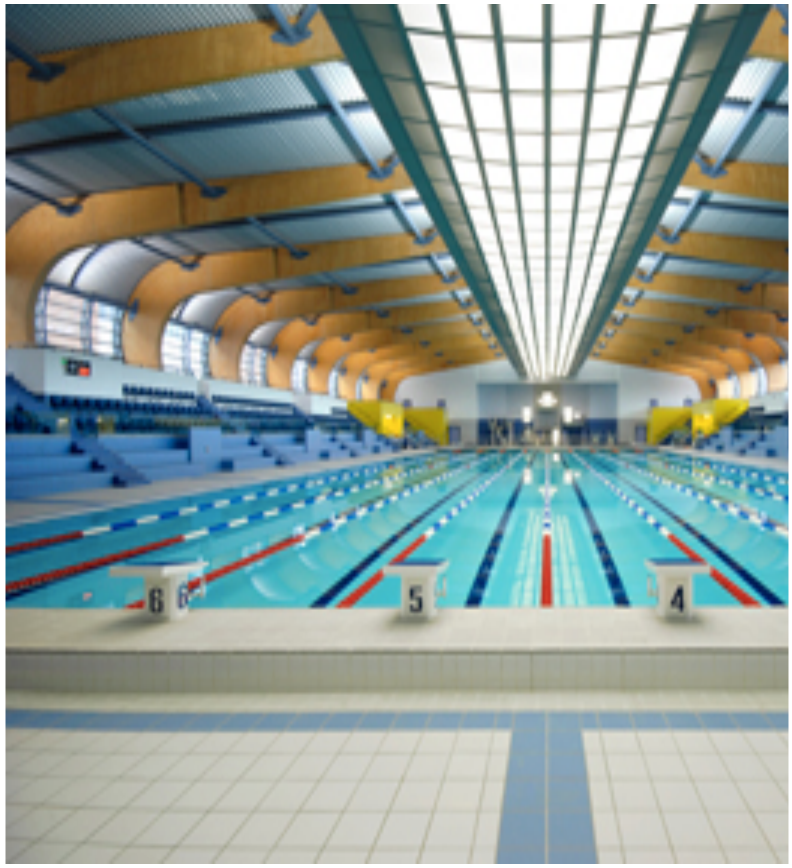

Code of Practice

THE MANAGEMENT AND TREATMENT OF SWIMMING POOL WATER

Pool Water Treatment Advisory Group

January 2013

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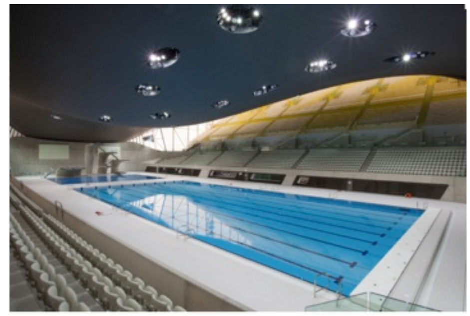


Code of Practice

THE MANAGEMENT AND TREATMENT OF SWIMMING POOL WATER

FOREWORD

While drinking water and even coastal waters are subject to regulation in the UK, there is no equivalent specific regulation for the control of swimming pool water quality.

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 2009), as updated by technical notes available from www.pwtag.org.

The CoP provides a practical summary of the recommendations and guidelines in the book, but also a specific charter to which pool operators can adhere and against which their operation can be evaluated.

PWTAG reserves the right to withdraw or amend this CoP, which will be reviewed at intervals not exceeding two years; any amendments arising from the review will be published in an amended CoP and publicised on the PWTAG website.

PWTAG acknowledges the support of these organisations, who were consulted in the development of its CoP: Amateur Swimming Association, British Association for Chemical Specialities, British Holiday and Home Parks Association, Chartered Institute for the Management of Sport & Physical Activity, DEFRA Drinking Water Inspectorate, Fitness Industry Association, Health Protection Agency, Health & Safety Executive, Institute of Engineers of Ireland, Institute of Swimming Pool Engineers, Public Health Wales, Royal Society of Public Health, Sport England, Sport Scotland, Swimming Pool & Allied Trades Association, Swimming Teachers Association, UK National Cryptosporidium Reference Unit. This CoP does not purport to contain all necessary provisions of a contract. Users are responsible for its correct application. Compliance does not of itself confer immunity from legal obligations.

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.

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 operation in accordance with PWTAG's book, *Swimming Pool Water: treatment and quality standards for pools and spas*, and associated technical updates (see www.pwtag.org).

1.1.1 These principles cover public health issues such as water quality, chemical risks, physical risks (eg drowning, slips and trips, entrapment) and infection (*Cryptosporidium*, *Legionella*, other water-borne illnesses).
1.1.2 It covers good practice from design and engineering through to operational management and training.

1.2 Good practice

The CoP focuses clearly on good practice. It provides firm guidelines for public pools; these guidelines can and should apply to other types of pools, including those who do not aspire to adopt all of this CoP.

1.3 Standards

The CoP assumes that the pool is designed in accordance with accepted practice; it then details the operational requirements for pools, depending upon their characteristics. The CoP is based principally on published guidance from PWTAG, but also on material from the Health and Safety Executive, the Health Protection Agency, Public Health Wales and the World Health Organisation; also on BSEN standards.

1.4 Water safety plan

A pool should have a plan that identifies all likely hazards from contaminated drinking and bathing water and aerosols. A full Water Safety Plan (see annex A) is the preferred approach. A risk assessment, using formal hazard analysis, targets each system in the facility, and prescribes criteria, targets and controls for ensuring each is dealt with. Verification, training, communication and review are critical.

1.5 Types of pool covered by the code of practice

The CoP covers swimming pools as defined in British and European standards:
1.5.1 Swimming pool type 1 – pools where the water-related activities are the main business (eg communal pools, leisure pools, water parks, aqua parks) and whose use is public.
1.5.2 Swimming pool type 2 – pools which are an additional service to the main business (eg school, hotel, camping, club, therapeutic) and whose use is public.
1.5.3 The CoP does not cover:

- hydrotherapy pools in hospitals
- spa pools
- natural (green) bathing pools
- interactive water features
- paddling pools
- domestic pools

The water treatment issues around these other types of pool are dealt with in *Swimming Pool Water: treatment and quality standards for pools and spas.*

2 REFERENCES

2.1 The following documents contain provisions which, through reference in this text, constitute elements of this CoP. For dated references, subsequent amendments or revisions do not apply. For undated references, the latest edition of the publication referred to applies.

2.1.1 *Swimming pool water: treatment and quality standards for pools and spas*. Pool Water Treatment Advisory Group 2009, ISBN 0951700766.

2.1.2 *Guidelines for swimming pools and similar environments*, World Health Organisation, June 2006 (being revised).

