PWTAG
Code of Practice for Swimming Pool Water – 2016

Updated to reflect the requirements of
Managing Health and Safety in Swimming Pools (HSG179)

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FOREWORD

This Code of Practice (CoP) has been prepared and published by the Pool Water Treatment Advisory Group (PWTAG), which retains its ownership and copyright. The CoP is based substantially on the book *Swimming Pool Water: treatment and quality standards for pools and spas* (PWTAG 201X), as updated by technical notes available from www.pwtag.org.uk.

This latest edition now incorporates the pool water treatment system requirements featured in the HSE document *Managing Health and Safety in Swimming Pools* (HSG179). These have also been integrated into this Code of Practice.

This CoP provides a practical summary of the recommendations and guidelines in the book, but also specific practices which pool operators can follow and against which their operation can be evaluated. It does not replace the book, which contains further practical detail and clarification.

1. SCOPE

This CoP contains general operational and safety recommendations for the management of swimming pool water treatment systems and associated water treatment plant, heating and ventilation systems. The CoP sets out how the technical operation of the pool should function for a safe and successful swimming pool water.

1.1) Why a code of practice?

The purpose of this CoP is to provide pool managers and operators with the fundamental principles of good practice in swimming pool water technical operation. Following it, pool staff should be able to provide a safe, enjoyable swimming experience for users as well as a safe operation for workers.

1.2) The main risk in swimming pool water treatment are health issues

- Water quality
- Chemical risks
- Physical risks (e.g. drowning, slips and trips, entrapment)
- Infection (e.g. *Cryptosporidium, Legionella*, *Pseudomonas aeruginosa*)

1.3) Potential risk to the individual

- Personal illness or death
- Long-term effects of illness
- Loss of employment, income, or educational opportunities
- Impoverished experience
- Increased costs
- Passing disease on to relations and friends and other swimmers

1.4) Potential risk to your organisation

- Damage to reputation
- Loss of income if visitors don't come because they perceive that the risk of harm is too great
- Civil claims arising from visitor illness, leading to financial loss
- Prosecution and penalties for breaches of criminal law
- Impact on the morale and esteem of employees

1.5) Good practice

This CoP focuses on good practice, based principally on published guidance from PWTAG, guidance to the industry from PWTAG that has been developed over many years. It also includes material from the Health and Safety Executive, Public Health England, Public Health Wales, Health Protection Scotland, the World Health Organisation and BS EN standards.

1.6) Standards of design and equipment

This CoP assumes that a pool is designed in accordance with the guidelines detailed in *Swimming Pool Water*. Where pools have inappropriate design or inadequate specification, then providing a safe, quality swimming pool water will present a challenge, which ideally should be addressed prior to defining operational practices.

1.7) Types of pool covered by the code of practice:

This CoP covers swimming pools as defined in British and European standards:
1.4.1 Swimming pool type 1 – pools where the water-related activities are the main business (e.g. communal pools, leisure pools, water parks, aqua parks) and whose use is public
1.4.2 Swimming pool type 2 – pools which are additional services to the main business (e.g. school, hotel, camping, club, therapeutic) and whose use is public.

1.8) Types of pool not covered by the code of practice:

- Spa pools (covered by HSE guidance HSG274 part 4)
- Natural (green) bathing pools
- Interactive water features
- Paddling pools
- Domestic pools

However, many of the principles contained within the CoP can also be successfully applied in these types of premises. And they are specifically dealt with in *Swimming Pool Water*.

2. MANAGEMENT REQUIREMENTS

The pool operator has a general duty to set out a safety policy for the operation of the pool in its environment.

2.1) PSOP - Pool safety operational procedures

The recognised way to define a pool's safety policy is to establish and maintain pool safety operational procedures (PSOP). There should be two sections – normal operational plans (NOP) and emergency action plans (EAP). The PSOP should include management's assessment of hazards associated with all aspects of the pool – physical, risk of infections and supervisory – as well as a section on the technical operation of the pool, which features swimming pool water quality.

2.2) Pool technical operation procedures (PTOP)

This CoP requires pool management to define and document its policy and procedures for the general operation of the pool water treatment. This is called the pool technical operation procedures (PTOP). The PTOP forms a part of the risk assessment process for the whole pool facility and the subsequent formulation of pool safety operational procedures (PSOP). It should take the form of a stand-alone document detailing a swimming pool's technical operation, which is part of the PSOP.

The pool PTOP will be based on PWTAG published guidance, but more particularly the requirements of the suppliers, manufacturers and installers of plant and equipment. It will set out how the plant should function and be operated safely. Just as significantly, the PTOP for a pool will incorporate operational considerations that provide a healthy, enjoyable, satisfying and safe experience for users. The PTOP may use this CoP for its structure, supplemented or amended where appropriate to the individual circumstances of a pool.

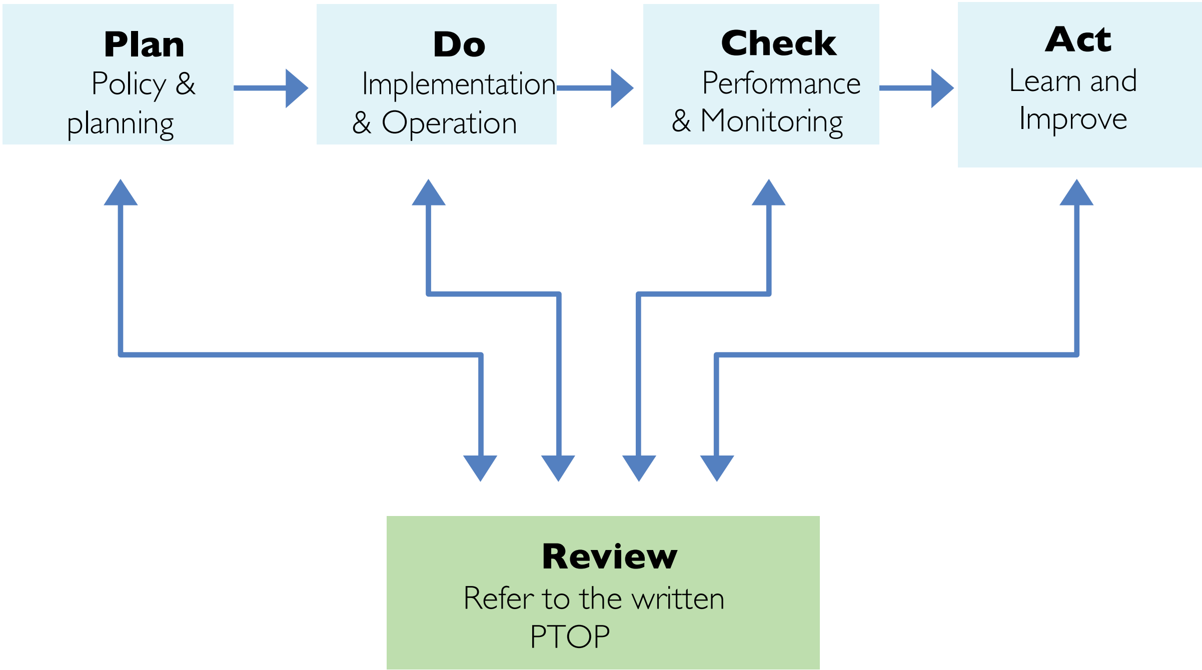
2.3) Planning and organising

Preparing a PTOP demands planning the approach to pool water, ensuring that it integrates with other management activities.

2.4) Elements of an organisation's PTOP

Whatever the size of organisation and resources available, the first step is to establish a policy for water quality, safety, and hygiene and to have a strategy for its implementation. There should be clear objectives and a good management plan to achieve them. Learning from experience is important. You should review the outcomes and if necessary make changes to improve things.

Preparing a PTOP is no different to other management processes that demand a systematic approach, as shown in the diagram below.



2.5) Policy and planning

Developing a policy for water quality management and promoting a plan for its achievement will ensure effective use of the organisation's resources as well as ensuring bather safety.

An effective policy will:

- Demonstrate the commitment of senior management to the quality and safety of pool water
- Integrate the quality and safety of pool water management with other relevant organisational policies and management activities throughout the organisation.

An effective strategy will:

- Clearly set out how the organisation is structured to deal with the quality and safety of pool water issues
- Show how that organisation might usefully change, and set out the steps to get there
- Identify the resources, in money and staff time, necessary to achieve the objectives.

2.6) Planning and organising

Develop plans for the management of the quality and safety of pool water at levels appropriate to the size and structure of the organisation. A large enterprise attracting hundreds of thousands of bather each year would need a detailed PTOP. For a small pool open on a limited basis a much more basic document covering essentials would be sufficient. This code of practice contains the information necessary for producing such a document.

2.7) Implementation and operation

The key to implementation and operation is defining clear roles and maintaining the awareness of those involved.

Define clear roles - State who is responsible for carrying out each task identified in the PTOP.

Awareness - Pool management should establish and maintain procedures in the PTOP to make staff and others involved aware of the importance of their roles and responsibilities in complying with the pool procedures, and with the requirements of the PTOP.

Performance monitoring - There should be a programme of inspection and clear records kept of the findings and actions. It helps to follow a written programme of priorities, keeping a record of what has been done, when, where and by whom, then listing work planned for the future. Management will then be able to demonstrate progress and ensure that the investigation and resolution of any outstanding issues is included in a work programme.

Learn from incidents and near misses - Incident and accident data are valuable indicators of risk and provide a measure of performance. Near misses should not be ignored; rather, staff should be encouraged to report them and treat them as an opportunity to learn from something that did not quite happen, this time.

2.8) Monitoring, analysis and improvement

As a minimum, pool management should monitor the safe and effective performance of their pool operation through the following:

- Plant and treatment systems logs
- Pool water testing
- Bacteriological monitoring and interpretation
- Feedback from regulatory authorities and users of the pool
- Actions taken or required to ensure compliance with operational plans and procedures
- Any corrective and preventive actions
- Responding to incidents and other emergencies
- Pursuit of the PWTAG Poolmark award and/or any other industry recognised awards.
- Staff training

2.9) Learning and improvement

Management should learn from the information gathered, in order to make improvements. Routine work should incorporate mechanisms that allow feedback to be used to improve services and safety, and to explain why no changes are being made.

2.10) Review against the written PTOP

Review is a key part of a management process. Decisions made as part of the monitoring, learning and improving processes should be checked at each stage to ensure they are consistent with guiding principles. Progress should be measured against plans, to identify problems and instigate any necessary corrective actions.

The water treatment system and the pool hall ventilation and heating should both be formally reviewed at planned intervals (at least annually) to ensure their continuing suitability and effectiveness. Ideally this should be prior to or during annual maintenance.

Input to the review should include assessing opportunities for improvement and the need for changes to the water treatment system, including the policy. Inputs to the management reviews should include:

- Feedback from bathers or other users of the pool, suppliers, regulators and other external parties on the performance of the water treatment system
- Action taken to restore or to improve water quality
- Incidents or emergencies impacting upon water quality
- Follow-up actions from previous management reviews
- External and environmental changes that could affect the water treatment system, including changes in pool plant or chemicals
- Changes in regulations or national standards including this CoP and relevant BS EN standards.

2.11) What pools – what staff?

All pools should have some form of staffed presence responsible for their technical operation and supervision. The type of cover depends on the type and use of pool. Both swimming pools types 1 and 2 (see 1.8) will need a swimming pool technical operator (SPTO) if they:

- Have more than 120m^2 of water area
- Have more than 120m^3 of water volume
- Have a throughput of an average of more than 200 bathers daily
- Are hydrotherapy pools, specifically designed or a pool that is used for hydrotherapy
- Are used to provide swimming lessons and swimming training
- Are permanent school pools
- Are facilities that are used by the general public and children that include interactive water features. [RC]

2.12) Swimming Pool Technical Operator (SPTO) –

These are qualified, trained and competent technical operators, available on-site/on call during all hours of operation:

Onsite designated supervisor, visiting technical operator

All pools that do not require an SPTO as defined above should instead have a staffed presence of an onsite designated supervisor with a visiting technical operator.

The onsite designated supervisor should be capable of testing the water quality as required by this CoP and know how to make adjustments as needed to maintain water quality. Although not responsible for plant maintenance, they must be knowledgeable and competent on the operation of the facility in terms as required in the pool's PSOP for both normal and emergency action plans

The visiting technical operator should provide regular [RC] (weekly minimum) visits and assistance whenever needed. Written documentation of these visits should be available at the facility. The written reports should at least show that:

- The circulation, filtration and disinfection systems were checked and working satisfactorily
- The safety equipment was noted as available on site and in working condition
- The pool and its infrastructure were in good condition
- Water chemistry and bacteriology were tested, their resulting values recorded on the report, and were found to comply with this CoP
- The operator took any corrective actions.

2.13) Training and competence

Only trained, competent people should operate plant and handle chemicals. In meeting this requirement, the training for the safe operation and use of equipment and chemicals will need to:

- Be related specifically to the design, operation and maintenance of the particular plant, hazards associated with it, and substances used. Employees' attention should be drawn to any manufacturers' instructions, and copies made conveniently available (e.g secured to the plant itself)
- Be given to enough employees to ensure that plant need never be operated by untrained, unqualified staff
- Be given to all employees whose actions or responsibilities may impact upon water quality or safety
- Include pool managers, to ensure they understand the functioning of the pool water system, including the plant and associated hazards, sufficiently to supervise safe operation
- Include the use, care and maintenance of personal protective equipment
- Include the use of clearly defined procedures based upon the NOP, EAP, Safety Data Sheets and safe systems of work for all processes involved
- Require those who have been trained to demonstrate that they can operate and maintain the plant safely.

2.14) Monitoring and recording of training

Pool management will need to check that trained technical staff understand and follow all procedures and responsibilities included in the PTOP. Monitoring and review of the effectiveness of arrangements should then follow. Details of qualifications and actual training sessions will need to be recorded and reviewed. Information, instruction, and training are the essential requirements for all staff involved in the operation of technical plant and the storage, handling and use of pool chemicals.

In meeting these requirements, training will need to include sufficient knowledge and understanding for staff to be alert to any changes affecting the operation of the system and likely to affect general safety. This should include changes to the pool plant equipment, chemicals or practices.

