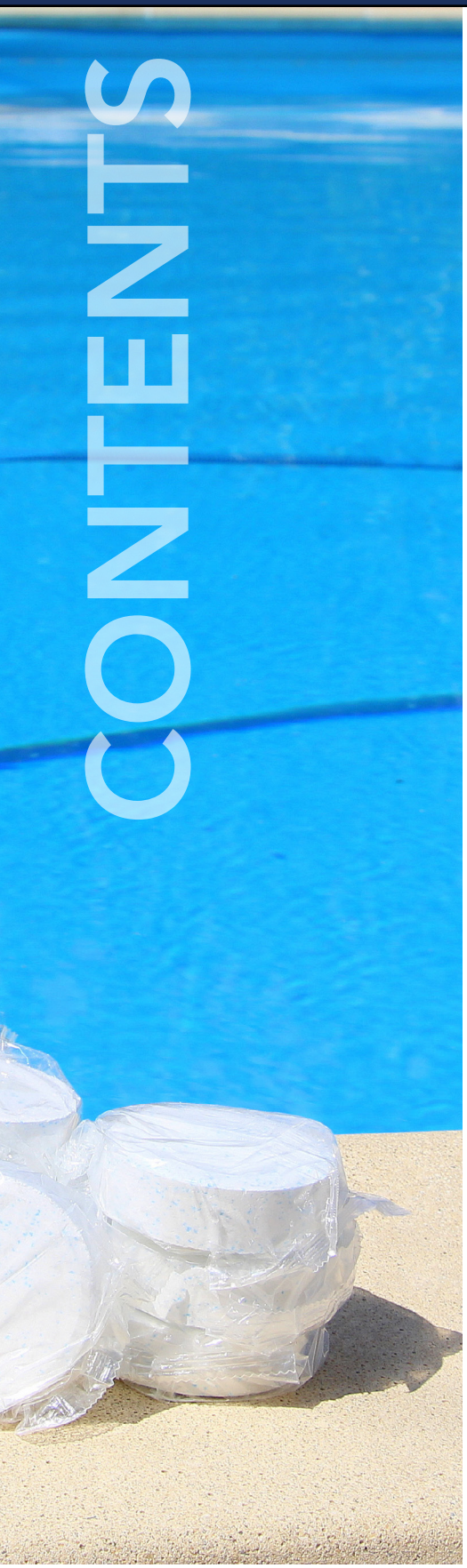

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Weatherability of Over-stretching a Vinyl Liner

There are many references in the technical literature concerning the adverse effects of mechanical stress on the acceleration of weathering degrading of various types of plastics. Unfortunately, vinyl swimming pool liners are also vulnerable to this phenomenon. There is general awareness in the industry that excess stretch in an installed liner can result in premature failure and most liner fabricators have been successful in reducing the built-in stress of their liners to a minimum. Curvatures of corners have been increased and computer technology has enabled more accurate design of liner dimensions for pools of all shapes and sizes.

The steady improvement of quality and increase in design sophistication of vinyl liners has reduced the incidents of failure to a low percentage. However, when failures are reported and samples are available for examination, there is invariably evidence of excess stretch from the area just below the beading down to the waterline.

The degree of stretch varies around the perimeter of the pool and tends to correlate with the severity of weathering degradation. In some cases, measurements of thickness indicate a loss of gauge from 20.0 Mil to a range of 15.0 - 17.0 Mil and from 28.0 Mil to a range of 20.5 - 25.0 Mil. The thickness near the bottom of the wall is usually closer to normal.

Investigation of several liners that have failed prematurely indicate that a shortfall in the perimeter of 3 ft. or more is possible. Experimental tests simulating the stretch in the perimeter, as well as the consensus of experts in the industry, however, indicate that a 3.0 - 4.0% shortfall of the perimeter alone cannot account for the extremely high gauge reduction in the area below the beading. Downward stretch to fill a larger pool cavity must also be involved.

Why are perimeters and/or other dimensions of a small fraction of liners out of tolerance? Are measurements for custom replacement liners always taken correctly? Improving the accuracy of all critical dimensions could prove to be an effective way of preventing some premature failures.