2.1.3 *Managing Health & Safety in Swimming Pools* (HSG 179); ISBN 0717626865 Health & Safety Executive (HSE) 2003 (being revised)

2.1.4 *Management of Spa Pools: controlling the risk of infection*, Health Protection Agency (HPA)/HSE, ISBN 0901144800 March 2006

2.1.5 *Swimming Pool Equipment* BS EN parts 13451 1 to 11. The Design Construction Management and Operation of Swimming Pools BS EN 15288 parts 1 & 2 2008

2.1.6 *Swimming Pool Design,* Sport England 2011

2.1.7 *Guidance for the investigation of Cryptosporidium linked to swimming pools 2011,* Public Health Wales

3 TERMS AND DEFINITIONS

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

3.1 Acid A chemical with a pH of less than 7.0, used to lower the pH value when added to pool water.

3.2 Activated carbon Carbon treated for use as an adsorption filter medium.

3.3 Air scour Air forced up through a filter bed prior to backwash to expand the filter media and loosen dirt particles.

3.4 Algae Simple form of microscopic plant life that thrives in sunlight and can make pool water cloudy.

3.5 Algicide A chemical that aids in killing, controlling and preventing algae.

3.6 Alkali A chemical with a pH above 7.0 used to raise the pH value of pool water; also called a base.

3.7 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.

3.8 Aluminium sulphate (alum) A coagulant, usually crystalline.

3.9 Ammonia A chemical formed from the breakdown of urea in urine and sweat.

3.10 Amperometric sensor Pool water sensor that measures, for example, hypochlorous acid.

3.11 Backwashing Cleaning of the filter by reversing the direction of water flow up through the filter media to waste.

3.12 Backwash holding (attenuation) tank A reservoir needed where the drainage system cannot accept the full backwash flow.

3.13 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.

3.14 Bather load A measure of the number of bathers in a pool over a set period of time.

3.15 BCDMH Bromo-chloro-dimethyl-hydantoin: a solid type of bromine disinfectant.

3.16 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.

3.17 Bromamines A disinfection byproduct from the action of bromine on ammonia and other nitrogenous wastes.

3.18 Bulk 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.

3.19 Bund A spillage containment tank for chemicals.

3.20 Buffer A chemical (or mixture of chemicals) which helps pool water resist changes in pH value.

3.21 Calcium chloride Used to increase calcium hardness.

3.22 Calcium hardness A measure of the calcium salts dissolved in pool water.

3.23 Calorifier A heat exchanger used to heat pool water indirectly.

3.24 Carbon dioxide A gas which dissolves in water to form the weak carbonic acid, used to lower pH.

3.25 Chloramine Disinfection byproduct from the action of chlorine on ammonia and other nitrogenous wastes.

3.26 Chloroform A product of the reaction between chlorine and organic nitrogen compounds; one of the trihalomethanes.

3.27 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.

3.28 Coagulation The action of a coagulant.

3.29 Coliforms Bacteria, universally present in the faeces of mammals, of which *E coli* is an example.

3.30 Collectors (laterals, filter nozzles, underdrains) Interior bottom part of the filter that collects the filtered return water.
3.31 Colloids Very fine suspended matter in water, which does not settle and contributes to turbidity.
3.32 Conductivity Electrical measurement of ions in water used to estimate total dissolved solids in swimming pool water.
3.33 Combined chlorine A measure of the chloramines in pool water.
3.34 Cyanuric acid A stabiliser that can be added to pool water to reduce chlorine loss due to sunlight.
3.35 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).
3.36 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.
3.37 Disinfection Process of inactivating potentially harmful microorganisms in pool water.
3.38 De-ozonation Removing ozone from water before it returns to the pool.
3.39 Diatomaceous earth A powder consisting of fossilised skeletal remains of microscopic marine plant life; used in some filters.
3.40 Dichlor Short for sodium dichloro-isocyanurate dihydrate (and also called troclosene). A type of stabilised pool chlorine disinfection.
3.41 *E coli* (*Escherichia coli*) A bacterium in human or animal faeces – one of the coliform organisms routinely monitored for signs of faecal pollution.
3.42 Erosion feeder A simple device that allows a steady flow of water to erode a stick or tablet of disinfectant, liberating the active ingredient.
3.43 Filtration Removal of colloidal and particulate matter by passing the pool water through filter media, usually a sand bed.
3.44 Filtration rate The velocity of water through a filter, measured as metres per hour (m/h), equivalent to $m^3/m^2/h$.
3.45 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.
3.46 Flooded suction Describes the arrangement where the pump and suction pipework are below pool water level.
3.47 Flow meters Measure normal flow and the backwash flow rate.
3.48 Fluidisation Suspension of the filter media when backwashing and sometimes air scouring.
3.49 Folliculitis An infection of the hair follicle caused by bacteria, usually *Pseudomonas aeruginosa.*
3.50 Free chlorine A measure of the chlorine residual (the sum of hypochlorous acid and hypochlorite ion) that is available for disinfection.

3.51 Gas chlorinator A device that controls the release of chlorine gas from bulk supply.
3.52 Halogen The chemical family that includes chlorine and bromine (and iodine).
3.53 Hardness A measure of all the calcium and magnesium salts in pool water (total hardness). See also calcium and permanent hardness.
3.54 Headloss The difference in water level between the upstream and downstream sides of a treatment process attributed to friction losses; sometimes called pressure drop.
3.55 Heat pump Heat pump coils remove heat or cool energy from one location and direct it to another.
3.56 Humic acid A constituent of mains water that reacts with halogen disinfectants to form trihalomethanes.
3.57 Hydrochloric acid An acid used to lower pool water pH value.
3.58 Hypobromous acid The main active factor in all bromine disinfectants.
3.59 Hypochlorite-based disinfectants (hypo) Sodium hypochlorite (liquid pool chlorine); calcium hypochlorite (solid pool chlorine).
3.60 Hypochlorous acid The main active factor in all chlorine disinfectants.
3.61 Injector Fitting enabling a chemical liquid or gas to be injected into the water circulation loop.
3.62 Ions Electrically charged chemical particles.
3.63 Langelier index A measure of the scale-forming or corrosive nature of water.
3.64 Loss of head Describes the loss of operating pressure (at the filter or pump outlet).
3.65 Make-up water Fresh water used to fill or top up pools, particularly after backwashing.
3.66 Nitrogen trichloride The most irritant of the chloramines.
3.67 Nephelometric turbidity unit (NTU) Unit of measure used in the measurement of turbidity.
3.68 Oxidation The process by which disinfectants remove pollution.
3.69 Oxidation-reduction potential (ORP) A measure of the oxidative powers of the water, which is measured in millivolts.
3.70 Ozone Gas generated on-site and used to purify pool water by oxidation.
3.71 PAC (Poly aluminium chloride) A commonly used liquid coagulant.
3.72 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.
3.73 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.
3.74 PPE Personal protective equipment: may include safety goggles, hearing protection, gloves and coveralls.
3.75 ppm Parts per million: a measurement that indicates the amount of chemical by weight in milligrams per litre of water (mg/l).
3.76 Pressure gauges Measure the headloss across the filter bed.

3.77 ORP sensors Pool water analysers that measure only the oxidative power of the water. See Oxidation-reduction potential.

3.78 Salt chlorinator An electronic device that produces free chlorine from sodium chloride.

3.79 Scaling The deposition (usually calcium carbonate) on pool walls, pipework, etc.

3.80 Sensor An electrical or electronic device for measuring a specific parameter, for example pH, water flow, chlorine, ORP, temperature.

3.81 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.

3.82 Sodium bicarbonate (bicarb) Used to raise total alkalinity.

3.83 Sodium bisulphate (dry acid) Used to lower pH.

3.84 Sodium carbonate (soda ash) Used to raise pH.

3.85 Sodium chloride (common salt) Added to pools with salt chlorinators.

3.86 Sodium thiosulphate pentahydrate Used for dechlorination of pool water (eg where free chlorine levels are excessive) and microbiological samples.