2.15) Technical operator qualifications and certificate

- A qualified technical operator should have completed a technical operator-training course that complies with this CoP. This should always be supplemented by on-site, specific training, with monitoring and assessment of competence.
- All operator-training courses should include as a minimum the learning elements detailed in the PWTAG CoP model syllabus (available from www.pwtag.org.uk).
- A qualified technical operator should have a current, in date certificate or written documentation showing satisfactory completion of a technical operator-training course.
- Originals or copies of such certificates or documentation should be available on site for inspection by the Environmental Health Officers/ Health and Safety Inspector for each qualified operator employed at or contracted by the site, as specified in this CoP. Originals should be made available upon request by the relevant authority.

2.16) PTOP: system documentation (an example of a PTOP is given in Annex 17)

The PTOP should be maintained in paper or electronic form and should contain or refer to the following:

- An organisation chart showing lines of authority, responsibility and allocation of functions stemming from senior management, and contact details
- The normal operational plan covering the operation and safety of the water treatment and heating and ventilation systems
- The emergency action plan
- A current schematic drawing showing the swimming pool, plant and associated pipework
- Procedures covering the identification of noncompliance against clauses of this CoP and action to be taken to resolve such issues.

2.17) Records

The pool management must ensure the effective implementation of all documented procedures and instructions and these must be recorded. Records should be maintained to chronicle the technical operation of the pool and plant.

It is important that records demonstrate that:

- Procedures have been effectively used and implemented
- There is compliance with the relevant clauses of this CoP
- Where compliance with clauses cannot be met, appropriate risk assessment methods have been applied to determine the safety of the system
- Appropriate means have been applied to ensure identified risks have been minimised and are within established safety limits
- Relevant, adequate qualifications and training has been provided for all staff involved in the safety and operation of water treatment, heating and ventilation systems

Records should be kept so that continued confidence may be demonstrated for a period of at least five years.

3. WATER TREATMENT

The effective technical operation and safety in any swimming pool starts with careful planning, specification and design. The specific sources of information from which the technical design and planning standards recommended for swimming pools can be obtained are:

- BS EN standards 15288-1 Safety requirements for design
- BS EN standards 15288-2 Safety requirements for operation
- PWTAG Swimming Pool Water: treatment and quality standards for pools and spas
- PWTAG online Technical notes
- Sport England Swimming Pools Design Guidance Note.

Everyone involved in the process of specifying, designing and constructing pools should be familiar with these design standards and should ensure that they are given careful consideration in all pool projects.

Water treatment systems are an integral part of the architectural, structural and mechanical design of a swimming pool. The design, selection and operation of water treatment plant has to take into account:

- Public health hazards
- Mains water quality and storage, dilution and drainage, coagulation, filtration and disinfection
- The size and type of pool, bathing load, circulation rate, circulation hydraulics and turnover period
- Pool operation, water treatment system and plant room.

3.1) Public health hazards

Within a pool facility there are many potential uses of water where users and those in the vicinity may be exposed to hazards with the potential to cause injury and waterborne illness. Examples include:

- Death through drowning, including hair and limb entrapment
- Neck and head injuries from diving into shallow water or hitting other swimmers
- Injury from falls, slipping, etc.
- Potential drowning where cloudy water prevents surveillance of swimmers under the water
- Cuts and abrasions due to sharp edges, cracked tiles etc.
- Ingestion of pool water containing pathogens (microorganisms causing illness) including the protozoal parasites C*ryptosporidium and Giardia* that can cause gastroenteritis
- Contact with contaminated water, especially in contact with open wounds
- Inhalation of aerosols containing hazards e.g. *Legionella* species in distributed water, such as when using showers, but also from water jets and indoor fountains
- Skin infections of the feet, including warts, verruca's and athlete's foot; some from pool floats and toys
- Possible exacerbation of asthma due to excessive disinfection by-products in the air
- Adverse health effects from water contaminated by chemicals

3.2) Mains water quality

The water companies' treatment processes provide safe water but, especially if from a river or reservoir (surface waters), are likely to contain some or all of:

- Organic materials, including humic acid (a precursor of the undesirable chlorination by-products called trihalomethanes, which themselves may be present)
- Lime and other alkalis (added to prevent corrosion in the supply network)
- Phosphates (added to prevent lead and copper dissolving from pipework, but which encourage algal growth in the pool)
- Other substances at levels, which, if boosted by pool water treatments, may take the levels above, recommended limits.

So it is essential that there is careful control of a pool's disinfection, pH, alkalinity, calcium hardness, dissolved solids and filtration.

3.3) Source water monitoring

Pool plant treatment should be set up to take account of an analysis of all relevant source water parameters. The water should meet drinking water quality standards; this applies also to private water supplies. The disinfectant type should so far as practicable be compatible with the source water supply.

3.4) Pool water clarity

Clarity of pool water is critical. It should be possible to see clearly the detail of the bottom of the pool at its deepest point from the pool surround. If not, this is a sign of deterioration in water quality and could lead to an immediate physical danger to anyone in distress, as well as the likelihood of discomfort to bathers because of the poor condition of the water. Also, it is a sign of ineffective disinfection and similarly if the cause of the cloudy water is ineffective filtration then disinfection will be compromised.

3.5) Turbidity

Clarity is reduced by turbidity – colloidal or particulate matter in suspension in the water. It is important to know the source of turbidity – whether pollution from bathers, external contamination, inadequate circulation/turnover or disinfection, or incorrect use of water treatment chemicals – in case this can be dealt with directly. The likeliest remedy, however, is adequate filtration and appropriate disinfection.

Turbidity in a swimming pool is measured in nephlometric turbidity units (NTU). The value generally used to measure turbidity in swimming pool water is 0.5NTU. Drinking water should have a value not exceeding 1.0NTU and the World Health Organisation (WHO, 2004) state that for effective disinfection to take place, the turbidity levels in the water to be disinfected must be <1.0NTU. High levels of turbidity can protect microorganisms from the effects of disinfection.

3.6) Primary disinfection

Disinfection means removing the risk of infection, and is achieved primarily by maintaining the correct concentration of disinfectant in the water. Primary disinfection will kill bacteria and viruses (and provide a residual to prevent cross-contamination); oxidation by disinfectants also breaks down soluble dirt and other organic contamination introduced by bathers.

At the same time other water quality parameters, in particular pH value, have to be kept at the correct value for disinfectant to act effectively and efficiently.

For disinfection to proceed freely, the water must be clear and free of suspended material, which may shelter the microorganisms from disinfectant activity. Effective filtration is key to this. Equally, the disinfectant has to be given time to kill.

Many disinfectants also oxidize waste matter, controlling the build-up of what is the food for many microorganisms (as well as a water contaminant in its own right) and helping maintain a fine sparkling water Mains water contains a small amount of such material, but the chief sources are introduced by bathers – sweat, skin particles, mucus and urine. Such bather pollution can and should be minimised by pre-swim hygiene (see 7.2).

Disinfection should extend beyond the pool water to the filters in the filter plant, as microorganisms often find excellent conditions for rapid reproduction in them, warmth, darkness, a bed of filter media, and a plentiful supply of food. Without adequate disinfection, filter beds may harbour pathogenic organisms including some amoebae, *Staphylococcus aureus* and *Pseudomonas aeruginosa*.

Dosing disinfectant before the filter prevents inadvertent mixing of disinfectants and acids (which are added post-filter). However there are arguments for dosing disinfectant post-filter; (this issue is dealt with in *Swimming Pool Water*). Secondary disinfection by ultraviolet (UV) radiation or ozone (which remove or reduce primary disinfectants), demands dosing disinfectant after the secondary treatment.

Automatic dosing (disinfectant and pH value kept to set limits in response to continual monitoring) is the preferred and usual method of applying disinfectant to the water.

3.7) Secondary disinfection

Secondary disinfection of pool water (UV or ozone) increases the kill of infectious organisms, especially the chlorine-resistant protozoan *Cryptosporidium*. Due to the risk of cryptosporidiosis it is recommended that swimming pools include secondary disinfection systems to minimise the risk to bathers associated with such outbreaks. This is particularly important with pools used by young children. There are other benefits in water quality, including the reduction of troublesome, irritant chloramines and being able to have lower disinfectant residuals in the pool water. These systems will take the form of either UV or ozone and should be designed to provide an effect equivalent to achieving a 99% reduction in the number of infective *Cryptosporidium* oocysts per pass through the secondary disinfection system.

UV

UV should be applied to the full flow of water through the treatment plant and monitored to ensure an effective dose rate. UV systems intended for the control of chloramines as well as microorganisms should be equipped with medium-pressure lamps at 60mj/cm^2 (broad spectrum between 200 and 320nm).

Low-pressure lamps (254nm) are only biocidal, so they will deal with bacteria and *Cryptosporidium* but do not deal with di and tri-chloramines as effectively as medium-pressure UV.

The system should be designed to achieve a minimum 99% reduction in the number of infective *Cryptosporidium parvum* oocysts per pass through the UV system. UV systems should be third-party validated (see PWTAG Technical note 31).

Ozone

Ozone should also be applied to the full flow of water through the treatment plant, with separate contact and deozonising systems. Contact time should be at least two minutes, and the ozone concentration 1mg/l in water circulated.

3.8) Dilution with fresh water

Disinfection and filtration will not remove all pollutants. UV and ozone will greatly improve removal but some pollution can be reduced only by dilution of the pool water with fresh potable water. This should also limit the build-up of pollutants from bathers and elsewhere, the byproducts of disinfection, and various other dissolved chemicals.

If dilution is inadequate, bather discomfort in the form of chlorinous, irritant gasses can result. Pool operators should be prepared to replace pool water with fresh water as a regular part of their water treatment regime at a rate of 30 litres per bather. The water that is replaced in the backwashing of filters contributes significantly to this requirement.

Dilution rates should be monitored and adjusted according to pool bather usage.

3.9) Bathing load

The maximum bathing load (number of bathers) allowed for at any one time determines the circulation rate, turnover, treatment plant size and other parameters. This bathing load should have been determined at the design stage for the pool. The maximum bathing load takes into account:

- The surface area of water in the pool
- The water depth
- The type of bathing activity the pool is intended for.

The maximum bathing load for each pool must be defined in the PSOP and pool managers shall provide systems controlling entrance to the pool or provide other means of monitoring to ensure that the maximum bathing load is not exceeded.

The starting point for calculating bathing load is the maximum loading of a pool for physical safety: 1 bather per 3m^2.

The maximum bathing load should also take into account the capacity of the water treatment plant, using the ratios in Table 1.

Table 1:

Water depth	Maximum bathing load
< 1.0m	1 bather per $2.2m^2$
1.0 m to 1.5m	1 bather per $2.7m^2$
> 1.5m	1 bather per $4.0m^2$

The operational daily bathing load should be reviewed regularly to determine whether the treatment system is capable of maintaining good water quality. It should be established using this formula:
Operational daily bathing load = 25 to 50% of maximum bathing load x number of hours use per day

The operational daily bathing load for each pool should be recorded, including details of the basis on which it was calculated. If the operational daily bathing load is approached or exceeded frequently, then attention may need to be given to:

- Increasing the treatment plant capability
- Additional dilution of the pool water with fresh water
- The use of secondary disinfection – UV or ozone.

3.10) Circulation rate

The circulation rate should be derived from this formula:
Circulation rate (m^3/h) = Maximum bathing load x 1.7
The circulation rate and turnover period are related and form the basis for sizing new water treatment plants, and for checking the capacity of existing water treatment plants.

3.11) Turnover period

The turnover period should be calculated from this formula:

$$\textbf{Turnover period (h)} = \frac{\textbf{Water volume (m}^3\textbf{)}}{\textbf{Circulation rate (m}^3\textbf{/h)}}$$

3.12) Pool type and turnover

Different sized pools and pools of different types should have turnover periods in accordance with Table 2.

Table 2: Turnover periods for different types of pool

Pool type	Turnover rate
Competition pools 50m long	3 to 4h
Conventional public pools up to 25m long with a 1m shallow end	2.5 to 3h
Diving pools	4 to 8h
Leisure water bubble pools	5 to 20min
Leisure waters up to 0.5m deep	10 to 45 min
Leisure waters 0.5 to 1m deep	30 to 75min
Leisure waters 1 to 1.5m deep	1 to 2h
Leisure waters over 1.5m deep	2 to 2.5h
Teaching/learner/training pools	30 to 90min

3.13) Maximum bathing load

If the turnover period calculated for an existing pool is longer than the values in Table 2, the maximum bathing load should be reduced using this formula:

$$\textbf{Maximum bathing load} = \frac{\textbf{Water volume (m}^3\textbf{)}}{\textbf{Turnover period (h)}} \textbf{ x 1.7}$$

The turnover period of pools with moveable floors should be appropriate to the pool at its shallowest point (ie potentially biggest bathing load).
The pool hydraulics should ensure appropriate turnover periods and good mixing of water in the pool; short circuits and dead legs should be avoided.

3.14) Dye testing

All pools should be dye tested when first commissioned, to prove the circulation and flow works as specified; And thereafter if there has been remedial work or if there is a circulation problem affecting water quality. See BS EN 15288 1 & 2 and Annex C.

4. POOL ESSENTIALS

Pool water should circulate 24 hours a day. If the pool has a moveable floor or bulkhead (boom), the circulation system should ensure proper water distribution in all possible positions.

4.1) Surface water removal

Surface water should be removed from swimming pools (a deck-level system is best). Between 50 and 80% (even 100% where the pool has bottom inlets) of the circulation flow should be removed as surface water.

4.2) Inlets and outlets

Inlets and outlets, grilles and covers should be designed in accordance with BS EN 13451-3. They should be inspected visually every day, and once a month subject to closer examination for obstruction, impact damage and vandalism and to make sure that they are correctly in place. If they are damaged or missing, swimming should be suspended immediately.

- Inlets: in water less than 800mm in depth and in sensitive areas (steps, teaching points, beside base inlets, etc.) the velocity of the water entering the pool should not exceed 0.5m/sec. In other areas, the velocity of the water entering the pool should not exceed 2.0m/sec.
- Outlets can cause entrapment and therefore have the capacity for serious harm. PWTAG guidance is that all pools should be tested to show that outlets comply with BS EN 13451-3. New completed pools should have this certification when built. Where this is not the case, pool outlets should be tested by a competent authority to show that they comply.
- Outlets should also be tested for hair entrapment. Annex D describes a test for hair entrapment.
- Pool outlets should be designed and installed so as to reduce the potential for entrapment of the user. As a general requirement, water speed through the outlet grilles should be ≤0.5m/sec.
- Grilles in outlets and inlets should comply with the requirements of BS EN 13451-1 and have gaps no greater than 8mm to prevent entrapment hazards.
- All wall and floor outlets should be fitted with a sump to a design that accords with BS EN 13451-3.