Wrinkling and Water Absorption

Research by both chemical suppliers and vinyl manufacturers have confirmed that wrinkles in swimming pool liners develop due to the growth of the vinyl through water absorption. Technical articles published in the past have stressed the adverse effect of low pH as the main cause of liner growth. However, recent experiments have shown that high levels of sanitizer level are allowed to remain high (up to five times higher) a normal amount of water can be absorbed. Therefore, controlling sanitizer levels is the number one priority when maintaining proper water chemistry - to avoid wrinkling issues.

Cyanuric acid stabilizer levels and pH are important secondary factors because they control the activity of the sanitizer. However, once wrinkles have developed, correction of pH or stabilizer content will not reverse the amount of water absorbed into the liner. In some cases, draining the pool and allowing the water to slowly desorb and evaporate has reduced or eliminated wrinkles. This procedure is not without risk because some liners, depending on age, may over-shrink and not stretch back into place without failing. It has also been shown that when the surface of the liner has been affected by the sanitizer, water can rapidly reabsorb, and the wrinkles may quickly reappear. Pool water clarity is often reduced by undissolved particulate matter introduced by bather load. Often, these particles can be flocculated using a clarifier and removed by filtration. The filtration system must be operated at its optimal level since sanitizer alone cannot eliminate excessive particulate matter present in the pool, and the overuse of chlorine or bromine to improve clarity will increase the probability of wrinkle development.

Experimental Results

1. Samples taken from heavily wrinkled liners, preserved in pool water, surface dried, weighed, then desiccated to constant weight, indicate that absorbed water can reach as high as 10% of liner weight.
2. Immersion testing of precisely weighted liner samples in pure distilled water and sanitizer free tap water showed that weight gain due to absorbed water levelled off at 0.6%. No dimensional changes occurred.
3. Immersion testing of precisely weighted liner samples in chlorinated and brominated water in the 20 to 50 ppm range showed weight gains that continued to climb indefinitely and did not level off. The dimensions increase by 1.0 - 3.0% were also measured on these samples
4. Immersion testing in water containing mono-potassium persulphate type non-chlorine shock showed weight gains levelling off at approximately 0.6%, essentially identical to unsanitized tap water.
5. Samples from heavily bleached, used pool liners showed high weight gains in immersion tests in comparison to un-bleached samples, taken from the same liner from above the waterline. Bleached test samples curled into tight coils with the bleached surface facing the outside because of greater water absorption occurring on the faded side than on the un-faded surface.

Recommendations

1. Maintain pH levels in the 7.2 - 7.8 range.
2. Do not allow free chlorine levels to exceed a maximum of 3 ppm, bromine levels a maximum of 4 ppm for long periods. Peak chlorine levels of 5-10 ppm are required for superchlorination but should be allowed return to the 2-3 ppm range by natural dissipation. If bleaching of the blue liner colour is occurring, it is a direct indication that the chlorine levels have been too high.
3. Routinely stabilize outdoor and indoor chlorinated swimming pools with cyanuric acid stabilizer and maintain a minimum level of 50 ppm. It is recommended that levels be checked every 3-4 weeks.
4. Test result accuracy can be adversely affected by poor quality test kits and reagents. Keep reagents current by replacing them every 6 months and use a professional quality test kit recommended by your pool dealer.
5. Use non-chlorine shock to reduce organic contaminants, rather than high levels of chlorine or bromine during the pool season, as well as preparing the pool for winter.
6. Use flocculants and a filtration system in proper operational condition to remove undissolved particulate matter instead of high levels of chlorine/bromine oxidizer, to attain sparkling clear pool water.

It is important to maintain thorough circulation of the pool water to prevent settling and concentration build-up of chemicals on the pool bottom. Even liquid chlorine can settle to the bottom if sufficient inter-mixing is not achieved.

7. Frequent reports have been received concerning wrinkle development on walls of pools employing automatic pool covers. The phenomenon is most likely a result of chlorine concentration build up due to the airtight nature of the cover design and/or temperature differentials between waterside and ground-side of liner causing accumulation of moisture from condensation that forms ripples.

Note: Vinyl Spa Liners

The material formulations for vinyl spa and pool liners are very similar; therefore, the above information relating to the sanitizer induced water absorption that results in wrinkling is also valid and applicable to spa liners, keeping in mind some differences in chemical treatment practices.