3.87 Total alkalinity Measure of alkalinity used to determine pH buffering capacity of pool water.

3.88 Total chlorine A measure of free plus combined chlorine.

3.89 Total dissolved solids (TDS) A measure of all the solids dissolved in the pool water measured in mg/l

3.90 Trichlor Trichloroisocyanuric acid (also called symclosene): a type of stabilised chlorine.

3.91 Trihalomethanes Compounds formed by reaction between chlorine or bromine and humic acid and other contaminants.

3.92 Turbidity Cloudiness, murkiness or lack of clarity in water caused by colloidal or particulate matter in suspension.

3.93 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.

3.94 Ultra-violet light (UV) Used as a point source non-residual disinfectant and to reduce chloramines.

4 MANAGEMENT

4.1 General requirements

In accordance with HSE guidance in *Managing Health and Safety in Swimming Pools*, pool management should establish and maintain Pool Safety Operational Procedures (PSOP). These should be defined in two sections – normal operation plans (NOP) and emergency action plans (EAP). The written safety policy should include management's assessment of hazards associated with all aspects of operation of the plant, and precautions to control the risk.

4.1.1 This CoP is concerned with the technical operation of a swimming pool facility and requires pool management to define and document its policy for the general operation of the swimming pool water treatment and the heating/ventilation systems. This is called the Swimming Pool Technical Operation (SPTO). The SPTO forms a part of the the risk assessment process for the whole pool facility and the subsequent formulation of pool safety operational procedures (PSOP). It may also take the form of a stand-alone document detailing a swimming pool's technical operation.

4.1.2 The pool SPTO will be based upon 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 SPTO for a pool will incorporate operational considerations that provide a healthy, enjoyable, satisfying and safe experience for users.

4.1.3 Management should, where necessary, review and revise its emergency preparedness and response procedures – in particular, after accidents and emergencies. Where practicable, the emergency procedures should be tested periodically.

4.2 Management responsibility

4.2.1 Pool management should review the water safety plan including the swimming pool water treatment system and the pool hall ventilation, heating and electrical system (SPTO) at planned intervals, at least annually, to ensure its continuing suitability, adequacy and effectiveness.

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

4.2.2.1 feedback from bathers or other users of the pool, suppliers, regulators and other external parties on the performance of the water treatment system
4.2.2.2 action taken to restore or to improve water quality
4.2.2.3 incidents or emergencies impacting upon water quality
4.2.2.4 follow-up actions from previous management reviews
4.2.2.5 external and environmental changes that could affect the swimming pool water treatment system, including any changes in regulations or national standards
4.2.2.6 recommendations for improvement.
4.2.3 **Outputs** from the management reviews should include any decisions and actions related to improvement of the effectiveness of the swimming pool water treatment system and its processes. Records from management reviews should be maintained to be used in subsequent reviews.

4.3 Measuring, monitoring, analysis and improvement

The effectiveness of the procedures and the operation of the water treatment and management system should be measured, monitored and analysed on a regular basis, to identify opportunities for improvement. As a minimum, pool management should monitor the safe and effective performance of their pool operation through:
4.3.1 bacteriological monitoring
4.3.2 chemical monitoring
4.3.3 plant and treatment systems monitoring
4.3.4 feedback from regulatory authorities and users of the pool
4.3.5 actions taken or required to ensure compliance with operational plans and procedures, including cleaning; also performance requirements
4.3.6 any corrective and preventive actions
4.3.7 responding to incidents and other emergencies.

4.4 Awareness

Pool management should establish and maintain procedures in the SPTO to make employees aware of:
4.4.1 the importance of complying with the pool procedures, and with the requirements of the SPTO
4.4.2 their roles and responsibilities in the requirements of the swimming pool management system, including the PSOP.

4.5 Competence

Only 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:

4.5.1 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 (eg secured to the plant itself)

4.5.2 be given to enough employees to ensure that plant need never be operated by untrained, unqualified staff

4.5.3 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

4.5.4 include the use, care and maintenance of personal protective equipment

4.5.5 include the use of clearly defined procedures and safe systems of work for all processes involved

4.5.6 require those who have been trained to demonstrate that they can operate and maintain the plant safely.

4.6 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 SPTO. 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 swimming pool chemicals.

4.6.1 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.

4.7 Requirements for on-site qualified technical operators

All pools should have an appropriate level of technical operation and supervision. The details depends on the type and use of pool.

4.7.1 *Full-time cover*: in order to comply with Health and Safety responsibilities and comply with this CoP, a qualified, trained and competent technical operator should be available on-site/on call during all hours of operation at any of the following:

4.7.1.1 public pool with more than $120m^2$ of water area

4.7.1.2 pool with more than $120m^3$ of water

4.7.1.3 pool with a throughput of an average of more than 200 bathers daily

4.7.1.4 hydrotherapy pool not in a hospital (*Swimming Pool Water: treatment and quality standards for pools and spas* includes guidelines for those in healthcare settings)

4.7.1.5 pool used to provide swimming lessons and swimming training

4.7.1.6 permanent school pool

4.7.1.7 facilities used by the general public and children that include interactive water features.

4.7.2 *Visiting technical operator*: all other pools or treated water facilities should have an on-site qualified, trained competent technical operator or a contract with a qualified, trained, competent technical operator for a minimum of weekly visits and assistance whenever needed. Written documentation of these visits should be available at the facility. As a minimum the written reports should indicate that:

4.7.2.1 the circulation, filtration and disinfection systems were checked and working satisfactorily; the safety equipment was noted available on site and in working condition

4.7.2.2 the pool and its infrastructure were in good condition

4.7.2.3 water chemistry and bacteriology were tested and their resulting values recorded on the report and were found to be in compliance with this code

4.7.2.4 any corrective actions were taken by the operator.

4.7.3 *Supervisory requirements – visiting technical operator*: additionally, all swimming pool water facilities without a full time, on-site qualified, trained and competent technical operator should have an on-site designated supervisor. This 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 as specified in this CoP, and should be knowledgeable and competent regarding the operation of the facility in terms as required in the pool's PSOP for both normal and emergency action plans

4.7.4 *Technical operator qualifications and certificate: a* qualified technical operator should have completed a technical operator training course that is in line with this CoP. These should always be supplemented by on-site, specific training, 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).

4.7.4.1 A qualified technical operator should have a current certificate or written documentation showing satisfactory completion of a technical operator training course. Originals or copies of such certificate 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.

4.8 Technical operation: system documentation and records

The SPTO should be maintained in paper or electronic form.

4.8.1 The SPTO should contain or refer to the following documentation:
4.8.1.1 an organisation chart showing lines of authority, responsibility and allocation of functions stemming from senior management, and contact details
4.8.1.2 the policy
4.8.1.3 procedures covering the operation and safety of the swimming pool water treatment and heating and ventilation systems
4.8.1.4 a current schematic drawing showing the swimming pool, plant and associated pipework
4.8.1.5 procedures covering the identification of noncompliance against clauses of this CoP and action to be taken to resolve such issues
4.8.1.6 emergency procedures.
4.8.2 It is imperative that pool management ensures the effective implementation of all documented procedures and instructions.
4.8.3 Records should be maintained to chronicle the technical operation of the pool and plant. It is important that records:
4.8.3.1 demonstrate that procedures have been effectively used and implemented
4.8.3.2 demonstrate compliance under the relevant clauses of this CoP
4.8.3.3 demonstrate that where compliance with clauses cannot be met, appropriate risk assessment methods have been applied to determine the safety of the system
4.8.3.4 demonstrate that appropriate means have been applied to ensure identified risks have been minimised and are within established safety limits
4.8.3.5 demonstrate that relevant and adequate qualifications and training has been provided for all staff involved in the safety and operation of water treatment, heating and ventilation systems
4.8.3.6 be identified, managed and disposed of in such a way as to ensure the integrity of the process and confidentiality of the information
4.8.3.7 be kept so that continued confidence may be demonstrated for a period of at least five years.