4.3) Where there is more than one outlet

- Outlet systems should be designed in such a way that:
- There are at least two functioning suction outlets per suction line
- The distance between the nearest points of the perimeters of the devices is ≥2m
- If any one of the suction outlets becomes blocked, the flow through the remaining suction outlet/s shall accommodate 100% of the flow rate
- It is not possible to isolate one of the outlet sump suction lines by means of a valve.

4.4) One outlet

In pools with only one outlet, the grille should be designed in such a way that:

- It cannot be blocked
- One user cannot cover more than 50% of the opening
- Raised grilles can be domed opposite to the flow direction, with prevalent peripheral suction; the height of the dome shall be at least 10% of the main dimension (diameter)
- Single grilles should have a grille area of $\geq 1m^2$.

5. FILTRATION

Effective filtration is the primary mechanism for ensuring water clarity. An effective filtration system including coagulation will also remove more than 90% of *Cryptosporidium* oocysts in a single pass of water-containing oocysts through the filter bed. It is an important function as these oocysts are much more resistant to disinfection than bacteria and viruses.

This CoP specifies filtration standards in terms of medium-rate filters using granular filter media, typically sand. This is a tried and tested method. There are filters that operate at higher rates, some with other media, some applying different filtration principles. These may be able to filter satisfactorily in some conditions, but operators should understand the potential disadvantages and be satisfied that they produce good clarity in the pool. Membrane and ultrafiltration systems are equally suitable and do not require the use of coagulant.

There are many pools in the public sector, where bather loads are not as high or as critical as public community pools (e.g. health clubs, hotels, schools) that use high-rate filtration – over 25 and up to 50 metres per hour. High-rate filters do not filter as well as medium-rate filters. Tests have shown they are about 10 to 25% as effective as medium rate. Accordingly, in these situations the bather loading should reflect the relative inefficiency of these filters (given that turnover and circulation are similar to pools with medium rate filters). Their use should be subject to a risk assessment.

5.1) Filters and filtration rate

Filters will usually be medium-rate pressure filters; 10 to 30m/h is the norm for public sector swimming pools with sand as the main filter medium (other filter media can be used).

5.2) Filter beds

Filters may be either single or multi-grade type. For single-grade filters the sand bed should be a minimum of 800mm deep; for multi-grade filters the sand bed should be a minimum 550mm deep supported on a bed of coarser material 250mm deep.

5.3) Serviceable filters

Every filter should be designed to be serviceable. They should have:

- An automatic air eliminator and a safe, manually operated quick air release mechanism
- Differential pressure gauges to indicate the pressure at the filter inlet and outlet
- A full-bore sight glass to observe the clarity of the effluent water throughout backwashing
- One or two viewing ports (acrylic windows) to observe the fluidisation of the bed during backwashing
- Access manholes – the number and size to be as indicated by the Confined Spaces Regulations 1997. For steel filters, and glass reinforced plastic (GRP) filters over 1.4m diameter, this means one manhole on the top and one on the side towards the bottom; each one at least 450mm diameter
- An air scour system to aid backwashing will enhance the cleaning process.

5.4) Annual inspection

The internal condition of the filters and the top of the filter media bed should be inspected annually for corrosion and problems with the filter medium e.g. mud balling, fissures, uneven bed.

5.5) Backwashing

- Medium rate filters should be backwashed at least once a week and whenever the pressure loss across the filter media bed reaches the level specified by the filter manufacturer.
- The backwashing period should continue either in accordance with the manufacturers' specified time or until the backwash water is clear – whichever is the longer.
- Filters should also be backwashed if the water circulation has been stopped (because of a failure or for maintenance) before the pool is re-opened.
- Backwashing must not take place when the pool is being used and should be done at the end of bathing for the day, normally in the evening. Allowing a period of at least 8 hours for the filters to settle and ripen will remove any remaining oocyst contamination of the pool water prior to the pool reopening
- Air scouring before backwashing at a rate of about 32m/h is desirable to aid backwashing.
- Filter plant should have a flow meter or meters fitted between the circulation pumps and filters to monitor the system's flow rate during normal operation, and backwashing rate.
- Backwash flow should be fast enough to fluidise the filter media bed, in accordance with manufacturers' instructions – at least 30m/h. Fluidisation of the bed should be checked visually through a viewing window.
- Backwashing protocol is critical; when neglected, it can for example be a factor in outbreaks of cryptosporidiosis.

5.6) Coagulation

A coagulant should be dosed continuously and precisely, by chemical dosing pumps. Continuous low-level dosing of a coagulant is recommended for all pools (except those with membrane and ultrafiltration systems) to improve the filtration efficiency and increase the removal of any contaminants from the pool. This procedure significantly reduces the risk associated with any unseen faecal release.

- The recommended coagulant is polyaluminium chloride (PAC).
- PAC should be dosed as far upstream of the filters as possible, but after the chemical controller's sample point.
- PAC should be dosed continuously using a peristaltic pump.
- All grades of PAC should be dosed at a rate of 0.1ml/m^3 of the total flow rate.
- Coagulants should not be dosed by hand (unless specifically designed for this purpose) or via the strainer box.

6. DISINFECTION

A wide range of disinfectants is available commercially. This CoP uses hypochlorite as a model for disinfection procedures. This is the commonest disinfectant, especially in public pools. But the CoP does not intend to rule out the use of other effective disinfectant systems, including those that may be developed in the future. The choice of disinfectant should take into account:

- Safety – by using only chemicals listed in *Swimming pool water: treatment and quality standards for pools and spas*)
- Compatibility with the source water supply – using an alkaline disinfectant, eg sodium or calcium hypochlorite with soft water (water low in calcium and magnesium ions); an acid disinfectant with hard water (helps disinfection and demands less use of other chemicals like pH adjusters)
- Type and size of pool – inorganic chlorine-based disinfectants are good choices for public pools, with the additional use of UV or ozone for better quality of water. Alternative forms of chemicals such as trichloroisocyanuric acid (trichlor) may be more appropriate to less demanding pools and outdoor pools where the addition of cyanuric acid will help to prevent depletion of chlorine due to sunlight. (Note: cyanuric acid may interfere with automatic controllers)
- Bathing load – if the bathing load is frequently high, and excessive combined chlorine is a problem, secondary disinfection with ozone or ultraviolet irradiation is useful in limiting chloramines as well as dealing with the threat from *Cryptosporidium*
- For pH control in waters with low natural alkalinity (up to 150mg/l as $CaCO_3$) and calcium hardness (up to 300mg/l as $CaCO_3$), carbon dioxide is usually preferred for pH reduction. Above that, and in wave pools, spa pools or pools incorporating water features, CO_2 is unsuitable; sodium bisulphate or hydrochloric acid are the norm.

6.1) Sodium hypochlorite

Sodium hypochlorite is a liquid supplied with a maximum strength of 15% weight for weight as available chlorine. If a liquid acid is used with it, there should be safeguards to prevent any accidental mixing, resulting in the release of chlorine gas. Sodium hypochlorite can also react vigorously with oxidising materials such as chlorinated isocyanurates.

Sodium hypochlorite can be generated electrolytically from a brine solution. This will elevate TDS levels quicker than the liquid chemical. Flammable hydrogen gas released during the process should be vented safely into the open air. Selection and siting of any electrical equipment associated with the electrolytic generator requires careful consideration.

6.2) Calcium hypochlorite

Calcium hypochlorite is a dry and relatively stable compound, supplied in drums as granules or tablets, with 65-78% available chlorine. Its use in hard water areas can precipitate hardness scale. It must be kept dry and free from contact with all organic materials including paper products, oil and oil products, chlorinated isocyanurates, detergents, cleaning fluids and acids. Such contact causes a heat reaction, and can lead to explosion, fire and the emission of toxic fumes. Contact with acids liberates toxic chlorine gas.

6.3) Chlorinated isocyanurates

Chlorinated isocyanurates are white or off-white granules or tablets with a chlorine odour, stable when dry but in contact with water slowly liberating chlorine. Confusion with other white chemicals must be guarded against. They can explode in contact with calcium hypochlorite, ammonium salts and other nitrogenous materials and will react vigorously with strong acids, alkalis and reducing agents. Cyanuric acid is a byproduct released into the water from dichlor and trichlor. Cyanuric acid makes the chlorine more stable in the presence of sunlight. For every mg of chlorine released almost as much cyanuric acid is added and accumulates in the pool water ultimately making the chlorine ineffective. To prevent this the cyanuric acid content must be diluted by the addition of fresh water.

6.4) Bromochlorodimethylhydantoin

Bromochlorodimethylhydantoin, in stick or tablet form, is stable when dry but releases bromine in contact with water. It must be dosed using a specific bromine feeder. It is important not to mix the product with other chemicals and to keep it well away from all alkaline substances. Strong concentrations can cause severe burns to the skin and eyes. Its use has been associated with a specific skin irritation affecting bathers.

6.5) Sodium bromide plus hypochlorite

Sodium bromide plus hypochlorite. This is a proprietary system that involves the conversion of bromide to free bromine residual by the reaction of sodium bromide solution with a chlorine donor. The bromide level has to be checked and maintained, for the bromine disinfection to work.

6.6) Chlorine gas

After many years of use in pools chlorine gas from cylinders was no longer recommended by the government in 1978 and is still not recommended by HSE. Methods for its use require a specially designed storage area for the chlorine cylinders. The installation must comply with Control of Substances Hazardous to Health regulation. It is vital to ensure that the building and ancillary areas have been designed to incorporate the requirements for the safe use of chlorine.

6.7) Ultraviolet radiation

Ultraviolet radiation is a secondary disinfection process (used alongside a primary disinfectant, usually chlorine).

It is recommended by PWTAG, both for its capacity to reduce chloramines and kill microorganisms – including chlorine-resistant *Cryptosporidium*. Its use can reduce the chlorine residual levels necessary to keep pool water healthy. It is increasingly used as an alternative to ozone (which similarly complements chlorination) as it is easier and cheaper to fit, especially to existing plant. (See PWTAG Technical Note 31 Ultraviolet disinfection: specification, maintenance and validation)

6.8) Ozone

Ozone gas can be generated in the plant room and used as a secondary disinfectant. HSE publishes guidance on the safe use of this toxic gas. This includes automatic alarms and shut down in the event of plant failure or indications from leak detectors.

7. BATHER HYGIENE PROCEDURES

The first priority is to control entry to the pool hall using notices at reception saying that bathers:

- With infections should not use the pool
- With diarrhoea must not swim – then, or for 48 hours afterwards.
- Who have been diagnosed with cryptosporidiosis must not swim for 14 days after diarrhoea has stopped.

7.1) Pre-swim hygiene

Pool water quality would be significantly improved if everyone using the pool showered with soap before entering the pool.

- Pre-swim showers should be provided, maintained in good working condition and bathers directed to use them before using the pool.
- Toilets should be provided en-route to the pool, after changing and before showering, and everyone encouraged to use them before showering and swimming.
- Hand washbasins with liquid soap and hand-drying facilities should be provided.
- Posters, signs and staff supervision should be used to enforce all operational procedures. These should cover the issue of when not to use the pool during and after diarrhoeal illness.

7.2) Babies and young children

The water in ordinary public pools is not suited to very young babies: water temperatures and pool water chemicals may affect sensitive skin. For this reason, parents should be encouraged not to bring children under the age of 6 months to public swimming pools where they share the water with other general swimmers.

- Ideally, young children’s pools should be provided with separate water treatment and filtration and should be able to be emptied in the event of a faecal accident.
- Children still using nappies should use special swimming nappies or pants, which are designed to absorb and retain soiling. Standard nappies are not adequate protection. Neither is suitable for children with diarrhoea; in this case they should not use the pool at all.
- Convenient nappy changing facilities should be provided in changing areas (these should be cleaned regularly), be equipped with basins for hand washing and have nappy disposal bins which are emptied regularly.

8. POOL CLEANING - EQUIPMENT AND SURFACES

All floors in the pool hall area, changing rooms, toilet and shower areas should be thoroughly cleaned each day.

8.1) Cleaning the pool surround

Pool surrounds should be cleaned at the start of each day by washing and scrubbing with 100mg/l chlorinated water (1ml of 10% w/w sodium hypo in 1 litre of tap water).

- Proprietary chemical cleaners formulated for pool use may be necessary for stubborn dirt.
- Mechanical scrubber driers on separated extra-low voltage (SELV) pick up the water and solution used in cleaning and then dry the surface. These are ideal but should be emptied and disinfected and dried after each use.
- If a deck-level pool surround falls away (to drain) from the transfer channel, lowering the water level in the pool can keep any cleaning residue out of the pool water.

8.2) Cleaning the water line

Deposits of dirt etc. just above the water line of a freeboard pool can be cleaned off with a chemical-free scouring pad, using sodium bicarbonate or carbonate solution. Operators should wear gloves and goggles.

8.3) Transfer channel

Some pools have a transfer channel fitted with a drain valve, which is capable of being isolated from the pool water system. So for cleaning purposes the pool water level can be lowered (pool circulation stopped) so that water from the pool no longer flows down the channel. Then the transfer channel can be cleaned and it can also be used to take any cleaning residue from cleaning the pool surround. By opening the drain valve and thoroughly flushing, the cleaning residue goes to waste.

8.4) Cleaning agents

Proprietary chemical cleaners should be avoided altogether if possible. They may contain surfactants that affect the monitoring of chlorine residual and cause foaming or phosphates, which promote algal growth. They may contain oxidising agents that give a false reading on water tests. Other compounds simply contain ammonia (they may smell of it) and could produce unhealthy pool conditions (through high combined chlorine levels).

If this is not possible every effort should be made to keep cleaning products out of the pool and any transfer channel. Ideally, there should be some way of draining all poolside washings to waste. Certainly care should be taken to avoid outright incompatibility between cleaning and pool chemicals, which could be dangerous. Chlorinated isocyanurates – often called trichlor or dichlor – can react violently with neat hypochlorites (particularly calcium hypochlorite). In general, reactions between acid and alkalis are potentially dangerous.

8.5) Proprietary cleaners where used

If proprietary cleaners are required, they should be formulated for poolside use, and come from reputable suppliers (even though the target is to prevent them getting into the pool water).

8.6) Chemical cleaning agents and pool water

Chemicals used for cleaning – whether for pool surrounds or the water line – should never be used when there are people in the pool.