Wrinkle Development in Unreinforced Liner

A great majority of the incidents of wrinkling that have been reported to us have occurred in commercial or semi-commercial installations which are, often,`a indoor pools.
These pools carry a high bather load and as a result operators apply chlorine or bromine sanitizers at high levels as insurance against sanitation problems in response to health department requirements. Severe bleaching of the liner is evident with chlorinated pools, confirming high chlorine concentration over long periods.

The root cause of wrinkle development has proven to be excessive chlorine or bromine levels, causing ongoing absorption of water and dimensional growth of liners.

Recommendations

Do not supply non-reinforced vinyl pool liners for commercial applications as operation of these pools at or below the maximum recommended sanitizer levels does not appear to be feasible.
The best material for commercial installations is reinforced 3-ply PVC pool liner sheeting.
The scrim reinforcement provides exceptional dimensional stability, preventing the possibility of wrinkle formations.
The situation with indoor residential pools is less clear. Cases of wrinkling have been reported, but not to the same extent as commercial pools; factors that can present problems here are the lack of stabilization with cyanuric acid and high bromine levels which present very little, if any, odour, and no bleaching. Bromine will also erode total alkalinity levels, resulting in greater pH swings. Before discontinuing the supply of regular liners for indoor residential pools, a survey of past installations is recommended to determine the extent of the problem.

Formation of Wrinkles with Installed liners

Wrinkles will develop if an installed vinyl liner is slightly oversized. However, the purpose of this bulletin is to discuss wrinkling that may occur in a properly sized liner.

Laboratory Testing

A laboratory testing program to study the effect of pH and cyanuric acid stabilizer levels on vinyl swimming pool liner materials was conducted by Union Carbide Corporation and FMC Corporation in 1969. The results of their experiments have been verified by other labs.

The most significant conclusions of the above study

1. Low pH is the major cause of dimensional instability resulting in wrinkling. Test samples immersed in 6.0 pH solutions showed weight gains much higher than samples immersed in 8.0 pH solutions. Dimensions of the samples also increased in proportion to weight gains.
2. Acidic chlorinating chemicals such as trichloroisocyanurates tend to lower pH unless using counteracted by neutralizing agents. Therefore, monitoring of pH is more critical than acidic sanitizers.
3. Cyanuric acid stabilizer levels of 50 ppm were shown to reduce the magnitudes of weight and dimensional increases at both 6.0 and 8.0 pH. Therefore, cyanuric acid stabilizer appears to have the ability to provide some insurance against the detrimental affect of the unanticipated pH fluctuation.

Incidents of wrinkling that have been reported to us, have almost always occurred in situations where cyanuric acid usage was deemed to be unnecessary, such as indoor/brominated pools. Therefore, it is recommended that all vinyl lined pools be routinely stabilized with cyanuric acid, including indoor pools.

Cracking

Pressure Cracking During Storage

The major type of deterioration that we are aware of during storage of vinyl liners is the development of “pressure cracks” under certain conditions. More recent investigation of this phenomenon has revealed that it is a two-phase process.

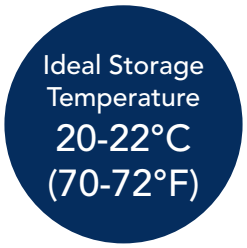
Phase I

During Phase I, a heavy crease develops on the inside of a double or triple fold
The factors that affect the crease formation adversely are:

1. High temperature during storage yields softer vinyl causing a greater amount of material displacement in the crease areas
2. Higher pressures cause greater weight on the fold
3. Time of fold being under pressure causes deeper creases

Phase II

Phase II is by far the more critical part of the process and involves the unfolding of the liner and flattening of the creased areas at moderately lower temperature of 3-10°C (38-50°F).
If the liner is not allowed to completely warm up to 20-22°C (70-72°F), the deformed inner loop of the crease, which has become shorter due to creep and is stiffer because of the lower temperature, cannot withstand the excess tension caused by the unfolding action, splits open, transforming the crease into a crack. If, however, the liner returns to room temperature, flexibility increases, minimizing the tension on the inner loop and greatly reducing the probability of splits developing.