5 WATER TREATMENT

5.1 General

The effective technical operation and safety in any swimming pool starts with careful planning, specification and design. There are specific sources of information from which the technical design and planning standards that are recommended for swimming pools can be obtained. These are referenced above. Everyone who is 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 swimming pool water treatment plant has to take the following factors into account:

5.1.1 public health hazards
5.1.2 mains water quality and storage, dilution and drainage, coagulation, filtration and disinfection
5.1.3 size and type of pool, bathing load, circulation rate, circulation hydraulics and turnover period
5.1.4 pool operation, water treatment system and plant room.

5.2 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 entrapment
- neck injuries from diving into shallow water or hitting other swimmers
- injuries from falls, slipping, etc
- drinking contaminated water or consuming food irrigated or prepared using contaminated water
- contact with contaminated water eg during bathing in swimming and spa pools, but also during the use of beauty equipment such as nailbaths, footbaths etc, especially when contaminated water is in contact with open wounds

- inhalation of aerosols containing hazards eg *Legionella* species in distributed water, such as when using showers, but also from agitated spa pool water, water jets and indoor fountains
- aspiration pneumonia – ie contaminated water unintentionally entering the lungs following near-drowning
- skin infections of the feet, including warts, verrucas and athletes foot resulting from poor floor cleaning
- possible exacerbation of asthma due to excessive disinfection byproducts in the air.

5.3 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 safe limits.

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

In general, the importance of a balance between public health demands and consumer acceptability are similar for both drinking and swimming waters. Disinfection cannot be compromised, but can be aimed towards minimising both disinfectant levels and the formation of unwanted substances, including disinfection by-products. Dilution (see 5.8) is an important factor in this process.

5.4 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 potable water quality standards; this applies also to private water supplies. The disinfectant type should so far as is practicable be compatible with the source water supply (see 5.6.5.2).

5.5 Water clarity

Clarity of pool water is critical. It should be possible to see clearly the bottom of the pool at its deepest point. If not, there is 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, disinfection will be compromised by reduced clarity. The pool water treatment system should be capable of providing clarity of no more than 0.5 nephelometric turbidity units (NTU).

5.5.1 Clarity is reduced by turbidity – colloidal or particulate matter in suspension in the water.
5.5.2 It is important to know the source of excess 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 backwashing, coupled with coagulation.
5.5.2.1 There should be enough filter capacity to cope with the design circulation rate.
5.5.2.2 Sand filters are generally recommended for swimming pools (see 7.1).
5.5.2.3 Routine use of coagulants is important (see 7.4).

5.6 Primary disinfection

Strictly, 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); **secondary disinfection** (UV or ozone – see 5.7) increases the kill of infectious organisms, especially *Cryptosporidium*; **oxidation** by disinfectants breaks down soluble dirt and other organic contamination introduced by bathers.

5.6.1 At the same time other water quality parameters, in particular pH value, have to be kept at the correct levels for disinfectant to act effectively and efficiently.
5.6.2 For disinfection to proceed freely, the water should 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.
5.6.3 Many disinfectants are also capable of oxidizing waste matter, controlling the build-up of what is the food for many microorganisms (as well as a water contaminant in its own right). Mains water contains a certain amount of such material, but the chief sources are sweat, skin particles, mucus and urine, introduced by bathers. Such bather pollution can and should be minimised by pre-swim hygiene (see 8.1).
5.6.4 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.*

5.6.5 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 disinfectant systems, including those that may be developed in the future. The **choice of disinfectant** should take into account:

5.6.5.1 *safety* – by using only approved chemicals, see *Swimming pool water: treatment and quality standards for pools and spas*

5.6.5.2 *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) and an acid disinfectant, eg chlorine gas with hard water, helps disinfection and demands less use of other chemicals (pH adjusters etc)

5.6.5.3 *type and size of pool* – chlorine-based disinfectants are good for public pools, with the additional use of ozone or ultraviolet irradiation for better quality of water (see 5.7). Alternative forms of chemicals such as dichlor and trichlor may be more appropriate to less demanding pools. (Note: cyanuric acid may interfere with automatic controllers).

5.6.5.4 *bathing load* – if the bathing load is frequently high, and excessive combined chlorine is a problem, secondary treatment (see 5.7) with ozone or ultraviolet irradiation is useful in limiting chloramines as well as dealing with the threat from *Cryptosporidium.*

5.6.6 *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.

5.6.7 *COSHH Regulations* Attention is also drawn to the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended). The Management of Health and Safety at Work Regulations 1999 require all employers to do a risk assessment of their work activities. For pool chemicals, this assessment would be carried out in accordance with the terms of COSHH regulations. These regulations also state that exposure to hazardous substances should be prevented (perhaps by using a less harmful substance) or controlled by measures which should be systematically monitored. Specific information about chlorine gas and other disinfectants is given in the PWTAG publication, *Swimming pool water: treatment and quality standards for pools and spas*.

5.7 Secondary disinfection

Due to the risk of infection from the disinfectant-resistant protozoan, *Cryptosporidium*, it is strongly 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 being able to have lower disinfectant residuals in the pool water.

5.7.1 These systems will take the form of either ozone or ultraviolet and should be designed when installed to have an effect equivalent to achieving a 3 log (99.9%) reduction in the number of infective *Cryptosporidium* oocysts per pass through the secondary disinfection system.
5.7.2 Ozone should 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 of water circulated.
5.7.3 UV should also be applied to the full flow, medium pressure at $60mj/cm^2$ and monitored to ensure an effective dose rate.

5.8 Dilution with fresh water

Disinfection (see 11.2) and filtration (see 7) will not remove all pollutants: some can be reduced only by dilution of the pool water with fresh water. This can also limit the build-up of pollutants from bathers and elsewhere, the byproducts of disinfection, and various other dissolved chemicals.

5.8.1 If dilution is inadequate, bather discomfort can result. Pool operators should be prepared to replace pool water as a regular part of their water treatment regime with up to 30 litres per bather. The water that runs to waste and is replaced in the backwashing of filters (see 7.3) contributes significantly to achieving the recommended dilution rates with fresh water.
5.8.2 Dilution rates should be monitored and adjusted according to usage.

5.9 Discharge

Since 1994, the water used in the backwashing of filters has been classified as a trade effluent. In England and Wales, discharge to sewers requires the consent of the local water service company; discharge to a water course has to be authorised by the regional office of the Environment Agency. In Scotland the relevant authorities are the local water authority for sewers and the

Scottish Environment Protection Agency (SEPA) for water courses; in N Ireland, the Department of the Environment.

5.9.1 These authorities may have specific requirements about the rate and quality of discharges from backwashing (including backwash holding tanks), dilution, pool emptying etc. Such authorities should be consulted about the operation of a pool and any proposed changes to it.
5.9.2 Backwash water may need dechlorination if it is to be discharged to a surface water drain.