8.7) Periodic removal of hard water scaling and body grease

It may be necessary in all wet areas, pool surrounds, showers, changing rooms and toilets to tackle a build-up of lime scale from the water and/or body grease and oils from bathers. Use sodium bicarbonate or carbonate to remove any organic build-up such as body oils or grease. Use an acid-based cleaner (e.g. weak hydrochloric acid/or citric acid) for removing scale. Care should be taken when using acid descalers in the presence of cementitious grout as prolonged contact at too high a strength may dissolve the grout. It is important that no residue from these cleaning programmes returns to the pool water.

8.8) Showers

Showers should be supplied with fresh water. Shower water should be stored at 60°C, and distributed so that it reaches at least 50°C at the feed to the shower and mixed at or within 2m of the point of use to 40°C (± 2°C).

- Showers should run to waste.
- All showers installations should comply with HSG 274 part 2 *The control of legionella bacteria in hot and cold water systems.*
- All showers should be cleaned and descaled in accordance with HSG 274 part 2 requirements

8.9) Pool covers
Pool covers should be checked regularly for any contamination, cleaned as necessary and disinfected with 100mg/l chlorinated water (1ml of 10% w/w sodium hypo/ 1 litre of tap water)).

8.10) Pool equipment
Any equipment, especially floating types, should be checked to ensure they are hygienic and clean before being used in the pool. This includes inflatable play devices, canoes, sub aqua equipment, arm bands, floats etc. They should be regularly cleaned physically, disinfected with 100mg/l chlorinated water solution (1ml of 10% w/w sodium hypo/ 1 litre of tap water) for 20 minutes, and dried prior to storage.

8.11) Transfer channels
Deck-level transfer channels should be cleaned as required, at least once a month. They should be drained and flushed out with 100mg/l chlorinated water (1ml of 10% w/w sodium hypo/ 1 litre of tap water)) which can be returned to the balance tank. Grilles should be scrubbed weekly with 100mg/l chlorinated water.

8.12) Balance tanks
Balance tanks should be inspected at least once a year and cleaned as necessary. Debris should be removed and inner surfaces brushed and flushed down with 100mg/l chlorinated water (see 8.1), which can be returned to the circulation system via the filters.

8.13) Pool bottom
The pool bottom should be kept clear of contamination, algae, and general debris by daily sweeping, suction cleaning or other means.

8.14) Pool shell
If a pool is emptied, then the bottom and sides should be scrubbed thoroughly with 100mg/l chlorinated water (1ml of 10% w/w sodium hypo/ 1 litre of tap water)) before refilling. It should be flushed thoroughly to drain before refilling. Check the integrity of the structure while the pool is empty.

9. POOL WATER CONTAMINATION EMERGENCY PROCEDURES

All operators should have, as part of the EAP, written procedures, which are practised and effective for dealing with the contamination involving faeces, blood and vomit. Faeces present the biggest risk, not least because of the threat from the chlorine-resistant protozoan *Cryptosporidium* (and its cousin *Giardia*).

This section largely duplicates PWTAG Technical notes 2 and 17 on the PWTAG website. There is further information on the subject in note 30.

9.1) Assess the risk
If faecal contamination has only been reported, and there is some doubt about the accuracy of the report, its presence should be confirmed by pool staff. If it cannot be confirmed, pool operators should assess the risk and may decide that the risk of harmful contamination is low and allow bathing to resume. This assumes that pH and disinfection are within normal limits.

9.2) Solid faeces
Solid faeces are relatively easy to deal with. It is unlikely that the perpetrator is suffering from an acute gastrointestinal illness and the microorganisms in it are relatively contained.

- The stools should immediately be removed from the pool using a scoop or fine mesh net and flushed down the toilet (not put in any pool drains)
- There must be certainty that all the faeces have been captured and disposed of. If not, and there is possible widespread distribution of the faeces in the pool, then the pool should be closed and the advice below for runny faeces considered
- All equipment that has been used in this process should be disinfected using a 1% solution of hypochlorite (100ml of 10% w/w sodium hypochlorite/ 1 litre of tap water)
- If the pool is operating properly with appropriate disinfectant residuals and pH values, no further action is necessary
- Depending on the extent of the contamination, how public it has been, and how quickly it can be dealt with, operators should consider clearing the pool of bathers for, say, 30 minutes while steps 1-4 are negotiated. This is certainly necessary if the faeces have broken up.
- Bathing should not resume until all the faeces have been removed.

9.3) Runny faeces

If the stool is watery, runny or soft (something like diarrhoea), the risk of infection is greater: the perpetrator is more likely to be carrying enteric pathogens, and if so they are likely to be spread through the pool water. It will certainly be impossible to remove the faecal material as it is with solid stool.

In most cases of diarrhoea in a swimming pool, the operator will not know if *Cryptosporidium* is involved. So the safest option is to assume that it is and immediately close the pool. There are in principle three procedures that will in time remove *Cryptosporidium* – coagulation/filtration, UV and superchlorination. The procedures to be followed primarily depend on the efficiency of the pool's filtration.

9.4) Pools with medium-rate filtration (up to 25 metres per hour)

This should include most public pools. Here the main emphasis is on filtration, which if effective should remove some 90% of the *Cryptosporidium* oocysts in each pass of pool water through the filter. This, then, is the procedure.

1. Close the pool – and any other pools whose water treatment is linked to the fouled pool. If people transfer to another pool, perhaps from a teaching pool to a main or leisure pool, they should shower first using soap and water
2. Hold the disinfectant residual at the top of its set range for the particular pool (e.g. 2.0mg/l free chlorine if the range is 1.0 to 2.0mg/l) and the pH value at the bottom of its range (e.g. pH 7.2-7.4). This will maintain the normal level of microbiological protection
3. Ensure that the coagulant dose is correct – for continually dosed PAC, 0.1ml/m^3 of the total flow rate
4. Filter for six turnover cycles (which may mean closing the pool for a day). This assumes good hydraulics and well-maintained filters with a bed depth of 800mm and 16/30 sand. This applies also to pools with secondary disinfection (UV or Ozone)
5. Monitor disinfection residuals and pH values throughout this period
6. Vacuum and sweep the pool. Cleaning equipment, including automatic cleaners, should be disinfected after use with a solution of 100ml of 10% sodium hypo/ 1 litre of tap water. This will at least move faecal contamination off surfaces and into the main pool water circulation, for eventual removal
7. Make sure the pool treatment plant is operating as it should (filters, circulation, disinfection)
8. After six turnovers, backwash the filters
9. Carry out rinse by allowing the filter media to settle by running water to drain for a few minutes before reconnecting the filter to the pool
10. Circulate the water for 8 hours. This will remove any remaining oocyst contamination of the pool and allow the filters to ripen. It is optional, depending on the pool operator's confidence in backwashing procedures
11. Check disinfection residual and pH value. If they are satisfactory re-open the pool
12. Any moveable floors and booms should be moved around from time to time during the whole process.

9.5) Pools with high-rate filtration (over 25 and up to 50 metres per hour)

High-rate filters do not filter *Cryptosporidium* oocysts, or anything else, as well as medium-rate filters. But because many pools have them, it is important to know how to deal with faecal contamination.

The main emphasis is on superchlorination (see also below and the PWTAG technical note 23 on superchlorination). High-rate filters without coagulation remove as little as 10% of *Cryptosporidium* oocysts in each pass. Even with coagulation, and perhaps 50% removal, it could take two days to be safe. The procedures below also apply to tier filters.

1. Close the pool – and any other pools whose water treatment is linked to the fouled pool. If people transfer to another pool, they should shower first using soap and water
2. If coagulation is not the norm, a supply of polyelectrolyte coagulant should be available so it can be hand-dosed, following manufacturers' instructions
3. Superchlorinate to 20mg/l adjusting the pH to 7.2-7.4 and leave for 13 hours (or 50mg/l for 5 hours). Procedures and supplies must be in place for this (see PWTAG Technical note 23 on superchlorination)
4. Vacuum and sweep the pool
5. Make sure the pool treatment plant is operating as it should
6. Backwash the filters
7. Allow the filter media to settle by running to drain for a few minutes (rinse cycle) before reconnecting the filter to the pool
8. Reduce the free chlorine residual to normal by dilution with fresh water or using an approved chemical. This may mean using the chemical gradually; procedures and supplies must be in place for this. See the Technical note 23 on superchlorination for details
9. When the disinfectant residual and pH are at normal values for the pool, re-open
10. Superchlorination should remove any current contamination but will not guarantee future water quality. So it is important to review procedures for the control and removal of contamination by Cryptosporidium.

9.6) Pools with no filtration (fill and empty pools)

Here there is the possibility of emptying the pool altogether. This might apply to a paddling or plunge pool, for example. For any pool, if operators are confident that they can safely empty the pool, this is the procedure that should be followed.

1. Close the pool – and any other pools whose water treatment is linked to the fouled pool
2. Superchlorinate the pool to 20mg/l for 13 hours or 50mg/l for 5 hours at pH 7.2.
3. Vacuum and sweep the pool.
4. Drain, rinse and refill.
5. Re-treat and when disinfectant residual and pH are at normal values for the pool, reopen the pool.

9.7) Blood

Pool disinfectants should kill any pathogenic microorganisms in blood or vomit, provided disinfectant residuals and pH values are within recommended ranges. But there are some precautions to take.

- Small amounts of blood, from a nosebleed say, will be quickly dispersed and any pathogens present killed by the disinfectant in the water.
- If significant amounts of blood are spilled into the pool, it should be temporarily cleared of people, to allow the pollution to disperse and any infective particles to be neutralised by the residual disinfectant.
- Operators should confirm that disinfectant residuals and pH values are within the recommended ranges; bathing can then resume.

9.8) Vomit

It is not unusual for swimmers to vomit slightly. It often results from swallowing water, or over-exertion, and so is very unlikely to present a threat through infection. PWTAG recommends that vomit occurrences of this nature in the pool should be treated as if it were blood. But if the contents of the stomach are vomited into a pool, the bather may be suffering from a gastrointestinal infection. And if that is cryptosporidiosis, infective, chlorine-resistant *Cryptosporidium* oocysts will be present. In this case the procedures outline above in 9.3 to 9.5 should be carried out

9.9) Contamination of pool surround

Any blood or vomit spillage on the poolside should not be washed into the pool or poolside drains and channels. Instead, like blood spillage anywhere in the building, it should be dealt with using strong disinfectant – of a concentration equivalent to 10,000mg/l of available chlorine. A 10:1 dilution of the sodium hypochlorite in use may be convenient. Using disposable gloves, the blood should be covered with paper towels, gently flooded with the disinfectant and left for at least two minutes before it is cleared away. On the poolside, the affected area can then be washed with pool water (and the washings disposed of – not in the pool). Elsewhere, the disinfected area should be washed with water and detergent and, if possible, left to dry. The bagged paper towels and gloves are classed as offensive/hygiene waste, which in only small quantities may be disposed of with the general waste.

10. MONITORING WATER QUALITY

There should be documented procedures for the use of the test kits and other test equipment, and operators should be given full training in their use for monitoring pool water quality.

The documented procedures should detail actions for operators to take if there are unexpected test results, especially if they show the pool water chemical composition is either below or exceeding safe limits.

10.1) Pool water testing equipment

The manual monitoring and measurement of the chemical condition of the pool water should be performed using appropriate test kits and following manufacturers' instructions. The accuracy of test kits should be maintained by:

- Keeping them scrupulously clean (including rinsing glassware components with deionised water to ensure that all traces of test reagents from previous uses are removed)
- Cells for testing pH and chlorine should be labelled accordingly and kept separate
- Not exceeding the shelf life of the test reagents
- Following storage instructions
- Using only the test kit manufacturers' specified test tablets
- Diluting and testing a second sample for chlorine residuals (products of the reaction between chlorine and ammonia) if the first gives a result at the top of the kit's range
- Using a test kit with the appropriate range for the water under test

- Being aware of the potential effects of high calcium hardness (may give a false high reading) or pool cleaning chemicals (false low reading) on test results
- Using colour standards to ensure that the equipment remains within the calibration range and accuracy is being maintained
- Using an appropriate source of north light or an approved lighting cabinet for a comparator.

10.2) Automatic monitoring of chemical levels

The readouts from the controller should be checked daily against the results from manual tests of the sample cell. The manufacturers' recommendations for the calibration of such equipment, including the use of suitable test solutions, should be followed. Records of all calibration tests and results should be recorded on log sheets and retained.

pH

Calibration for pH should incorporate the use of two buffer solutions, normally pH4 and pH9.2. Single-point calibration is not recommended. Readouts from the controller should be checked daily against the results from manual tests of the sample cell. If the difference is more than 0.2, the controller should be recalibrated

Disinfection

Readouts from the controller should be checked daily against the results from manual tests of the sample cell. If the difference is more than 15%, the controller should be recalibrated after first confirming the result with a further manual test.

Automatic monitors require checking daily to ensure that the readings are correct. They do not mean that manual testing of water from the pool itself is unnecessary, although the frequency may be reduced – from every two hours for manual systems to no less than three times a day with automatic systems. Automatic control does not monitor combined chlorine; to ensure adequate control of chloramines, chemical testing may need to be more frequent.

10.3) Chemical testing of pool water

Where disinfection and pH are not monitored and controlled automatically by the water treatment plant, manual testing is needed, using commercially available test kits and the appropriate tablets. The frequency of chemical testing should be determined by the risk assessment, but recommended test intervals are:

- Before the pool opens
- Every two hours while it is open
- After it closes.
- Automatic control does not monitor combined chlorine; to ensure adequate control of chloramines, chemical testing may need to be more frequent.

10.4) Sampling points

Pool water samples for chemical analysis should be taken from the pool at a depth of 100-300mm (not from the sampling cell in automatic monitoring equipment). They should routinely be taken at the deep end and furthest from the inlets – the most vulnerable part of the pool – and occasionally elsewhere.

10.5) Free chlorine levels

The values below – indeed, any values – require validation by satisfactory bacteriological water quality standards

For all pools using hypochlorite, assuming the pH value is 7.2, the free chlorine levels should be maintained at 1mg/l or below, to an absolute minimum of 0.5mg/l. This assumes satisfactory microbiological monitoring results (see section 11).

The use of secondary disinfection (UV or ozone) can help minimise the required free chlorine levels. These values can be achieved only where the pool is designed and engineered and operated well with effective pre-swim hygiene and not overloaded.

Upper limits

Free chlorine levels above 3mg/l should not be necessary in any pool using hypochlorite. If this is exceeded, dosing should be reduced.