Recommendations for Minimizing Formation of “Pressure Cracks”

1. Do not unfold liners at temperatures below 20°C (70°F), in the plant or prior to installation of the liner at the pool site. This is especially critical during installation in the fall, when morning as well as daytime temperature can be well below 22°C (72°F)
2. Do not store a boxed liner outside or in an unheated storage area prior to installation at the pool site during the cooler spring or fall season. The liner may not necessarily warm up sufficiently in a span of a few hours in the morning due to insulation provided by the outer layers of the liner
3. Minimize the length of time finished liners are stored in cartons
4. Ideal storage temperature is 20-22°C (70-72°F)
5. Minimize or eliminate stacking of cartons to reduce pressure
6. Keep the number of folds in the liner to a minimum
7. Use larger cartons for large liners; cartons that resist collapsing under pressure will afford more protection to the liner

Cold Crack Properties

CGT in-ground swimming pool vinyl has been formulated to meet a cold crack rating of -35°F according to test method ASTM D1790. The temperature determined by the above test method is the lowest temperature at which at least 50% of the samples folded into a loop and subjected to sever impact, do not crack into two separate pieces.

This method can be thought of as a yardstick which can be used to compare the inherent cold crack resistance of different materials under the same conditions of impact. Vinyl materials with a cold crack rating of 4°C (40°F) (i.e., possessing virtually no inherent cold crack resistance) can be subjected to temperatures as low as 40°C (-40°F) and -46°C (-50°F) and remain free of cracks or breaks, as long as they remain immobile. Therefore, it is apparent that the severity of impact or flexing is the most important factor that results in failure of vinyl materials at low temperatures. Liners that are installed in a pool are held immobile by the beading and the water pressure. Incidents of failure due to cold crack are extremely rare since it is not possible for the liner to flex. Damage caused by ice is rupture due to high pressure rather than low temperature failure. On the other hand, liners moved around warehouses, shipped on unheated transport trucks, or allowed to drop during unloading may occasionally crack if the combined effect of low temperatures and impact is severe enough.

Recommendations

1. If possible, avoid shipping liners when temperatures are likely to fall below -23°C (-10°F).
2. Secure the cartons or drums containing the liner so that they are not able to bounce or shift when being transported over rough roads.
3. Do not store liners in containers outdoors.
4. Handle liners with care in cold weather. Do not allow containers to drop or be hit by any moving object

Staining

Black Staining of Vinyl Pool Liners

Black staining that appears on vinyl pool liners can originate from several sources, primarily falling into three categories: metal staining, black algae, and effects of “pool tar”. Depending on the type of the staining, different treatments are required to correct the problem. This bulletin focuses on stains resulting from metals and black algae as the `pool tar` issue.

Metal Staining

Copper, Iron and Manganese will oxides in chlorinated pool water and can precipitate out of solution resulting in stains on the pool liner. These stains are generally black, brown, or grey in colour. The metals may be introduced into the pool via the water source used to fill the pool. Copper can also dissolve from copper or brass fittings in the plumbing when pool water pH conditions of less than 7 occur. It may be present in some algaecides, although most now use copper in a chelated or complex form that remains in solution. The presence of metal staining can be confirmed by treating a small portion of the stained area with a pH reducer to dissolve the metals. If the stain can be removed by this treatment, the staining is a result of metal deposits, and the remainder of the stains can be treated in a similar manner. If not, the stain is likely due to an organic source such as black algae (see below). If the staining is due to metals, the pool water may need to be treated with a metal treatment (referred to as sequestering or chelating agents) once the staining has been removed, to prevent a re-occurrence.