5.10 Bathing load, circulation rate and turnover period

The bathing load, circulation rate and turnover period are the three parameters used to determine the settings for the running of the treatment plant, and may be varied according to the prevailing, or expected conditions of pool usage. However the three parameters are determined, the turnover period should not exceed that in Table 2 below.

5.10.1 The **maximum bathing load** (number of bathers) allowable for safety at any one time determines the circulation rate, turnover, treatment plant size and other indicators. 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 to be used for.

5.10.1.1 The maximum bathing load for each pool should be recorded and pool managers should ensure that the systems controlling entrance to the pool ensure that the maximum bathing load is not exceeded during operation of the pool.
5.10.1.2 The starting point for calculating bathing load is the maximum loading of a pool for physical safety (as defined in *Managing Health & Safety in Swimming Pools*): 1 bather per $3m^2$.
5.10.1.3 The maximum bathing load should also take into account the capacity of the water treatment plant, using the formulae in Table 1.

Table 1 Maximum bathing load values

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 $4.0m^2$

5.10.2 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 12

5.10.2.1 The operational daily bathing load for each pool in operation 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 additional treatments, such as ozone or ultraviolet.

5.10.3 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.
5.10.4 The **turnover period** should be calculated from this formula:

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

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

5.10.4.1 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:

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

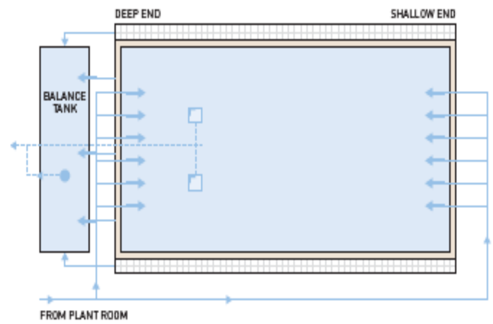
5.10.4.2 The turnover period of pools with moveable floors should be appropriate to the pool at its shallowest point (ie potentially biggest bathing load).

5.11 Dye testing

All pools should be dye tested when first commissioned, to prove the circulation and flow works as specified, thereafter if there has been remedial work and if there is a circulation problem affecting water quality. See annex B.

6 POOL REQUIREMENTS

6.1 Water circulation



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.

6.1.1 **Surface water** should be removed from swimming pools (a deck-level system is best). Between 50 and 80% of the circulation flow should be removed as surface water.

6.1.2 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.

6.1.2.1 **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/s. In other areas, the velocity of the water entering the pool should not exceed 2.0m/s.

6.1.2.2 **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.

6.1.2.2.1 Outlets should also be tested for hair entrapment. Annex C describes a test for hair entrapment.

6.1.2.2.2 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/s.

6.1.2.3 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.

6.1.2.4 All wall and floor outlets should be fitted with a sump to a design that accords with BS EN 13451-3.

Additionally at least one of the following two requirements should be met.

6.1.2.4.1 **Multiple** suction 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.

6.1.2.4.2 In the case of suction outlet systems on existing pools with **only one grille**, 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
- single grilles should have a grille area of ≥1m^2.

7 FILTRATION

Effective filtration, alongside continuous coagulation, is the primary mechanism for ensuring adequate water clarity (see 5.5). An effective filtration system will also remove more than 99% of *Cryptosporidium* oocysts in one pass. This should be achievable by all pools using this CoP. It is important, as these oocysts are much more resistant to disinfection than bacteria and viruses (see 9.1 and 9.2).

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. Any filtration system needs to be able to deal with the unwanted buildup of microorganisms.

7.1 Filters and filtration rate

Filters will usually be medium-rate pressure filters with sand as the main filter medium (other filter media can be used). They should be manufactured as specified in *Swimming Pool Water: treatment and quality standards for pools and spas* and in accordance with relevant European and British Standards.

7.1.1 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.

7.1.2 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.

7.1.3 Medium-rate filtration is 10 to 25m/h, and is the norm for public swimming pools.

7.2 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, eg mud balling, fissures, uneven bed.

7.3 Backwashing

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. 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.

7.3.1 Backwashing should always be done at the end of the working day.
7.3.2 Air scouring before backwashing at a rate of about 32m/h is desirable to aid backwashing.
7.3.3 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 of backwashing.
7.3.4 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.
7.3.5 The backwashing period should continue either in accordance with the manufacturers' specified time or until the backwash water is clear - whichever is the longer.

7.4 Coagulation

7.4.1 A coagulant (see *Swimming Pool Water: treatment and quality standards for pools and spas* for more details) should be dosed continuously and precisely, by chemical dosing pumps.
7.4.2 Coagulants should not be dosed by hand or via the strainer box.
7.4.3 The injection point should be as far in advance of the filter as is practicable, downstream from sampling points and other dosing points.
7.4.4 The coagulation injection should ensure good mixing.

POOL OPERATING PROCEDURES

8.1 Pre-swim hygiene

8.1.1 Anyone with diarrhoea should not use the pool.
8.1.2 Pre-swim showers should be provided, maintained in good working condition and bathers directed to use them prior to using the pool.
8.1.3 Toilets should be provided en route to the pool, after changing and prior to showering, and everyone encouraged to use them before showering and swimming.
8.1.4 Hand washbasins with liquid soap and hand-drying facilities should be provided.
8.1.5 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 diarrhoeal illness.

8.2 Babies and very young children

8.2.1 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 (unsuitable water temperatures and pool water chemicals may affect sensitive skin). 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 fouling incident.
8.2.2 Very young children should use special swimming nappies, which are designed to absorb and retain any soiling. Standard nappies are not adequate protection. Neither is suitable in the event of diarrhoea; in this case babies should not use the pool.
8.2.3 Convenient nappy changing facilities should be provided in changing areas (these should be cleaned regularly), be equipped with sinks for hand-washing and have bins for nappy disposal which are emptied regularly.

8.3 Showers

8.3.1 Showers should be supplied with fresh water. Shower water should be stored at 60°C, piped at 50°C and mixed to 40°C (± 2°C). Showers should run to waste.
8.3.2 All showers should comply with ACOP L8 HSE *Legionnaires' disease. The control of legionella bacteria is water systems.*

9 EMERGENCY PROCEDURES /*CRYPTOSPORIDIUM*

9.1 Faecal fouling

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.

9.1.1 **Solid faeces**: 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). Then if there is any doubt that all the faeces have been captured and disposed of, 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 followed.

9.1.2 All **equipment** that has been used in this process should be disinfected using a 1% solution of hypochlorite (1:10 dilution of commercially available sodium hypochlorite).

9.1.3 If the pool is operating properly with appropriate disinfectant residuals and pH values, no further action is necessary.

9.1.4 Faeces that is **smeared** on slides, tiling or other surfaces in contact with pool water should be cleaned off without contaminating the pool water and the surface disinfected with a 1% solution of hypochlorite. The procedures described below for runny faeces should then be followed.

9.1.5 **Runny faeces**: assume that the diarrhoea is caused by *Cryptosporidium*, a chlorine-resistant protozoan; then this is the code to follow. (Operators may well not know if this organism is involved, in which case this is the safest option.)

NOTE This is the procedure for pools with medium-rate filtration; there is separate advice for high-rate filters on www.pwtag.org.

9.1.5.1 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.