If dosing has gone wrong and free chlorine reaches 5mg/l, chlorination should be stopped immediately; if free chlorine continues to rise bathing should cease until the fault has been rectified and the residual is under control.

10.6) Chloroisocyanurates

The same principle applies to pools on chloroisocyanurates (or with cyanurates added as a chlorine stabiliser). Chlorine residuals of up to 5mg/l may be necessary in normal operation. For pools using chlorinated isocyanurates as disinfectant, free chlorine should be maintained at 2.5-5mg/l and the cyanuric acid at no more than 150mg/l.

Some automatic controllers may not be accurate in the presence of cyanuric acid and their compatibility should be checked.

10.7) Combined chlorine levels

The level of combined chlorine residuals should be as low as possible. Combined chlorine levels should be less than half the free chlorine, and no more than 1mg/l no matter what the level of free chlorine.

If this ratio of combined to free chlorine is unsatisfactory, some correction may need to be applied (see *Swimming Pool Water: treatment and quality standards for pools and spas*).

10.8) pH value

The pH values for the pool water should be maintained within the range recommended for the disinfectant being used. But a pH value of between 7.2 and 7.4 should be the target when using chlorine-based disinfectants. At levels above this range the free chlorine will not be so effective and accordingly may need to be increased.

10.9) Alkalinity

To ensure effective coagulation and a stable pH when using acidic disinfectants, alkalinity in pool water should be maintained at a level between 80 and 200mg/l (measured as $CaCO_3$).
Alkalinity measurements should be taken weekly, using commercially available alkalinity test kits and the appropriate tablets. Dilution or dilute acid should be used to lower the levels of alkalinity.

10.10) Calcium hardness

Pool water should be maintained for bather comfort, and grout should withstand that water.
Ideally calcium hardness should be maintained between 75 and 150mg/l as $CaCO_3$.
However, in areas with a hard water supply this cannot be practically achieved. It is therefore very important that water treatment chemicals do not further enhance the calcium hardness content over and above that in the hard water make up supply.
Calcium hardness concentrations higher than 300mg/l may result in the deposition of scale with sudden changes in temperature and pH

Calcium hardness measurements should be taken weekly, using commercially available test kits with the appropriate tablets.

10.11) Total dissolved solids (TDS)

Dissolved solids are aggressive at high levels and should not be allowed to rise more than 1,000mg/l above the level in the source water. (There are exceptions for electrolytically generated chlorine, see PWTAG Swimming Pool Water). TDS concentration should be reduced by dilution if necessary. TDS concentration should be measured weekly, using a commercially available electronic meter that has been calibrated against a commercially available standard.

10.12) Sulphates

Sulphate levels should be maintained below 360mg/l. Sulphate levels should be measured once a week using a commercially available test kit.

10.13) Balanced water

It is important to maintain the water in balance, but usually this is achieved when the pH is properly controlled. Alkalinity, calcium hardness, TDS and temperature are also factors.

The Langelier index is a formula that brings together all these factors. It makes sense to calculate Langelier weekly when measuring alkalinity, calcium hardness and TDS .

11.MICROBIOLOGICAL TESTING

Swimming pool water should be microbiologically tested each month to monitor for the presence of potentially harmful microorganisms. Testing should be performed only by competent personnel at a UKAS-accredited laboratory.

Tests should also be done
- before a pool is used for the first time
- before it is put back into use, after having been shut down for repairs
- if there are difficulties with the treatment system
- if contamination has been noted
- as part of any investigation into possible adverse effects on bathers' health
- in the event of adverse results.

More frequent sampling will be necessary if there is a problem, or for particularly heavily loaded pools. Hydrotherapy pools, even those not in a healthcare setting, should be tested weekly.

11.1) Chemical testing at the same time

Whenever a microbiological sample is taken it is important that a pool water chemical test of free and combined chlorine and pH is taken at the same time, from the same location as a reference. The water clarity and the bather load should also be noted.

11.2) Aerobic colony count (ACC)

Aerobic colony count also commonly known as Total Viable Count (TVC) at 37°C is the basic test for pool water quality and is a measure of the aerobic bacteria present in the water. It does not necessarily give an indication of microbiological safety, but gives valuable information on the general quality of the pool water and whether the filtration and disinfection systems are operating satisfactorily.
- The aerobic colony count should not be more than 10 colony forming units (cfu) per millilitre of pool water after incubation for 24 hours at 37°C
- A colony count in excess of 100cfu/ml is unsatisfactory
- A consistently raised colony count of 10 to100cfu/ml is unsatisfactory and should be investigated.

11.3) Escherichia coli (E coli)

Escherichia coli is a bacterium that is normally only found in human and animal faeces and does not grow in water. The presence of *E coli* indicates the presence of recent faecal contamination in the water. *E coli* should be absent in a 100ml sample.

Coliforms

Coliforms are related to *E coli* but may also be found in soil and on vegetation. Their presence therefore indicates some external contamination of the pool water.
- Total coliforms should be absent in 100ml.
- Less than 10 per 100ml is acceptable provided it does not happen in consecutive samples, there are no *E coli*, the ACC is less than 10cfu/ml and the residual disinfectant concentration and pH values are within the recommended ranges.

11.4) Pseudomonas aeruginosa

Pseudomonas aeruginosa is an opportunistic pathogen capable of growing in water even at relatively low temperatures. It will readily colonise filters, deck level transfer channels, balance tanks and flexible polymeric materials used in some inflatables, tubing and pool covers. Most species of *Pseudomonas* are non-pathogenic for healthy people, but *Pseudomonas aeruginosa* can cause skin rashes and ear infections.
- It should be absent in a 100ml sample.
- If the count is over 10cfu/100 ml, but less than 50cfu/ml, the sampling and analysis should be repeated whilst maintaining the free chlorine and pH values.
- Where repeated samples contain *Pseudomonas aeruginosa*, the filtration, disinfection and cleaning procedures should be examined to determine whether there are areas within the pool system where the organism is able to multiply. Pool equipment e.g. swimming aids, and pool covers may also need to be checked. It can easily colonise water systems, forming biofilms and their presence requires cleaning and disinfection with a 50mg/l free chlorine solution.
- When counts exceed 50cfu/100 ml pool closure is advised as there is significant risk of bather infection.

11.5) Acting on failures

- **Step 1** If a result is unsatisfactory, a preliminary investigation should be undertaken, remedial action taken and the test should be repeated as soon as practicable.
- **Step 2** If the second result is also unsatisfactory, the pool's management and operation should be investigated and the test repeated.

- **Step 3** If the third result is still unsatisfactory, immediate remedial action is required, which may mean closing the pool.

These procedures should be included in the emergency action plan

11.6) Closure

The pool should be closed if there is chemical or physical evidence of unsatisfactory disinfection eg poor clarity or low free chlorine concentration.

The pool should also be closed if microbiological testing discloses gross contamination, which means one of two things:
1 *E. coli* over 10 per 10 ml PLUS either colony count over 10 cfu per ml or *Pseudomonas aeruginosa* over 10 per 100ml (or, of course, both)
2. *Pseudomonas aeruginosa* over 50 per 100ml PLUS colony count over 100 per ml.

12. PLANT ROOM

The plant room should be a secure area for authorised personnel only. Plant rooms should be adequately sized and not used for general storage, or for storing hazardous chemicals, unless appropriate precautions are taken. There should be no risk from fire or overheating.

Chemicals should be stored in containment structures or devices designed to control spillages. There should be adequate separation from other chemicals and substances stored in the plant room; containers should be kept securely closed, cool and dry. Chemicals supplied in paper or plastic sacks should be stored in plastic bins before opening, and securely closed after use.

12.1) Plant room protocol

It is essential that temperature, humidity and ventilation are controlled for the equipment and its use. Four air changes per hour is the usual minimum but this will increase where ozone treatment is used.

Plant, including electrical equipment, should be inspected and maintained in accordance with a planned programme.

12.2) Automatic equipment maintenance

Automatic monitoring and control equipment should be maintained and calibrated in accordance with the manufacturers' recommendations.

12.3) Safety systems provided and maintained

Relevant safety systems (e.g. chlorine gas detectors, fire/smoke detectors), safety equipment and personal protective equipment should be in the plant room, and should also be maintained in accordance with a planned programme. Monthly inspection of personal protective equipment is required to check its continuing suitability.

12.4) Confined spaces

Cleaning or maintenance activities may require employees or contractors to enter confined spaces. A confined space is a place which is substantially enclosed (though not always entirely, for example a pool balance tank after it is emptied) and where serious injury can come from hazardous substances or conditions within the space or nearby (e.g. lack of oxygen).

If work is required on plant or equipment in confined spaces pool operators should have arrangements in place to ensure the work can be done safely. The following principles apply:

- Working in a confined space avoided whenever possible, for example by doing the work outside
- Where confined space working is required, staff must have appropriate training in accordance with the regulations (see below)
- A safe system of work if working inside
- Appropriate arrangements for rescue in an emergency.

Detailed guidance on managing the risks from work in confined spaces is available at http://www.hse.gov.uk/confinedspace/

13. CHEMICALS

Every employer has a responsibility to assess the risks associated with hazardous substances in the workplace and to take adequate steps to eliminate or control those risks. The chief relevant legislation are the Control of Substances Hazardous to Health Regulations 2002 (COSHH)

13.1) COSHH

COSHH applies to pool chemicals and to microorganisms.

- Risk must be assessed for each chemical and microorganism.
- Assessment should be done by a competent person. The assessor will need to know about which chemicals are used and how; other chemicals on site; site location in relation to the impact of a chemical accident; staff training and competence in using chemicals; risks to health arising from microorganisms.
- Exposure to hazardous substances must be prevented or controlled.
- Prevention is obviously best. The pool operator will need to consider whether this can be achieved by substituting a less harmful substance, or one that is compatible with other chemicals on site.

Only where prevention is not reasonably practicable can the pool operator turn to other controls. Personal protective equipment should not be the first option. Instead, the risk must be reduced to acceptable limits by using the least potentially harmful (but effective) chemical or 'engineering' control measures by isolating or physically separating chemicals.

These procedures must be systematically recorded to include:

- Identification of the hazards
- Identification of who might be harmed and how
- Evaluation of the risks arising from the hazards, and decisions about precautions
- Recording the findings
- Regular review of the assessments and any necessary revisions.

COSHH Regulations require suppliers of chemicals to provide a safety data sheet (SDS) for each chemical. These should be displayed in the vicinity of the chemicals. It is also the plant installer's responsibility to provide relevant information on plant safety etc. - which may include SDSs.

There will need to be SDSs for all the chemicals in the plant room including pool chemicals, cleaning chemicals, pool water testing chemicals and chemicals used in maintenance programmes.

13.2) Training in chemical handling

COSHH Regulations require that all staff involved in the handling and use of chemicals should receive appropriate training and instruction. This may include lifeguard staff and cleaning staff. Training should include the knowledge and understanding of the chemicals needed for staff to be alert to any changes affecting safety.

The training for the safe operation and use of equipment and chemicals should be:

- Related specifically to the particular situation and hazards associated with it, and substances used
- Given to enough employees to ensure that plant need never be operated or process conducted by untrained staff
- Include pool managers, to ensure they understand chemicals hazards and the functioning of the pool water system
- Include the use, care and maintenance of personal protective equipment.

13.3) Personal protective equipment (PPE)

The Personal Protective Equipment Regulations 2002 and Personal Protective Equipment at Work Regulations 1992 (as amended) require pool operators to assess and provide necessary personal protective equipment (PPE) when performing certain tasks. HSE publications HSG53 and INDG174 give full guidance.

Pool operators should take the advice of suppliers about what PPE is needed. Some or all of the following protective clothing may be needed during delivery, handling of materials, cleaning or maintenance: dust masks and face protection, eye protection (to BS EN 166:2002); aprons or chemical suits; boots; gauntlets; respirators.

- Respirators should be available where there is any risk of generating chlorine or bromine gas by accidental mixing of chemicals. Further information on the selection, use and maintenance of respirators is available at http://www.hse.gov.uk/respiratory-protective-equipment/index.htm
- There should be enough canister respirators for all employees liable to be present at any one time. They should be where there might be a leak and also at the entrance door to these areas.

- Canisters need to be replaced in accordance with the expiry date marked on them. The period of exposure should be recorded and when the number of hours exposure is exceeded the canister should be replaced

Pool operators need to consider suitable emergency procedures for more serious chemical gas formation or leaks, where appropriate in consultation with the fire authorities.

13.4) Chemical spillage

Any spillage should be cleared away using a safe method agreed between chemical supplier and pool operator. The method should be displayed on a notice, together with the provision of the necessary equipment and its location. Care should be taken to prevent any chemical from entering a drain unless it is safe to do so.

13.5) Toxic gas leaks

There should be an emergency action plan (EAP) for dealing with any major release of toxic gas. The procedure should include arrangements for any necessary evacuation and co-ordination with emergency services, including informing them immediately of hazardous substances present (unless they already have this information).

13.6) Safety information on site

Precaution cards and first aid instructions should be displayed for each chemical. CAS and EINECS numbers should be included on the precaution cards so that in the event of an accident emergency services will know what is the correct medical treatment.

13.7) First aid

First aid provision should include equipment for dealing with the consequences of direct contact with chemicals; for example, by providing eyewash bottles and emergency drench showers.

- Eyewash facilities should be located in close proximity to the hazard to enable immediate action.
- A washbasin with running water should be provided in case chemicals come into contact with the skin or eyes.
- Where staff could be subject to severe exposure to a harmful chemical, emergency drench showers should be provided.

13.8) Delivery of chemical

Everyone involved in the transport, handling and storage of dangerous goods (some forms of pool chemicals) by law needs training appropriate to their duties, with periodic refresher training.

Offloading

Procedures and training for dealing with chemical deliveries should be established and understood by all staff.

- It is essential that all deliveries proceed only when a trained staff member is available to receive and check the materials.
- All staff involved in chemical offloading should have specific training in delivery of chemicals, dealing with spillages and manual handling.
- Unloading should not be on the public highway. Where this is unavoidable, local authority permission should be sought and suitable warnings provided.
- The safe working load (SWL) of any lifting apparatus used should not be exceeded; regular inspection, testing and certification should be observed.

Bulk delivery of sodium hypochlorite and hydrochloric acid

There should be documented procedures for transfer and handling during delivery. Suppliers should be required to comply with these procedures.