Black Algae

Black algae appear as a series of small black spots on the pool liner. They are very tenacious organisms with a chlorine resistant coating that requires several steps to remove: The algae spots must first be brushed (using a nylon brush) to open up the algae coating. Test the pH of the water and reduce it to the lower limit of the normal operating range (pH=7.2) to improve the effectiveness of the chlorine. Then, super-chlorinate the pool (normally to 10 ppm free available chlorine) and add a dose of a quaternary (quat) type algaecide. The quaternary algaecide will wet the algae’s coating to improve the penetration of chemicals. Make sure to follow the recommended dosage of quat algaecide from the manufacturer as excessive usage may result in foaming. Continue to brush the algae stains to maximize the penetration of the chemicals. Vacuum the dead algae to the drain once they have been killed, as they will now have been liberated from the vinyl liner. Twenty-four hours after super-chlorination, add a dose of a polymer algaecide (polyquat) as per the manufacturer’s recommendations. Polyquats are more expensive than regular quaternary algaecides but are more effective in controlling these resistant types of algae. Once the staining has been removed, resume

normal chlorination and water balance. Remember, the best protection against algae growth is a constantly held free chlorine level in the range of 1-3 ppm.

Another type of grey/black coloured stain can occur because of micro-organism activity on the back side of the liner. These micro-organisms can produce dyes that are soluble in the plasticizers used to make the vinyl liner pliable. The microbial dye becomes visible on the pool side of the liner as it wicks through the liner creating an unsightly, irregular shaped blotch. The stains can be diminished on the pool side through super chlorination, for a period, but will re-appear since the source of the stain originates from the back side of the liner. Low lying areas or those with high water tables may be more likely to contain these micro-organisms. Installation of a polyethylene barrier between the walls and Floor of the pool, and the vinyl liner, may provide a barrier to staining resulting from these types of organisms.

Pool Goo

The consensus in the pool industry is that there are several sources of sticky substances, often referred to as ‘pool goo’ or ‘pool tar’ that adhere and coat portions of the vinyl pool liner.

Source of Issue:

1. Algaecide-humate or Quat-humate formed from the interaction of quaternary ammonium compound in some algaecides and decaying organic material such as leaves, grass, insects, etc.
2. Interaction of quat algaecides with other substances. Even chlorine (Cl-) can interact with quats and form sticky material if both chlorine and algaecide exceed the recommended dosage levels. Quats can easily meet high chlorine levels in automatic chlorinators, resulting in a gummy material gradually being fed into the pool, where it’ll eventually precipitate on the liner. Many quat containers are labelled with cautionary notes warning against mixing with pool water while having high chlorine concentrations.
3. Chlorinator goo can form when organic material from cosmetics, tanning lotions, etc. are oxidized by high chlorine concentrations resulting in a beige, waxy material.
4. A light coating of vinyl plasticizer may exude to the surface of newly installed liners during the first idle period of winterization. This material is clear and only turns dark if contaminated with dirt. It is attributed to lack of circulation, since it has never been observed in a pool that has been circulated over the winter. It will almost always re-absorb in two or three weeks if the water is allowed to warm up and is circulated and shocked with chlorine every couple of days. The problem is not known to occur more than once in the life of a liner and always the first time the pool is re-opened after winterization.
5. Pool scum is a ring that forms around the pool at the water line and is made of soil contaminants from suntan lotion, environmental pollution, and organic materials from bather load, etc.

How to Eliminate ‘Pool Goo’:

The following procedure has been recommended by experts in the pool industry as being effective in eliminating ‘pool goo’ or ‘pool tar’ problems:

1. Reduce and maintain pH at 7.0 - 7.2
2. Superchlorinate every other day to 6.0 - 8.0 ppm
3. Stop using quaternary algaecides
4. Use heater to speed up warming of water (if available)

5. Continue to circulate water and monitor pressure of filter
6. Backwash filter as often as required

The attached technical information bulletin issued by BioLab Inc. and reprinted with the permission of BioLab discusses the plasticizer exudation phenomenon in greater detail. I feel that it will be very useful in promoting greater understanding of this problem.

Pink Staining of Vinyl Pool Liners

It is very likely that pink blotches, which can appear on liners of all colors (including white), are caused by an indelible pink dye that is excreted by bacterial micro-organisms. Because the dye is highly soluble in the plasticizers used in flexible PVC pool liners, it can easily migrate through the entire thickness of the liner.

The portion of the dye that is exposed on the surface can be bleached by chlorine; however, new dye will migrate to the surface and will appear as though the chlorine is having little or no affect. The bacterial micro-organisms can become established on either the water side or the back side of the liner. Growth on the water side may occur if free chlorine levels are allowed to drift below 1.5 ppm while organic matter and bacteria have accumulated in the water. Superchlorination at this stage will rid the pool water of the contamination, but if the dye happened to penetrate below the surface, the staining tends to linger indefinitely.