9.1.5.2 Hold the disinfectant residual at the top of its set range for the particular pool (eg 1.0 to 2.0 mg/l free chlorine) and the pH value at the bottom of its range (eg pH 7.2-7.4).

9.1.5.3 Ensure that the coagulant is being dosed correctly (at least 0.1mg/l as aluminium if alum is used, and 0.1ml/m^3 if PAC).

9.1.5.4 Filter for six turnover cycles (which may mean closing the pool for a day), with no backwashing. This assumes good hydraulics and well maintained filters with a bed depth of 800mm and 16/30 sand (or other, equivalent filter media).
9.1.5.5 Monitor disinfection residuals throughout this period.
9.1.5.6 Vacuum and sweep the pool.
9.1.5.7 Make sure the pool treatment plant is operating as it should (filters, circulation, disinfection).
9.1.5.8 After six turnovers, backwash the filters.
9.1.5.9 Allow the filter media to settle by running water to drain for a few minutes before reconnecting the filter to the pool.
9.1.5.10 Circulate the water for 8 hours. This will remove any oocyst contamination of the pool caused by imperfect backwashing. It is optional, depending on the pool operator's confidence in backwashing procedures. It is certainly necessary if the filter does not have a drain facility.
9.1.5.11 Check disinfection levels and pH. If they are satisfactory re-open the pool.
9.1.5.12 Disinfect any equipment used in the cleaning process or any pool equipment that may have been contaminated by virtue of being in the pool at the time.

9.2 Blood and vomit

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.

9.2.1 **Small amounts of blood**, from a nose bleed say, will be quickly dispersed and any pathogens present killed by the disinfectant in the water.
9.2.1.1 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.
9.2.1.2 Any **blood 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.

9.2.2 It is not unusual for swimmers to **vomit** slightly. It often results from swallowing too much water, or over-exertion, and so is very unlikely to present a threat through infection. 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. This is a rather theoretical, unevaluated risk.

9.2.2.1 PWTAG recommends that vomit in the pool should be treated as if it were blood (ditto vomit on the poolside). See 9.2.1 for details.

10 POOL HYGIENE AND CLEANING

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

10.1 Cleaning the pool surround

Pool surrounds should be cleaned at the start of each day by washing and scrubbing with water chlorinated to 10mg/l. Proprietary chemical cleaners formulated for pool use may be necessary for stubborn dirt.

10.1.1 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.
10.1.2 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.
10.1.3 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.
10.1.4 Some pools have a transfer channel, 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 is used to take any cleaning residue, and by opening the drain valve and thoroughly flushing, the cleaning residue goes to waste.

10.2 Cleaning agents

10.2.1 Proprietary chemical cleaners, if required, should be formulated for poolside use, and come from reputable suppliers (even though the target is to prevent their getting into the pool water). 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).
10.2.2 For all these reasons, proprietary cleaners should be avoided altogether if possible. But in any case, 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.
10.2.3 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.
10.2.4 Chemical cleaners - whether for pool surrounds or the water line - should never be used when there are people in the pool.

10.3 Periodic removal of hard water scaling and body grease

10.3.1 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 (eg weak hydrochloric acid/or citric acid) for removing scale. It is important that that no residue from these cleaning programmes returns to the pool water.

10.4 Showers

All showers should be cleaned and descaled in accordance with ACOP L8 HSE *Legionnaires' disease. The control of legionella bacteria in water systems*.

10.5 Pool covers

Pool covers should be checked regularly for any contamination and cleaned as necessary with 10mg/l chlorinated water.

10.6 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 10mg/l chlorinated water solution for 20 minutes, and dried prior to storage.

10.7 Transfer channels

Deck-level transfer channels should be cleaned as required, at least once a month. They should be drained and flushed out with 10mg/l chlorinated water which can be returned to the balance tank. Grilles should be scrubbed weekly with 10mg/l chlorinated water.

10.8 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 10mg/l chlorinated water, which can be returned to the circulation system via the filters.

10.9 Pool bottom

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

10.10 Pool shell

If a pool is emptied, then the bottom and sides should be scrubbed thoroughly with 10 mg/l chlorinated water before refilling. It should be flushed thoroughly to drain before refilling. Check the integrity of the structure while the pool is empty.

11 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 that operators should take if there are unexpected test results, especially if they show the pool water chemical composition is either below or exceeding safe limits.

11.1 Pool water testing equipment

The manual monitoring and measurement of the chemical condition of the pool water should be performed using appropriate test kits. 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)
- 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 a approved lighting cabinet for a comparitor

11.2 Automatic monitoring of chemical levels

The readouts from the controller should be checked daily against the results from manual tests of the sample cell. If the difference is more than 0.2, the controller should be recalibrated. The manufacturers' recommendations for the calibration of such equipment, including the use of suitable test solutions, should be followed.

11.2.1 Calibration for pH should incorporate the use of two buffer solutions, normally pH4 and pH9.2. Single-point calibration is not recommended.
11.2.2 Records of all calibration tests and results should be retained.

11.3 Chemical test requirements

11.3.1 Where disinfection and pH are *not* monitored and controlled automatically by the water treatment plant, manual testing should be carried out, 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.

11.3.2 Automatic control is preferable: free chlorine and pH are maintained at prescribed levels. But manual checks of free and combined chlorine and pH in the pool are still necessary. Where their results are satisfactory and stable, testing three times a day may be sufficient - at the start, midway and at the end of each day. But automatic control does not monitor combined chlorine; to ensure adequate control of chloramines, chemical testing may need to be more frequent.
11.3.3 Pool water samples for chemical analysis should be taken at a depth of 100-300mm. They should routinely be taken at the deep end and furthest from the inlets - the most vulnerable part of the pool - and occasionally elsewhere.

11.4 Free chlorine levels

11.4.1 For all pools using hypochlorites, 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. The use of ozone or UV (see 5.7) 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.
11.4.2 These values - indeed, any values - require validation by satisfactory bacteriological water quality standards.
11.4.3 Chlorine levels above 3mg/l should not be necessary in any pool. At above 5mg/l chlorination should be stopped immediately, and above 10mg/l bathing should cease.
11.4.4 For pool using chlorinated isocyanurates as disinfectant, free chlorine should be maintained at 2.5-5mg/l and the cyanuric acid at 50-100mg/l.

11.5 Combined chlorine levels

11.5.1 The level of combined chlorine residuals should be as low as possible.
11.5.2 Combined chlorine levels should never be more than half the free chlorine, and never more than 1mg/l no matter what the level of free chlorine.
11.5.3 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*, Chapter 8).

11.6 pH value

11.6.1 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.

11.7 Alkalinity

11.7.1 To ensure effective coagulation and a stable pH when using acidic disinfectants, alkalinity in pool water should be maintained at a level between 75 and 150mg/l (measured as $CaCO_3$).
11.7.2 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.

11.8 Calcium hardness

11.8.1 Hardness levels should ideally be maintained above 75mg/l (so that a scale forms that prevents corrosion) and up to 150mg/l measured as $CaCO_3$.
11.8.2 Higher levels in hard water areas and for pools using calcium hypochlorite as a disinfectant can be acceptable.
11.8.3 Calcium hardness measurements should be taken weekly, using commercially available test kits with the appropriate tablets.