- Pipework should be clearly labelled and specific to the delivery of that product, to prevent delivery hoses being incorrectly connected up. It is important that any other chemical delivered in bulk has a separate, different size or type of connection. Pipework fill points should be clearly labelled and locked when not in use.
- Bulk tanks can be connected to day tanks either by gravity or pumping, but there should be separate fill routes and/or pumps for each chemical.
- Pools should not be dosed directly from bulk tanks.
- Bulk and day tanks should be in separate bunds sized to take 110% of the volume of the tanks.

Transport from offloading area to store

It is important that the chemical containers should be taken to a suitable storage area as soon as possible; should not be left unattended in an offloading area; are kept upright and never rolled; and are used in stock rotation.

- Where chemical containers are to be handled manually, a risk assessment should be done; where appropriate, mechanical aids should be provided.
- Where more than one chemical is being transported they should be segregated. Where chemicals are incompatible, it is essential that they are not transported together.

13.9) Chemical storage essentials

Each chemical should be stored separately from all other chemicals.

- Chemicals should be stored in containment structures or devices designed to control spillages, they can be permanent (e.g. bunds), portable (e.g. drip trays) or built into equipment (e.g. double skinned tanks).
- All containers should be kept securely closed, cool and dry and out of direct sunlight.
- Chemicals supplied in paper or plastic sacks should be stored in plastic bins before opening, and securely closed after use.
- Safety data sheet (SDSs)s should be available at the point of storage.
- Non-returnable containers should be flushed out with water and scored to prevent re-use before appropriate disposal. Procedures should be established to deal with the safe disposal of chemical products that are no longer required, or which have exceeded their shelf life.

13.10) Chemical store

Chemical stores should provide clean and dry storage for solid materials to avoid contact with water and should also be protected from sunlight and hot pipework or plant. Chemical stores should:

- Have warning signs, be secure and accessible only to authorised, appropriately trained people
- Be at the same level as the delivery point and not be situated close to public areas, doors, windows or ventilation intakes
- Have adequate natural ventilation to a safe open area or mechanical ventilation providing four air changes per hour.

13.11) Dosing practice

In general, the most effective dosing systems are also the safest for bathers and operators. Automatic dosing (disinfectant and pH values kept to set limits in response to continual monitoring) is preferred; but manual testing of the pool water is required to verify its operation.

The dosing system should be backed up by regular monitoring and verification. -

Hand dosing

Hand dosing in normal operation should not happen. It is rarely justified and only after all relevant health and safety issues have been settled. No chemicals should be added to the pool while bathers are in it, nor should bathers be readmitted until all materials have been fully dissolved and dispersed.

Where to dose

Dosing disinfectant before the filter prevents inadvertent mixing of disinfectants and acids (which are added post-filter). But there are arguments for disinfectant dosing post-filter; (this issue is dealt with in *Swimming pool water: treatment and quality standards for pools and spas*). With UV and ozone (which remove or reduce residual chlorine), dosing is always after the secondary treatment.

Circulation feeders

Circulation feeders, which hold tablets of disinfectant, should be used only in accordance with the manufacturers' instructions.

- Ensure the feeder is compatible with the chemical being dosed.
- Feeders should not be used for any chemical or size of tablet other than that specified.
- They should be fitted with a gas bleed-off line which is piped back into the circulation system.
- Trichlor tablets in use should be kept completely submerged and should be fully used up prior to extended periods of circulation shut down.
- Circulation feeders should not be sited near a heat source, nor installed such that they are subjected to heat.

13.12) Chemical dosing operations

Chlorine gas can be generated and an emergency arises where disinfection chemicals mix inadvertently with pH correcting chemicals. This can happen when pool chemicals continue to be dosed when main pump circulation fails.

- Chemical dosing systems monitors and automatic controls should be interlinked with the circulation pumps and the circulation of water through the system, so that dosing stops if there is pump failure or significant loss of pumping rate. These systems should always fail to safety and require manual restart when circulation is restored.
- Further protection is provided against the effects of continued dosing when water circulation fails if chlorine disinfection is dosed pre filter and pH-correcting chemicals dosed post filter.

- Written procedures should be established for day tank filling, mixing or diluting chemicals and cleaning injectors. There should also be built-in safeguards to cover those periods when the plant is not attended.
- If the plant is to be shut down for longer than 60 hours, valves in filling lines between the day and bulk tanks should not be closed, as decomposition products might otherwise build up. After such a shutdown, the whole of the dosing system should be flushed through gently with low-pressure water.

13.13) Chemical line safety

- All chemical pipework, suction lines, delivery lines and tanks should be marked to identify the contents.
- Pipes should also be labelled with the direction of flow.
- All pipes used for delivery of chemicals to injection points should be double sheathed.
- Disinfectant and pH dosing systems should be kept separate.
- Dosing sets should be kept separate in individual bunds.

13.14) Scaling of chemical lines and pumps

To prevent scale, hypochlorite disinfectant chemicals can contain polycaroxylate, sodium hexametaphosphate or may be diluted prior to injection. Any scale should be removed by rodding.

13.15) Preparing dosing chemicals

- Chemicals should always be added to water and never the other way round when preparing solutions.
- Non-liquid chemicals should be kept dry until dissolved in water.
- Calcium hypochlorite should be kept away from all other chemicals in its preparation for dosing.
- If hydrochloric acid is not being dosed direct from a container and is then automatically diluted, it should be diluted to a weaker solution by filling the day tank with a known quantity of water, adding a known quantity of acid to it, and mixing thoroughly. For small pools a 5%v/v solution is ideal and reduces atmospheric corrosion.
- Any sludge formed from the incomplete dissolving of chemicals should be cleared periodically but if the solutions are prepared correctly this should not happen.

14HEATING AND AIR CIRCULATION

Maintaining satisfactory environmental conditions is essential for the comfort of bathers, lifeguards, staff, spectators etc., and for the pool to operate successfully over its working life.

14.1) Pool water heating

Table 3 gives recommended temperature ranges for different types and use of pool

Table 3 Pool Temperatures:

Pool use	Temperature range (°C)
Competitive swimming and diving, fitness swimming, training	26-28
Recreational swimming and adult teaching	27-29
Leisure waters	28-30
Children's teaching	29-31
Babies, young children, disabled and infirm	30-32
Hydrotherapy and aquatic rehabilitation pools	32 -36 Ideally at 34.5°C (thermoneutral).

14.2) Pool hall air

- The pool hall air temperatures should be no more than 1deg C above or below that of the water temperature. Air temperatures over 30°C should be avoided.
- Hydrotherapy and aquatic rehabilitation pool air temperature should be maintained at approximately 25-28°C
- Relative humidity should be maintained at a level of 60% (no less than 50%, no more than 70%) throughout the pool hall area.
- The pool hall area (water plus wet surrounds) should preferably be ventilated at a rate of over10 litres of ventilation air per second per square metre of pool hall area.
- Where leisure pools include extensive water features, consideration should be given to an increase in the ventilation rate.
- Ventilation systems should be designed to provide a minimum of 12 litres per second of fresh air for each occupant of the pool hall (bathers, staff and spectators). An extra 10% on top of the running rate should be

available when necessary (eg for temporary higher bather loads or if high levels of contaminants are detected in the pool atmosphere)

- Where the ventilation system is capable of using recirculated air, at least 30% of the air content should be provided from a fresh source where possible.

15. TERMS AND DEFINITIONS

For the purposes of this CoP, the following terms and definitions apply.

1. Acid - A chemical with a pH of less than 7.0, used to lower the pH value when added to pool water.
2. Air scour - Air forced up through a filter bed prior to backwash to expand the filter media and loosen dirt particles.
3. Algae -Simple form of microscopic plant life that thrives in sunlight and can make pool water cloudy or green.
4. Algicide - A chemical that aids in killing, controlling and preventing algae.
5. Alkali -A chemical with a pH above 7.0 used to raise the pH value of pool water; also called a base.
6. Alkalinity -A measure of the alkaline content of water; generally expressed in mg/l or ppm; a measure of the resistance to change in pH value.
7. Aluminium sulphate - (alum) A coagulant, usually crystalline.
8. Ammonia - A chemical formed from the breakdown of urea in urine and sweat.
9. Amperometric sensor - Pool water sensor that measures, for example, hypochlorous acid.
10. Backwashing - Cleaning of the filter by reversing the direction of water flow up through the filter media to waste.
11. Backwash holding (attenuation) tank - A reservoir needed where the drainage system cannot accept the full backwash flow.
12. Balance tank - A reservoir of water between the pool and the rest of the circulation system. It maintains a constant pool water level and supply to the pumps, and holds water displaced by bathers.
13. Bather load - A measure of the number of bathers in a pool over a set period of time.
14. BCDMH Bromo-chloro-dimethyl-hydantoin - A solid type of bromine disinfectant.
15. Breakpoint chlorination - A disinfection method in which chlorine dose is sufficient to oxidise rapidly all the ammonia nitrogen in the water, and to leave a suitable free chlorine residual to protect against cross-infection in the pool. When the combined chlorine level in the pool falls, after rising as chlorine is added, this indicates that nitrogenous pollution is being successfully oxidised.
16. Bromamines - A disinfection byproduct from the action of bromine on ammonia and other nitrogenous wastes.
17. Bulk tank- A tank designed to hold chemicals in bulk. The tank should be marked with the chemical name and have a level indication so that it is clear when it needs to be filled, and when it is full.
18. Bund - A spillage containment tank for chemicals.
19. Buffer - A chemical (or mixture of chemicals) which helps pool water resist changes in pH value.
20. Calcium chloride - A Chemical used to increase calcium hardness.
21. Calcium hardness - A measure of the calcium salts dissolved in pool water.
22. Calorifier - A heat exchanger used to heat pool water indirectly.
23. Carbon dioxide - A gas which dissolves in water to form the weak carbonic acid, used to lower pH.
24. Chloramine - Disinfection byproduct from the action of chlorine on ammonia and other nitrogenous wastes.

25. Chloroform - A product of the reaction between chlorine and organic nitrogen compounds; one of the trihalomethanes.
26. Coagulant - A chemical which produces a gelatinous precipitate in water and causes the agglomeration of finely divided particles into larger particles which can be filtered out.
27. Coagulation - The action of a coagulant.
28. Coliforms - Bacteria occurring in human and animal faeces but also capable of survival and growth in soil and on vegetation. The group includes E. coli
29. Collectors - (laterals, filter nozzles, underdrains) Interior bottom part of the filter that collects the filtered return water.
30. Colloids - Very fine suspended matter in water, which does not settle and contributes to turbidity.
31. Conductivity - Electrical measurement of ions in water used to estimate total dissolved solids in swimming pool water.
32. Combined chlorine - A measure of the chloramines in pool water.
33. Cyanuric acid - A stabiliser that can be added to pool water to reduce chlorine loss due to sunlight.
34. Day tank - Tanks designed to hold the amount of dosing chemical to fulfil a day's needs. Each different chemical should be separately bunded (walled around so spillages are contained).
35. Deck-level - A pool with the water and poolside deck at the same level, and having a transfer channel to remove surface water to the balance tank.
36. Disinfection - Process of inactivating potentially harmful microorganisms in pool water.
37. De-ozonation - Removing ozone from water before it returns to the pool.
38. Dichlor - Short for sodium dichloro-isocyanurate dihydrate (and also called Troclosene sodium dihydrate). A type of stabilised pool chlorine disinfectant.
39. E coli (Escherichia coli) - A bacterium found in human or animal faeces that is normally incapable of growth outside the intestine– its presence in water indicates faecal pollution.
40. Erosion feeder - A simple device that allows a steady flow of water to erode a stick or tablet of disinfectant, liberating the active ingredient.
41. Filtration - Removal of colloidal and particulate matter by passing the pool water through filter media, usually a sand bed.
42. Filtration rate - The velocity of water through a filter, measured as metres per hour (m/h), equivalent to $m^3/m^2/h$.
43. Flocculants see coagulant - A chemical compound (eg aluminium chloride, poly aluminium chloride) that improves filtration by causing the particles produced by coagulation to come together to form large accumulations, or flocs.
44. Flooded suction - Describes the arrangement where the pump and suction pipework are below pool water level.
45. Flow meters - Measure normal flow and the backwash flow rate.
46. Fluidisation - Suspension of the filter media when backwashing and sometimes air scouring.
47. Folliculitis - An infection of the hair follicle caused by bacteria, usually Pseudomonas aeruginosa.
48. Free chlorine - A measure of the chlorine residual (the sum of hypochlorous acid and hypochlorite ion) that is available for disinfection.
49. Gas chlorinator - A device that controls the release of chlorine gas from bulk supply.
50. Halogen - The chemical family that includes chlorine and bromine (and iodine).
51. Hardness - A measure of all the calcium and magnesium salts in pool water (total hardness). See also calcium and permanent hardness.

52. Headloss - The difference in water level between the upstream and downstream sides of a treatment process attributed to friction losses; sometimes called pressure drop.
53. Heat pump - Heat pump coils remove heat or cool energy from one location and direct it to another.
54. Humic acid - A constituent of mains water that reacts with halogen disinfectants to form trihalomethanes.

55. Hydrochloric acid - An acid used to lower pool water pH value.
56. Hypobromous acid -The main active factor in all bromine disinfectants.
57. Hypochlorite-based disinfectants (hypo) Sodium hypochlorite (liquid pool chlorine); calcium hypochlorite (solid pool chlorine).
58. Hypochlorous acid - The main active factor in all chlorine disinfectants.
59. Injector - Fitting enabling a chemical liquid or gas to be injected into the water circulation loop.
60. Ions - Electrically charged chemical particles.
61. Langelier index - A measure of the scale-forming or corrosive nature of water.
62. Loss of head - Describes the loss of operating pressure (at the filter or pump outlet).
63. Make-up water - Fresh water used to fill or top up pools, particularly after backwashing.
64. Nitrogen trichloride - The most irritant of the chloramines.
65. Nephelometric turbidity unit (NTU) - Unit of measure used in the measurement of turbidity.
66. Oxidation - The process by which disinfectants remove pollution.
67. Oxidation-reduction potential (ORP)- A measure of the oxidative powers of the water, which is measured in millivolts.
68. Ozone - Gas generated on-site and used to purify pool water by oxidation.
69. PAC (Poly aluminium chloride) - A commonly used liquid coagulant.
70. Permanent hardness - That part which does not precipitate from the water on heating; it consists of calcium and magnesium salts other than carbonates and bicarbonates.
71. pH - A measure of the acidity/alkalinity of water on a logarithmic scale of 0–14.0. A pH below 7.0 is acidic and above 7.0 is alkaline basic.
72. PPE - Personal protective equipment may include safety goggles, hearing protection, gloves and coveralls.
73. ppm - Parts per million a measurement that indicates the amount of chemical by weight in milligrams per litre of water (mg/l) these are numerically the same.
74. Pressure gauges - Measure the headloss across the filter bed.
75. ORP sensors - Pool water analysers that measure only the oxidative power of the water. See Oxidation-reduction potential.
76. Salt chlorinator - An electronic device that produces free chlorine from sodium chloride.
77. Scaling - The deposition (usually calcium carbonate) on pool walls, pipework, etc.
78. Sensor - An electrical or electronic device for measuring a specific parameter, for example pH, water flow, chlorine, ORP, temperature.
79. Shock dosing (superchlorination) - Reactive dosing of higher levels of chlorine to combat chloramines, growth of algae and other forms of contamination. It needs to be followed by dechlorination – if only by allowing sufficient time for residuals to fall to acceptable levels.
80. Sodium bicarbonate (bicarb) Used to raise total alkalinity.
81. Sodium bisulphate (dry acid) Used to lower pH.
82. Sodium carbonate (soda ash) Used to raise pH.
83. Sodium chloride (common salt) Added to pools with salt chlorinators.

