

Part 2

Guidance on the control of infectious agents in spa pools

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Overflow channel with a section of the cover removed revealing the overflow drain. Note the cleanliness (with kind assistance of Esporta Ltd)

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Background

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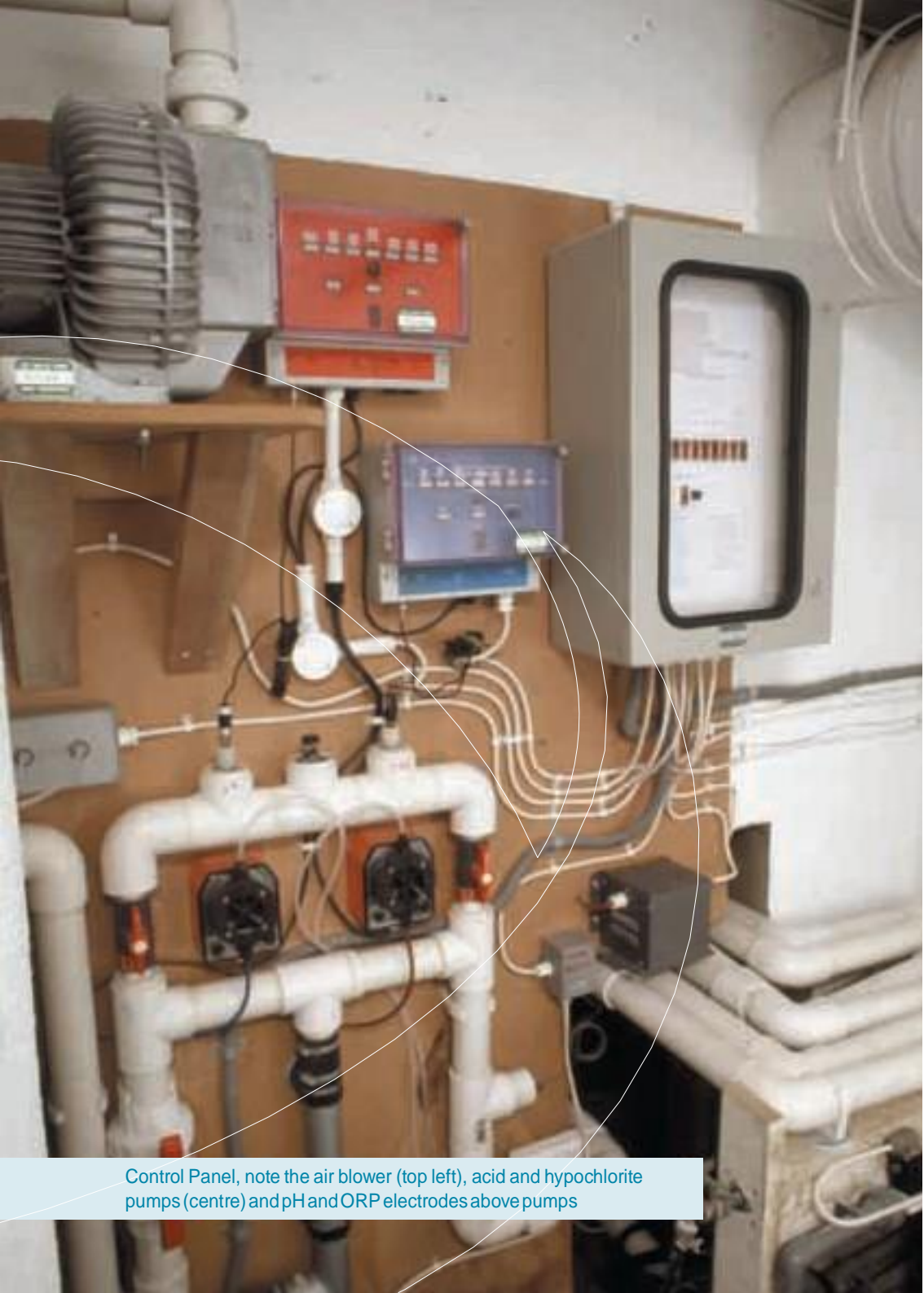
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Control Panel, note the air blower (top left), acid and hypochlorite pumps (centre) and pH and ORP electrodes above pumps