11.9 Dissolved solids

11.9.1 Total dissolved solids (TDS) are aggressive at high levels, and their concentration should be measured weekly, using a commercially available electronic meter that has been calibrated against a commercially available standard.
11.9.2 TDS should not be allowed to rise more than 1,000mg/l above the level in the source water. TDS concentration should be reduced by dilution, if necessary.
11.9.3 Sulphate levels should be maintained below 360mg/l. Sulphate levels should be measured once a week using a commercially available test kit.

11.10 Balanced water

11.10.1 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.
11.10.2 The Langelier index is a formula that brings together all these factors.

12 MICROBIOLOGICAL TESTING

12.1 Frequency and protocol

Tests should be performed monthly to monitor the presence of microorganisms. 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.

12.1.1 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.
12.1.2 Microbiological testing should be performed only by competent and accredited personnel at a UKAS laboratory.
12.1.3 Samples should be taken as in 11.3.3 and in accordance with BS EN ISO 19458:2006.
12.1.4 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 as a reference. The water clarity and the bather load should also be noted.

12.2 Results

12.2.1 The total viable count (**colony count**) should not be more than 10 colony forming units (cfu) per millilitre of pool water at 37°C for 24h.
12.2.2 A colony count in excess of 100 cfu/ml is unsatisfactory.
12.2.3 A consistently raised colony count of 10 to100 cfu/ml is unsatisfactory and should be investigated.
12.2.4 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 *Escheria coli*, the colony count is less than 10 cfu/ml and the residual disinfectant concentration and pH values are within the recommended ranges.
12.2.5 ***E coli*** should be absent in a 100ml sample.
12.2.6 ***Pseudomonas aeruginosa*** should be absent in a 100ml sample. If the count is over 10 cfu/100 ml, the test should be repeated.
12.2.6.1 Where repeated samples contain *P aeruginosa*, the filtration and disinfection procedures should be examined to determine whether there are areas within the pool circulation where the organism is able to multiply. When counts exceed 50 cfu/100 ml pool closure is advised.

12.3 Acting on failures/pool closure

12.3.1 If a result is unsatisfactory, a preliminary investigation should be undertaken and the test should be repeated as soon as practicable.
12.3.2 If the second result is also unsatisfactory, the pool's management and operation should be investigated and the test repeated.
12.3.3 If the third result is still unsatisfactory, immediate remedial action is required, which may mean closing the pool.
12.3.4 The pool should be closed if there is chemical or physical evidence of unsatisfactory disinfection.
12.3.5 The pool should be closed if microbiological testing discloses **gross contamination**, which means one of two things:
1 *E coli* over 10 per 100 ml PLUS **either** colony count over 10 cfu per ml **or** *P aeruginosa* over 10 per 100 ml (**or, of course, both**)
2 *P aeruginosa* over 50 per 100 ml PLUS colony count over 100 per ml.

13 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 chemicals. See also 15.10.

13.1 Plant room protocol

13.1.1 It is essential that temperature, humidity and ventilation are controlled for the equipment and its use. Four air changes an hour is the usual minimum.
13.1.2 Plant, including electrical equipment, should be inspected and maintained in accordance with a planned programme.
13.1.3 Automatic monitoring and control equipment should be maintained and calibrated in accordance with the manufacturers' recommendations.
13.1.4 Relevant safety systems (eg 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.

14 HEATING 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	*Range of temperature (^oC)*
Competitive swimming and diving, fitness swimming, training	26-28
Recreational swimming, adult teaching	27-29
Leisure waters	28-30
Children's teaching	29-31
Babies, young children, disabled and infirm	30-32

14.2 Pool hall air

14.2.1 The pool hall air **temperatures** should be no more than 1 degree C above or below that of the water temperature. Air temperatures over 30°C should be avoided.
14.2.2 Relative **humidity** should be maintained at a level of 60% (no less than 50%, no more than 70%) throughout the pool hall area.
14.2.3 The pool hall area (water plus wet surrounds) should preferably be **ventilated** at a rate of >10 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.

14.2.4 A minimum of 12 litres per second of **fresh air** should be provided for each occupant of the pool hall (including 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).

14.2.5 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 APPLICATION AND USE OF CHEMICALS

Disinfectant and pH dosing systems, like the water circulation systems, should continue 24 hours a day.

15.1 Chemical safety

15.1.1 A risk assessment should be undertaken that takes into account the following:

- the chemicals on site
- storage and handling arrangements
- the likely impact of an incident or accident
- staff training and competence in handling chemicals
- the use of personal protective equipment
- emergency preparedness and response arrangements
- disposal of chemicals and their containers.

15.1.2 Detailed records should be maintained and procedures regularly reviewed to ensure risks involved in the use and storage of chemicals are minimised and clearly understood.

15.1.3 Attention should be paid to the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) and the Workplace (Health, Safety and Welfare) Regulations 1999.

15.2 Dosing practice

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

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

15.2.3 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 pumping chemicals should be double sheathed.

15.2.4 Dosing systems should be kept separate and bunded separately.

15.2.5 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.

15.3 Preparing dosing chemicals

15.3.1 Chemicals should always be added to water and never the other way round when preparing solutions.
15.3.2 Non-liquid chemicals should be kept dry until dissolved in water.
15.3.3 Calcium hypochlorite should be kept away from all other chemicals in its preparation for dosing.
15.3.4 If hydrochloric acid is not being dosed direct from a container, dilution should be introduced by filling the day tank with a known quantity of water, adding a known quantity of concentrate, and mixing thoroughly.
15.3.5 Any sludge formed from the incomplete dissolving of chemicals should be cleared periodically.

15.4 Chemical dosing operations

15.4.1 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.
15.4.2 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 shut down, the whole of the dosing system should be flushed through gently with low-pressure water.
15.4.3 Chemical dosers should be interlinked with the circulation pumps and the circulation of water through the system, so that dosing stops if there is pump failure.

15.5 Circulation feeders

15.5.1 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.
15.5.2 Trichlorinated isocyanurate tablets should be kept completely submerged and should be fully used up prior to extended periods of circulation shut down.
15.5.3 Circulation feeders should not be sited near a heat source, nor installed such that they are subjected to a heating effect.

15.6 Delivery of chemicals

Unloading should not be carried out on the public highway. Where this is unavoidable, local authority permission should be sought and suitable warnings provided.

15.7 Offloading

15.7.1 Procedures and training for dealing with spillages should be established and understood by all staff.
15.7.2 It is essential that all deliveries proceed only when a trained staff member is available to receive and check the materials.
15.7.3 All staff involved in chemical offloading should have specific training in delivery of chemicals and dealing with spillages and manual handling.
15.7.4 The safe working load (SWL) of any lifting apparatus used should not be exceeded; regular inspection, testing and certification should be observed.

15.8 Bulk delivery of sodium hypochlorite and hydrochloric acid

15.8.1 There should be documented procedures for transfer and handling during delivery. Suppliers should be required to comply with these procedures.
15.8.2 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.
15.8.3 Bulk tanks can be connected to day tanks either by gravity or pumping, but there should be separate routes and/or pumps for each chemical.
15.8.4 Pools should not be dosed directly from bulk tanks.
15.8.5 Bulk and day tanks should be in separate bunds sized to take 110% of the volume of the tanks.

15.9 Transport from offloading area to store

15.9.1 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.
15.9.2 Where chemical containers are to be handled manually, a risk assessment should be done; where appropriate, mechanical aids should be provided.
15.9.3 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.