84. Sodium thiosulphate pentahydrate Used for dechlorination of pool water (eg where free chlorine levels are excessive) and microbiological samples.
85. Total alkalinity - Measure of alkalinity used to determine pH buffering capacity of pool water.
86. Total chlorine - A measure of free plus combined chlorine.
87. Total dissolved solids (TDS) - A measure of all the solids dissolved in the pool water measured in mg/l
88. Trichlor Trichloroisocyanuric acid (also called Symclosene) - a type of stabilised chlorine usually in tablet form.
89. Trihalomethanes - Compounds formed by reaction between chlorine or bromine and humic acid and other contaminants.
90. Turbidity Cloudiness, murkiness or lack of clarity in water caused by colloidal or particulate matter in suspension.
91. Turnover period - The time taken for a volume of water equivalent to the entire pool volume to pass through the filtration and circulation system once. The shorter it is, the more frequent and thorough the water treatment.
92. Ultra-violet light (UV) - Used as a point source non-residual disinfectant and to reduce chloramines.

16. Annex A

16.1) The Law

This section is provided to aid awareness and understanding. It looks at the legislation and court judgements that affect safety and outlines your responsibilities under the law. References in this chapter are to legislation for England and Wales. There are differences in the legislation in Scotland (also covered here).

Someone injured through your negligence can bring an action for damages against you in a civil court of law. If you are found negligent, you may be ordered to pay compensation for loss of earnings, medical expenses, pain, suffering and the like.

Claims for damages after accidents are perceived to be on the increase, with solicitors and accident claim practitioners touting for new business by offering no win no fee terms. Concern about the growth of the compensation culture led to the introduction of the Compensation Act in 2006. This brought in changes to the law on liability and breach of statutory duty aimed at tackling perceptions that can lead to a disproportionate fear of litigation and risk-averse behaviour. Despite this, Lord Young states in his 2010 report *Common Sense, Common Safety*, the problem of the compensation culture prevalent in society today is one of perception rather than reality. The number of claims for damages due to an accident or disease has increased slowly but nevertheless significantly over recent years. Furthermore, there is clear evidence that the public believes that the number of claims and the amount paid out in damages have also risen significantly.

Not only organisations but also individuals can face prosecution in a criminal court for not complying with legal duties imposed by government legislation. You can be fined, or even face imprisonment, if found guilty in a criminal court.

16.2) Criminal law

Health and Safety Legislation
Health and Safety at Work etc. Act 1974
A criminal offence will arise from a failure to comply with legal duties imposed by the Health and Safety at Work etc. Act 1974 (HSWA) and regulations made under it.
This legislation places a duty on employers to ensure, as far as is reasonably practicable, that in the course of conducting their undertaking, employees and members of the public are not put at risk.

The phrase ‘conducting their undertaking’ also includes cleaning, maintenance and repair of the plant, machinery and buildings necessary for carrying on the business. The employer cannot delegate responsibility for this duty. Therefore, in effect, you need to consider the consequences of the actions of contractors as well as your employees.

You need to consider the cost and effectiveness of any precautions that you can take to minimise risk of harm. If a precaution is cheap, easy to take and is very effective, then it is reasonable to implement it even if the risk of harm is small. If the risk of harm is great, then more expensive precautions may be reasonable.

16.3) Enforcement of health and safety legislation

Responsibility for the enforcement of health and safety legislation rests with the Health and Safety Executive (HSE) and local authorities. Their inspectors have powers to investigate incidents and complaints or carry out routine inspections. When there has been a breach of health and safety law the enforcing authority can serve improvement or prohibition notices or prosecute.

The local authority will be the enforcing authority for most privately owned pools whereas the HSE is responsible for public pools.

Where an offence is committed with the 'consent, connivance or neglect of any director, manager, secretary or other similar officer', that person may be guilty of an offence along with the organisation. If the breach in the law results in death, the police are involved and they may refer the case to the Crown Prosecution Service.

16.4) The Corporate Manslaughter and Corporate Homicide Act 2007

This created a criminal offence of corporate manslaughter in England, Wales and Northern Ireland and corporate culpable homicide in Scotland. This Act applies to all companies, most government bodies, partnerships, trade unions, employers' associations and incorporated charities. Crown immunity has been largely abolished. The Act does not apply to unincorporated bodies such as some charities, friendly societies etc., or individuals.

Corporate manslaughter and corporate homicide investigations are led by the police. They can be lengthy and intrusive. The existing provisions of the HSWA still apply.

16.5) Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH)

Chemicals and microorganisms that may cause ill health are subject to the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended). These Regulations require an employer or self-employed person to:

- Assess the risks to employees, self-employed people and the public from exposure to hazardous substances, including micro-organisms.
- Prevent, or, where this is not reasonably practicable, adequately control exposure to the hazardous substances.
- Introduce and maintain control measures.
- Inform, instruct and train employees about the risks and precautions to be taken.
- Inform visitors about the risks and precautions to be taken.
- Regularly review the assessment and the effectiveness of control measures.

16.6) Management of Health and Safety at Work Regulations 1999 as amended

The Management of Health and Safety at Work Regulations 1999 require you to carry out risk assessments to identify hazards and take any necessary steps to reduce the risk of an incident. Regulation 3(1)(b) states:
Every employer shall make a suitable and sufficient assessment of—
(a) The risks to the health and safety of his employees to which they are exposed whilst they are at work;
(b) The risks to the health and safety of persons not in his employment arising out of or in connection with the conduct by him of his undertaking

In effect (b) means that your risk assessments should consider the risks to visitors you invite onto your property, or other people who might be affected by your undertaking or your activities.

Regulation 5 states:
'Every employer shall make and give effect to such arrangements as are appropriate, having regard to the nature of his activities and the size of his undertaking, for the effective planning, organisation, control, monitoring and review of his preventive and protective measures.'
Where the employer employs five or more employees, the arrangements should be recorded.

16.7) Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1999 (RIDDOR)

You are legally bound under RIDDOR to report within 7 days certain accidents, dangerous occurrences and types of ill health to the enforcing authority. They may well send an inspector to investigate. The authority will also investigate complaints made by members of the public. It is essential that you are able to demonstrate that you have effective procedures in place to identify and manage risk

16.8) Public Health legislation

The Health Protection Regulations 2010 (England & Wales) apply
Where voluntary cooperation to avert a health risk cannot be secured and where other methods of control are ineffective, unsuitable or disproportionate to the risk involved.

The Department of Health has published guidance that was written by Public Health England and the Chartered Institute of Environmental Health, which describes how these powers should be used. [link/ref?]

Powers that impose restrictions or requirements are conditional. The local authority makes an application to a magistrate who must be satisfied that the relevant criteria are met. The criteria cover evidence of infection or contamination, assessment of the potential for significant harm to human health, risk of spread to others and necessity for action to be taken in order to reduce or remove that risk. The legislation also contains various safeguards for people who might be subject to the legal measures.

The measures are contained in the Public Health (Control of Disease) Act 1984 (as amended) together with the Health Protection (Local Authority Powers) Regulations 2010 and the Health Protection (Part 2A Orders) Regulations 2010 .

16.9) Civil law

The foundation of most personal injury actions is in proving negligence under common law. An action for damages is brought in the civil courts.
To win an action and be awarded compensation the injured person must be able to demonstrate that they were owed a duty of care, and there was a breach of that duty leading to the injury.
A civil case can also be brought for breach of statutory duty that results in injury or ill health.
Common law duties essentially derive from decisions made by judges over the years. Under common law you owe someone a duty of care if there is:

- Sufficient proximity between you and the person injured, and it was
- Reasonable to foresee that harm may result from your actions, and
- It is fair, just and reasonable to impose a duty of care on you.

Proximity can be geographical, contractual, or through a care relationship (for example between teacher and child). If you breach that duty of care, and foreseeable physical or psychological damage results, then you are liable to negligence. Employers may be held liable for the negligence of their employees (this is called vicarious liability).

Visitors must take reasonable care for their own safety. If they don't and come to harm, then their 'contributory negligence' would lessen any claim against you.
Note that children cannot be expected to appreciate dangers in the same way as adults. It is highly unlikely that contributory negligence could be attributed to the actions of a very young child. Adults, however, will be expected to exercise responsibility for children in their care.

In civil law, the duty of care has been further defined by legislation.
Under the Occupiers' Liability Acts of 1957 (OLA57) and 1984 (OLA84), the occupier of premises owes a duty of care to lawful visitors (OLA57) and trespassers (OLA84), by reason of the state of the premises and things done or omitted to be done on them. In Scotland, a similar duty of care is owed under the Occupiers' Liability (Scotland) Act 1960.

The 'occupier' is the person or body that has sufficient control over the premises to be in a position to take the steps necessary to protect people who otherwise may be at risk.
If there is more than one occupier, each owes a duty of care that is in relation to the degree of control each has over the premises.

An occupier has the duty of care and cannot delegate this duty to someone else. So, in effect, you may be responsible for the actions of contractors working on your behalf.

Visitors

Under Section 2(2) of the OLA57, the occupier has:
'A duty to take such care as in all the circumstances of the case is reasonable to see that the visitor will be reasonably safe in using the premises for the purposes for which he is invited or permitted by the occupier to be there.'

- You must consider the particular needs of people you invite onto your property.
- You must be able to demonstrate that your precautions are reasonable in the circumstances.
- You must be prepared for children to be less careful than adults. Furthermore, a warning sign, however clear in itself, cannot warn if the child is unable to read. However, in some circumstances, particularly in the case of a young child, the parent may hold the primary duty of care.

Warning a visitor of dangers might be sufficient to absolve you from liability, but only if it was sufficient to enable the visitor to be reasonably safe.

Under OLA57, you can choose to restrict or exclude your liability by imposing entry conditions. However, the Unfair Contract Terms Act 1977 says:
'A person cannot by reference to any contract term or to a notice exclude or restrict his liability for death or personal injury resulting from negligence.'
In the case of other loss or damage, liability can be excluded or restricted only if the terms are reasonable.

17. Annex B

17.1) Model Pool Technical Operational Procedures

What a pool technical operational procedures look like:

1. Statement of policy
For example
Our intention is to always provide a swimming pool technical operation that is safe, healthy and environmentally friendly. We shall maintain compliance with the PWTAG Code of Practice and where relevant other national and European standards

2. Management system
The person responsible for writing and reviewing the PTOP for this pool is………
We carry out a formal review of our written plan on an annual basis and or whenever we carry out major adaptations or if there is a notable incident affecting pool water safety
We provide training and qualification for the key staff at the pool which is always maintained within currency requirements and /or employ certified personnel to undertake key roles as essential to comply with PWTAG Code of Practice

3. Staff structure and responsibilities
For this pool we always ensure that a Swimming Pool Technical Operator is on duty during all hours of the pools operation

4. Description of pool(s) and operation
25m x 12.5m public pool with 12.5 X 8m teaching pool open to the public from 7am to 10pm Monday to Friday and 7am to 8pm Saturday and Sunday 50 weeks of the year

5. Schematic of swimming pool system and key indicators
Our simple schematic plan of the pool is attached
Key indicators
Medium rate sand filters
100 % surface water removal
Turn over period 3 hours
Maximum capacity bathers 100 bathers
Disinfection is Sodium Hypochlorite
pH correction is CO_2

6. Normal operational procedures for the pool water, heating and ventilation plant
Nb include the relevant clauses of PWTAG CoP sections 3 to 14

For example:

6.1 water treatment
The water treatment system for the pool is based upon PWTAG requirements, European and national standards and takes into account
- Public health hazards
- Mains water quality and storage, dilution and drainage, coagulation, filtration and disinfection
- The size and type of pool, bathing load, circulation rate, circulation hydraulics and turnover period
- Pool operation, water treatment system and plant room.

6.2 Public health hazards
Our risk assessment for this pool considers the following hazards:
- Death through drowning, including hair and limb entrapment

- Neck and head injuries from diving into shallow water or hitting other swimmers
- Injuries from falls, slipping, etc.
- Ingestion of pool water containing pathogens including the protozoal parasites C*cryptosporidium and Ggiardia* that can cause gastroenteritis
- Contact with contaminated water, especially in contact with open wounds
- Inhalation of aerosols containing hazards e.g. *Legionella* species in distributed water, such as when using showers, but also from water jets and indoor fountains
- Skin infections of the feet, including warts, verruca's and athlete's foot
- Possible exacerbation of asthma due to excessive disinfection byproducts in the air
- Illness from water contaminated by chemicals
- Potential drowning where cloudy water prevents surveillance of swimmers under the water
- Cuts and abrasions due to sharp edges, cracked tiles etc.

6.3 Mains water quality
Our water treatment system takes into account the mains water characteristics

6.4 Pool water clarity
We monitor pool water quality to ensure no danger to bathers

6.5 Primary disinfection
Our primary disinfection is sodium hypochlorite which is monitored and dosed automatically.

6.6 Secondary disinfection
This pool uses UV to help prevent the threat from *Cryptosporidium* and to limit combined chlorine. The system installed and dosed in accordance with PWTAG requirement

6.7 Dilution with fresh water
We replace pool water with fresh mains water as a regular part of the water treatment regime with up to 30 litres per bather according to pool bather usage.