Growth on the back side may not take place directly on the liner, but rather on some other material in contact with the liner such as soil or a backing material like Styrofoam, felts, or taping. Even though an anti-microbial agent is incorporated into the vinyl formulation, the dye can migrate from unprotected components and stain areas well beyond the point of infestation. If there is a lot of pink dye visible on the back side or any backing material, it will certainly be the source of the problem. If the liner is replaced, all contaminated materials must be removed, and the entire pool shell (floor/walls) must be disinfected with a liquid chlorine spray or other the applicable disinfectant. Special problems are presented by locations that have high water tables of which continually bring water loaded with micro-organisms to the back side of the liner. Using disinfectants at these sites may be ineffective since they will be quickly washed away. A possible defence may be some type of barrier layer; either a plastic sheet, perhaps polyethylene between the pool shell and liner or a barrier coating of some kind applied directly to the pool shell.

Use of Automatic Pool Covers with Vinyl Lined Pools

Pool covers serve to help reduce operating costs by retaining heat in the pool water, and minimizing water loss due to evaporation, chemical use, and debris from getting into the pool. Several types of pool cover exist such as solar, thermal, automated, and winter covers which have various advantages and disadvantages. This article will focus on the impact of automatic pool covers on vinyl lined pools.

Automatic pool covers as the name implies offer an easy method to open and close the cover at the push of a button. They are typically made of interlocking slats which can be easily reeled and unreeled to uncover and cover the pool and provide a close fit to the perimeter of the pool. One of their advantages is that they keep a large amount of the debris out of the pool water, however there are some negative impacts that are worthy of note.

Due to the relatively tight-fitting nature of automatic pool covers they can allow for a buildup of heat and chlorine in the head space above the pool water and below the underside of the cover. This area of high temperature and high chlorine can lead to increased water absorption into a vinyl pool liner. A high level of water absorption can cause liner wrinkling and discoloration in the same way that it can occur when an excessive level of free chlorine is maintained in the pool water thereby shortening the life of the liner. In fact, the wrinkling and discoloration can occur at a faster rate in the area between the water surface and cover due to the elevated exposure conditions.

It is important that automatic covers be vented or periodically opened to minimize the heat buildup and increased free chlorine conditions. Without taking these steps wrinkling and discoloration of the vinyl pool liner are likely to occur.

Impact of Salt-Water Chlorine Generators on Vinyl Pool Liners

The use of salt-water chlorine generators to supply free chlorine to pool water for sanitization has increased significantly in recent years. Although these units provide more consistent dosing of chlorine to pool water than manual dosing there are several factors to consider so that their use does not lead to abuse and cause exposure of the liner material to excessive levels of free chlorine. Many homeowners who have been sold salt-water chlorine generators do not realize that their system is indeed a chlorine generator and not simply the use of salt to sanitize their pool. As such many are sold on the idea of “set it and forget it” as an easy and time saving method to treat the pool water. The first thing to remember with the use of these systems is that the requirement for diligence in testing and balancing pool water to maintain parameters within the recommended ranges is as important as it is with manual chemical additions.

To maintain a vinyl pool liner and maximize its service life CGT recommends controlling the water chemistry parameters within the following ranges:

1. Total Alkalinity: 80 – 120 ppm
2. pH: 7.2 – 7.6
3. Calcium Hardness: 200 - 300 ppm
4. Free Chlorine: 1 – 3 ppm
5. Cyanuric Acid Stabilizer: 25 – 50 ppm

Exposure of the vinyl liner material to the water chemistry parameters outside of the recommended ranges can result in a variety of negative effects. Some of these include liner wrinkling, liner color loss/staining and stiffening of the liner material which can lead to premature tearing and failure of the liner to hold water. All these result in a shortened service life for the liner.

Should you have any questions about your pool, call your dealer – they are your pool professionals.

Poolside by CGT
Canadian General Tower Ltd.
52 Middleton Street
Cambridge, ON, Canada
N1R 5T6

poolsidebycgt.com
technical@cgtower.com

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