15.10 Storage of chemicals

15.10.1 All containers should be kept securely closed, cool and dry.
15.10.2 Chemicals supplied in paper or plastic sacks should be stored in plastic bins before opening, and securely closed after use.
15.10.3 Each chemical should be stored separately from all other chemicals. Liquid chemical storage areas should be separated by sealed bunds with sumps.
15.10.4 Material safety data sheets should be available at the point of storage.
15.10.5 Non-returnable containers should be flushed out with water before appropriate disposal. Procedures should be established to deal with the safe disposal of products which are no longer required, or which have exceeded their shelf life.

15.11 Chemical store

15.11.1Chemical stores should have warning signs, be secure and accessible only to authorised, appropriately trained people.
15.11.2 Be at the same level as the delivery point and not be situated close to public areas, doors, windows or ventilation intakes
15.11.3 Have adequate natural ventilation to a safe open area or mechanical ventilation providing four air changes per hour
15.11.4 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
15.1.5 Provide enclosure with a minimum fire resistance of half an hour for all chemicals

16 ANNEX A

Water Safety Plans

Risk assessments have for some time routinely been made - and should always - to determine risks to health from legionellae in water distribution systems, spa pools etc. There is an increasing awareness that there are other waterborne hazards which may also cause harm within buildings (a waterborne hazard is defined by the World Health Organisation (WHO) as an agent which might cause harm to health as a result of water use). Such hazards may be of a microbiological nature, eg microorganisms such as legionellae, *Cryptosporidium*, *Pseudomonas aeruginosa* or chemical, eg lead, excess copper, pesticides. Within a leisure complex there are many potential uses of water where the users and sometimes those in the vicinity may be exposed to hazards with the potential to cause waterborne illness. For example:

- through drinking contaminated water or consuming food irrigated or prepared using contaminated water
- by contact with contaminated water, eg during bathing in swimming and spa pools but also during the use of beauty equipment such as nailbaths, footbaths etc - especially when contaminated water is in contact with open wounds
- by inhalation of aerosols containing hazards, eg legionellae in distributed water when using showers, wash hand basins and toilet flushing - but also from agitated spa pool water, water jets and indoor fountains and, if present, evaporative cooling tower drift etc.
- by aspiration of contaminated water unintentionally entering the lungs during drinking (water going down the wrong way) or near-drowning

The use of microbiological targets alone, such as those defined within legislation to determine potability, is not sufficient for all types of water use. For example the absence of indicators of faecal pollution would not indicate whether *Cryptosporidium* was present in swimming pool water or legionellae in a spa pool. So a management system is needed which will identify all potential waterborne hazards and their routes of exposure including those hazards which may not be adequately removed by water treatment.

In 2011, WHO published *Water Safety in Buildings,* which outlines how building owners, managers and those in charge of systems and equipment in buildings can ensure the safety of the water within them, for all types of users and all types of potential uses, by adopting a Water Safety Plan (WSP) approach. This encompasses a multi-step process which includes the need for a risk assessment using HACCP (Hazard Analysis - Critical Control Points).

The implementation of a WSP ensures that a water management system is developed specifically for each element (or piece of equipment, eg a spa pool) which contains or uses water - to manage and monitor the water quality from point of entry into the system or equipment (source water quality) to the point of use by the consumer.

In practice, where the source water is provided by a water utility it can be assumed that water entering the building will be of potable quality. The management process will then be to manage the water within the building to ensure that the there is no deterioration in quality which may lead to waterborne illness. However, if the water entering the building or equipment is from a source other than a mains supply, then a risk assessment is required to determine whether point of entry treatment - filtration, UV or biocide - is required to provide water of an appropriate entry quality.

A Water Safety Plan includes:

- appointing a water management team; identifying a person to take day-to-day responsibility for water safety (often the person responsible for legionellae control, eg the 'responsible person'). The team should include people with knowledge of the building, the types of equipment present, the hazards and risks associated with each, the ways that people may be exposed, factors which may increase the susceptibility of users (eg the very young, the elderly, those with poor mobility, the immunocompromised). This team should include all the stakeholders who may have an impact on water quality such as buildings owners/ managers, facilities managers, water treatment specialists, engineers, pool operators, environmental health officers together with representatives from users including beauty therapists, hairdressers and café operators
- a risk assessment to define the quality of water supplied into the premises / building system or equipment used within the building
- an assessment of all potential sources of hazards and potential routes whereby they may be transmitted.
- a system assessment to determine the ability of the water treatment system to remove hazards and achieve defined water quality targets
- process control using HACCP principles
- process/system documentation for both steady state and incident-based (eg failure or fault event) management
- communication and education about water quality and how safe water quality can be achieved.

In the context of a leisure complex this would involve nine elements.

- Ensuring that the water entering the building was of potable quality, ie meets the microbiological criteria for drinking water: no harmful chemicals or indicators of microbial contamination present and supplied at a temperature of $< 20°C$ throughout the year. Where this is not the case then appropriate water treatment should be put in place.
- All systems and equipment which use water should be itemised (an asset register) and potential routes of exposure to waterborne hazards determined for each.

- Water quality targets should then be determined for each of the above depending on the type of use and type of user.
- A risk assessment should be carried out by a person competent and accredited to assess each type of system (in complex premises more than one assessor may be needed) to determine the points where identified hazards may enter or increase within each system. These findings should be documented.
- A scheme of control should then be determined for each system with appropriate monitoring points, intervals and parameters identified. Any parameter should have a maximum and minimum permissible level together with actions pre-determined for use when results outside of specifications are received.
- The control scheme should then be validated to determine that it is effective for that specific system/ equipment in both normal and anticipated abnormal operating conditions. For example, a failure in a dosing pump is a predictable event and there should be a plan in place to cope with this, which may include criteria for when to close a pool.
- A scheme for on-going verification to ensure the control measures remain effective should be then identified and documented.
- A training programme should be developed for everyone who has any impact on water quality.
- Lines of communication should be clearly identified and documented (lines for reporting and accountability) together with contact details for key personnel – including where appropriate for out of hours, eg water treatment specialists

The plan should be reviewed when there are any substantive changes which may impact on the WSP including any changes to the treatment regime, adverse results, changes in key personnel etc, or at least every two years.

17 ANNEX B

Dye test

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.

18 ANNEX C

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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55 BS EN 13451-1. Swimming pool equipment. Part 1. General safety requirements and test methods Published Date: 06/03/2009 Status: Current, Draft for public comment
56 BS EN 60598-2-18:1994+A1. Luminaires. Part 2. Particular requirements. Section 18. Luminaires for swimming pools and similar applications Published Date: 06/01/2010 Status: Current, Draft for public comment.
57 BS EN ISO 19458:2006 Water quality – Sampling for microbiological analysis.

Code of Practice – Revision History

First published November 2012 – PWTAG CoP 11.12

First revision Jan 2013 PWTAG CoP 1.13

- 9.2.1.2 Disposal of hygiene waste
- 10.8 Balance tanks - Annual inspection and cleaning as necessary
- 11.1 North light or lighting cabinet for comparator
- 11.3.3 Depth of taking sample to 100-300mm
- 12.1.3 Samples taken according to BS EN ISO 19458
- 15.2.2 Disinfectant dosing post ozone/uv
- 15.2.5 CAS and EINECS numbers to include on precaution cards
- 15.9.2 Risk assessment for manual handling of chemical containers