6.8 Bathing load
The maximum bathing load (number of bathers) allowed for at any one time is……………

6.9 Turnover period
The turnover period for this pool is ……………………..

6.10 Dye testing
This pool was dye tested when first commissioned

6.11 Water circulation
This pool operates the water treatment system continuously

6.12 Surface water removal
This pool uses a deck level surface water removal system and bottom drains. 80% of the water removal is from the surface

6.13 Inlets and outlets
Inlets and outlets, grilles and covers are in accordance with BS EN 13451-3. They are inspected visually every day, and once a month subject to closer examination for obstruction, impact damage and vandalism and to make sure that they are correctly in place. If they are damaged or missing, swimming is suspended immediately.

6.14 Filters and filtration rate
This pool uses medium-rate pressure filters; with sand as the main filter medium.

6.15 Serviceable filters
The filters are designed in accordance with PWTAG requirements

6.16 Annual inspection
The filters are inspected annually for corrosion and problems with the filter medium

6.17 Backwashing
Filters are backwashed at least once a week and whenever the pressure loss across the filter media bed reaches the level specified, at the end of bathing for the day.

Our filters have flow meters fitted between the circulation pumps and filters to monitor the system's flow rate during normal operation, and backwashing rate.

6.18 Coagulation
We dose PAC continuously, at a rate of 0.1ml/m^3 of the total flow rate.

6.19 Bather hygiene procedures
We have notices at reception saying that bathers:
- With infections should not use the pool
- With diarrhoea must not swim – then, or for 48 hours afterwards.
- Who have been diagnosed with cryptosporidiosis must not swim for 14 days after diarrhoea has stopped.

6.20 Pre-swim hygiene
We provide pre-swim showers and toilets en-route to the pool and encourage everyone to use them before swimming. Hand washbasins with liquid soap and hand-drying facilities are provided. Staff and notices enforce all operational procedures including when not to use the pool during and after diarrhoeal illness.

6.21 Babies and very young children
We have special periods when babies and very young children are encouraged to use the pool. We insist that babies use appropriate swim wear to help prevent faecal release in the pool and provide excellent baby changing facilities

6.22 Pool cleaning - equipment and surfaces
All floors in the pool hall area, changing rooms, toilet and shower areas are thoroughly cleaned each day. We ensure that floor-cleaning materials do not enter the pool water

6.23 Showers
Showers comply with HSG 274 part 2 *The control of legionella bacteria in hot and cold water systems* and are cleaned and descaled in accordance with HSG 274 part 2 requirements

6.24 Pool covers
Pool covers are checked regularly for any contamination and cleaned as necessary with 100mg/l chlorinated water

6.25 Pool equipment
All equipment is checked to ensure it is hygienic and clean before being used in the pool.

6.26 Transfer channels
Deck-level transfer is cleaned as required, at least once a month.

6.27 Balance tanks
Balance tanks are inspected at least once a year and cleaned as necessary.

6.28 Pool bottom
The pool bottom is kept clear of contamination, algae, and general debris by daily sweeping, suction cleaning.

6.29 Monitoring water quality
We have documented procedures for testing the pool water, which follow the guidance of PWTAG and the kit instructions, and operators are given full training in their use for monitoring pool water quality. The documented procedures include detail actions for operators to take if there are unexpected test results, especially if they show the pool water chemical composition is either below or exceeding safe limits.

We test the water chemically every 2 hours and the target levels for pH and disinfection are pH7.0 to 7.4
Free chlorine 0.5mg/l to 1.0mg/l
Combined Chlorine nil or up to a maximum of 0.5mg/l

On a weekly basis we test the water for balance and chemical levels
Alkalinity between 80 and 200mg/l
TDS no more than 1000 above the source water
Calcium hardness between 75 and 150mg/l

Automatic monitoring of chemical levels
The readouts from the controller are checked daily against the results from manual tests of the sample cell. The manufacturers' recommendations for the calibration of the equipment, including the use of suitable test solutions, are followed. Records of all calibration tests and results are recorded on log sheets and retained.

pH
Readouts from the controller are checked daily against the results from manual tests of the sample cell. If the difference is more than 0.2, the controller is recalibrated

Disinfection
Readouts from the controller are checked daily against the results from manual tests of the sample cell. If the difference is more than 15%, the controller is recalibrated after first confirming the result with a further manual test.

6.30 Microbiological testing
The swimming pool is microbiologically tested each month to monitor for the presence of potentially harmful microorganisms by the following ………………………….. UKAS-accredited laboratory.

Tests are also done

- Before it is put back into use, after having been shut down eg for repairs
- If there are difficulties with the treatment system
- If contamination has been noted
- As part of any investigation into possible adverse effects on bathers' health.

The required microbiological conditions are in accordance with the PWTAG Code of Practice

6.31 Acting on failures/pool closure
Step 1 If a result is unsatisfactory, a preliminary investigation is undertaken and the test repeated as soon as practicable.
Step 2 If the second result is also unsatisfactory, we investigate further and the test repeated.
Step 3 If the third result is still unsatisfactory, we take immediate remedial action

6.32 plant room
The plant room is a secure area not accessible by unauthorised persons. It is not used for general storage, or for storing hazardous chemicals, unless chemicals are in containment structures or devices designed to control spillages with adequate separation from other chemicals and substances stored in the plant room;

Plant, including electrical equipment is inspected and maintained in accordance with a planned programme.

6.33 Safety systems provided and maintained
Relevant safety systems and safety equipment and personal protective equipment is held in the plant room, maintained in accordance with a planned programme. Monthly inspection of personal protective equipment is carried out to check its continuing suitability.

6.34 Confined spaces
Staff are not permitted to work in confined spaces

6.35 Chemical safety - COSHH
Pool management ensure a competent person assess the risks associated with hazardous substances in the workplace and that we put in place procedures to eliminate or control those risks.

These procedures are systematically recorded to include:

- Identification of the hazards
- Disinfection and pH chemicals
- Identification of who might be harmed and how
- Swimming pool technical staff
- Evaluation of the risks arising from the hazards, and decisions about precautions
- Based upon the Safety Data Sheets

- The findings are recorded here
- Sodium Hypochlorite
- CO_2
- PAC

- Cleaning materials
- We carry out regular review of the assessments and make necessary revisions.

We ensure SDSs are provided and available for all the chemicals in the plant room including pool chemicals, cleaning chemicals, pool water testing chemicals and chemicals used in maintenance programmes.

6.36 Training in chemical handling
W provide all staff involved in the handling and use of chemicals with appropriate training and instruction.

6.37 Personal protective equipment (PPE)
Pool management take the advice of suppliers about what PPE is needed and ensure that this is provided and maintained:
Gloves
Overalls
Goggles
Foot wear
Respirators

6.38 Chemical spillage
Any spillage is cleared away using a safe method agreed between chemical supplier and pool operator. The method is displayed on a notice, together with the provision of the necessary equipment and its location.

6.39 Safety information on site
Precaution cards and first aid instructions are displayed for each chemical.

6.40 First aid
First aid provision including equipment for dealing with the consequences of direct contact with chemicals is provided which includes.

- Eyewash facilities should be located in close proximity to the hazard to enable immediate action.
- A wash-basin with running water should be provided in case chemicals come into contact with the skin or eyes.

6.41 Delivery of chemicals
Everyone involved in the transport, handling and storage of pool chemicals receives initial and refresher training in the procedures involved

Deliveries proceed only when a trained staff member is available to receive and check the materials.

6.42 Bulk delivery of sodium hypochlorite and hydrochloric acid
There are documented procedures for transfer and handling during delivery. Suppliers help to establish and must comply with these procedures.

Pipework is clearly labelled and specific to the delivery of that product, Pipework fill points are clearly labelled and locked when not in use.

6.43 Transport from offloading area to store
Chemical containers are taken to a suitable storage area as soon as possible; not left unattended in an offloading area; are kept upright and never rolled; and are used in stock rotation.
The method of handling chemical containers is described in these procedures and staff informed and trained in these

6.44 Chemical store
Chemical stores are kept clean and dry for the storage of solid materials, protected from sunlight and hot pipework or plant. Chemical stores have warning signs, are secure and accessible only to authorised, appropriately trained people

6.45 Dosing
Hand dosing in normal operation is not permitted at this pool

6.46 Chemical dosing operations
Written procedures are provided for day tank filling, mixing or diluting chemicals and cleaning injectors.

Chemical dosing systems monitors and automatic controls are interlinked with the circulation pumps and the circulation of water through the system, so that dosing stops if there is pump failure or significant loss of pumping rate. These systems are designed to always fail to safety and require manual restart when circulation is restored.

6.47 Chemical line safety
All chemical pipework, suction lines, delivery lines and tanks is marked to identify the contents and the direction of flow.

All pipes used for delivery of chemicals to injection points are double sheathed.

Disinfectant and pH dosing systems are kept separate.

Dosing sets are separated in individual bunds.

6.49 Preparing dosing chemicals
Chemicals are added to water and never the other way round when preparing solutions.
Non-liquid chemicals are kept dry until dissolved in water.

6.5 Heating and air circulation
This pool maintains the following temperatures

Pool use	Temperature range (°C)
Competitive swimming and diving, fitness swimming, training	26-28
Recreational swimming and adult teaching	27-29
Leisure waters	28-30
Children's teaching	29-31
Babies, young children, disabled and infirm	30-32

6.6 Pool hall air
The pool hall air temperatures are maintained at no more than 1deg C above or below that of the water temperature. Air temperatures over 30°C are not permitted.
Relative humidity is maintained at a level of 60% (no less than 50%, no more than 70%) throughout the pool hall area.

Ventilation systems are designed and operated to provide a level of fresh air for each occupant of the pool hall (bathers, staff and spectators).

8 Emergency Procedures for pool water, heating and ventilation plant
Nb include the relevant clauses of PWTAG CoP sections 3 to 14

For example

8.1 Faecal accidents and *Cryptosporidium*
This pool has a written agreed procedure for dealing with faecal fouling which follows the guidance on the PWTAG website and in the Code of Practice

8.2 Blood and vomit pool water contamination
If significant amounts of blood are spilled into the pool, it is temporarily cleared of people, to allow the pollution to disperse and any infective particles to be neutralised by the residual disinfectant. We then confirm that disinfectant residuals and pH values are within the recommended ranges and bathing can then resume.

8.3 Contamination of pool surround
Any blood spillage on the poolside is dealt with using strong disinfectant – of a concentration equivalent to 10,000mg/l of available chlorine. The blood is covered with paper towels, gently flooded with the disinfectant and left for at least two minutes before it is cleared away.

8.4 Vomit in the pool
Our procedures for vomit in the pool and vomit on the poolside are the same as when dealing with blood.

8.5 Pool closure and Microbiological contamination

We close the pool immediately if there is chemical or physical evidence of unsatisfactory disinfection eg poor clarity or low free chlorine concentration.

The pool is closed if microbiological testing indicates gross contamination, which means one of two things:
1 *E. coli* over 10 per 10 ml PLUS either colony count over 10 cfu per ml or *Pseudomonas aeruginosa* over 10 per 100ml (or, of course, both)
2. *Pseudomonas aeruginosa* over 50 per 100ml PLUS colony count over 100 per ml.

8.6 **Toxic gas leaks**
There is an emergency action plan for dealing with any major release of toxic gas.
The procedure includes Safety of staff and customers arrangements for any necessary evacuation co-ordination with emergency services, who are consulted in the preparation of this plan

9 Records and logs
For example
- Daily swimming pool water log
- Monthly bacteriological log
- Swimming pool water incident log and faecal accident log
- Automatic monitoring calibration
- Monthly inspection of safety equipment and PPE
- Staff training in handling chemicals
- Staff training in pool water testing

18. ANNEX C Dye test

[new requirements to come from BS EN 15288]

The pool water is first de-chlorinated using sodium thiosulphate pentahydrate or equivalent.
1 Any ozone treatment plant or carbon filters are bypassed (and the flow rate restored to what it was before the bypass); other filters not bypassed should be clean.
2 There are a number of different dyes used, and the precise nature of the test will be affected by that choice. Eriochrome black T (solochrome) is used dosed at 0.2g/m^3 of pool water; potassium permanganate is dosed at 0.3g/m^3 (UV as well as ozone treatment plant should be by-passed if permanganate is used). The dye is dosed for 5-10 minutes. It is added to the pool close to the chlorine dosing point, usually through a chemical dosing pump or strainer box.
3 The time taken for the pool water to become evenly coloured gives a first measure of the adequacy of the distribution system. This should be achieved within 15 minutes for the result to be satisfactory.
4 Once the colouration of the pool is completed, the dye should be removed without delay using chlorine, ozone or equivalent. As well as avoiding any staining, this addition initiates the second part of the test. 5mg/l of chlorine should clear the dye colour in 15 minutes to confirm the test result.

19.ANNEX D - Hair entrapment test

1 A hair probe is made of 50g of natural or of a good quality synthetic, both medium to fine, straight, 400mm in free length. The hair probe shall be in good condition; tangle free and the end of single strand may not be jagged.
2 One side of hair probe is attached to a rod of 25 to 30mm diameter. The rod should be at least 300mm long.
3 A dynamometer with an accuracy of 0.5N, to determine the traction force against the entanglement, is needed.
4 For the on-site test, the pool has to be in full operation. The test may be carried out from basin edge, water surface or by diving or robotic equipment.
5 Saturate the hair for at least 2min in pool water. After being saturated, place the free end of the hair approximately 300mm in front of the device and above the uppermost surface of the face of the device
6 Slowly move the hair ends closer to the device and feed the highest possible quantity of hair ends into the device itself in the direction of the intake flow. Continue to feed the hair slowly by moving the rod from side to side while shortening each pass for at least 60 seconds until ideally at least 50% of the length has been sucked in. In any case a length suitable to detect the presents of turbulence behind the grille has to be fed in. Then lay the rest of the hair against the device, in such a way that the hair remains in contact with it for at least 30 seconds.

7 The surface of the device is divided into areas of about 50 x 50cm. In the centre of each area and additionally above the pipe, where the water speeds is highest, one test is done. If the hair does not get sucked into the sump the test is passed. With the pump still operating, test the pulling force necessary to free the hair from the device. Measure the force of entanglement.
8 Repeat the test three times for each area. For devices with perforated plates, grilles (eg with a larger surface) move the free end of the hair over and against the whole surface. Detect if the hair probe gets sucked.
9 If one device serves more than one attraction, the test is done at the maximum of the possible flow rate.
10 Brush hair periodically, to keep tangle-free.

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