2.1 Background

2.1.1 Operating spa pools

99. General guidance on controlling Legionella bacteria can be found in the HSE publication Legionnaires' disease: The control of Legionella bacteria in water systems. Approved Code of Practice and Guidance (L8)⁵. Part 2 puts the control measures outlined in L8 in the context of operating a spa pool and also covers the control of other infectious agents.

100. This section provides guidance on the simple principles and practices for maintaining the water in spa pools in acceptable condition. A wide range of individuals and organisations undertakes spa pool maintenance with varying skills including hoteliers, health clubs, local authorities, leisure companies and private owners.

101. To encourage the use of any spa pool it must appear inviting, offer a safe and pleasant environment to use, and be free from irritant substances, infectious agents (viruses, bacteria, protozoa and fungi) and algae.

102. In spa pools the refreshing agitation of the water is achieved by the combination of air jets and pulsating water flow. Splashing of water and bursting of the bubbles breaking through the water surface creates an aerosol immediately above the water surface in the breathing zone of the occupant(s). In Legionnaires' disease the principal route of infection is through the inhalation of the bacteria into the lungs with the risk of disease rising with increasing numbers of inhaled bacteria. Rarely, infection may occur by aspiration. Good disinfection and filtration are therefore essential for maintaining health and safety standards in spa pools.

103. The small volume of water, high operating temperature and generally heavy bathing loads makes the water treatment of spa pools more onerous than in conventional swimming pools.

104. Objectives of spa pool water treatment are the same as those for swimming pools, namely

- to remove suspended and colloidal matter and to render the water clear, bright and colourless;
- to remove organic matter, which may act as a source of food for bacteria and give an unaesthetic appearance to the water;
- to provide an appropriate level of disinfectant to control the growth of infectious agents;
- to maintain the pH of the water at an optimum for disinfection; and
- to maintain a comfortable temperature for bathers.

105. There are essentially two types of pollution; that generated by bathers and that from external sources ie atmosphere, surface surrounds and bathing costumes. The pollution generated by bathers comes from

- nose – mucus,
- mouth – saliva,
- skin - perspiration, dead skin, sun tan lotion, cosmetics, shampoo and soap residues
- urine and faecal matter, and
- hair.

2.1.2 Operating natural spa pools

106. The concept of natural spa pools is for the water to remain untreated, but this in itself can pose potential health and safety implications. The water for natural spas should be shown to be of satisfactory microbiological quality before construction of the spa. However, natural spa pools must be managed to control the risk of exposure of users and others to infectious agents. This will usually require the natural spa pool to be managed in the same manner as any other commercial spa pool. Managers of natural spa pools should, therefore, follow the guidance on control measures given here.

2.1.3 Storing water

107. Stored water requires ongoing management if water quality (including aesthetic quality) is not to be impaired. It is especially important to ensure the

water in storage does not rise above 20°C. *Legionella* bacteria and other infectious agents can proliferate in storage at temperature above 20°C, particularly if a biofilm is allowed to develop on the inside of the cistern.

2.1.4 Spa pool water purification

108. Water treatment can be divided into two main steps - filtration and disinfection. Filtration is necessary to maintain a physically clean, clear and safe environment. Chemical or physical disinfection is required to prevent cross infection between bathers and the growth of infectious agents within the water and on the surfaces within the spa pool and it's associated water and air circulation system.

109. Effective purification relies on powerful filtration working in conjunction with continuous disinfection via a complete and speedy circulation system, to collect, clean and disinfect water without plant failure, undue water and chemical wastage or needless expense.

110. To minimise pollution it is essential to encourage good hygienic standards. Bathers should be strongly encouraged to visit the toilets, and to wash and shower before use of the spa pool. Introduction of shampoos, moisturisers and other skin products into spa pools will adversely affect the water balance and therefore bathers should ensure these are removed by showering before entering the pool.

111. The daily spa pool maintenance programme needs to achieve proper physical operation of the spa pool and provide a suitable chemical balance and the correct microbiological control. To ensure optimum water quality within the spa pool it is essential that the turnover time of the spa pool and the design bathing loads do not exceed recommended limits (see below).

2.1.5 Information managers should provide for users

112. The risk assessment will identify the information that should be provided to customers, and may include having a wall clock clearly visible from the spa pool and a notice pointing out the recommended bathing time along with the maximum number of people allowed in the spa pool at any one time. They may also require a notice, clearly displayed near the spa pool, advising individuals of the correct procedures when using the spa pool. For example

- It is recommended that bathers do not wear sun tan lotions or skin creams in the spa pool.
- Bathers should use the toilet and shower before entering the spa pool.
- Bathers should not use the spa pool if they have had diarrhoea within the last 14 days.
- Bathers should be discouraged from swallowing the spa pool water.
- It is recommended that bathers do not exceed 15 minutes immersion at a time.
- Bathers should not exceed the maximum number permitted in the spa pool.

- Children under four should not use the spa pool.
- Children (and others) who are unable to keep their faces out of the water should not use the spa pool.
- All other children using the spa pool must be supervised.
- Babies' nappies should not be changed beside the spa pool.
- It is recommended the spa pool is not used after a heavy meal or while under the influence of alcohol or sedatives.
- If intended users are suffering from diseases of the heart and circulation, skin conditions, are immunosuppressed, subject to fits, or taking drugs affecting the cardiovascular or nervous systems, they should seek medical advice before bathing in spa pools.
- Pregnant women are advised to consult with their doctor before using a spa pool (see section 1.1.5.2)

(This is not an exhaustive list and the information that needs to be displayed will depend on the risks identified for each spa pool.)

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Treatment programmes

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pH and chlorine electrodes (with kind assistance of Esporta Ltd)

2.2 Treatment programmes

2.2.1 Maintaining water quality

2.2.1.1 The effect of pH on disinfectants

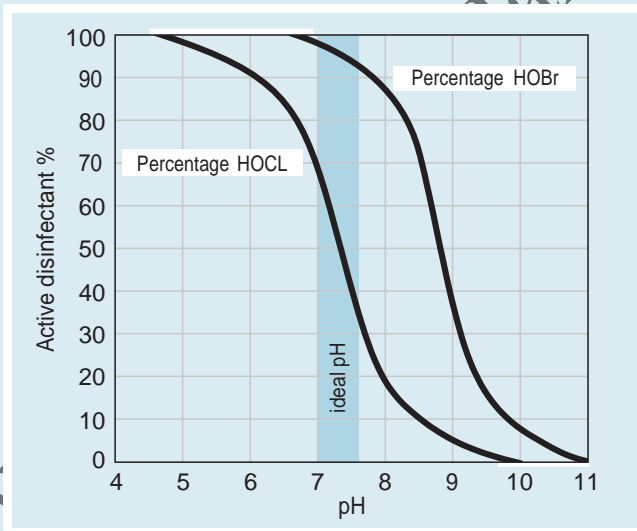
113. The pH (a logarithmic scale) is a measure of the degree of acidity or alkalinity (also known as the basicity) of the water:

0 ← **ACID** — **7.0** — **ALKALI** → **14.0**
neutral

Ideal range 7.0 - 7.6

The most important factor in water balance is pH and the ideal pH range is similar to the pH of most body fluids.

Figure 2: The effect of pH on disinfection



114. Figure 2 shows the effect of pH on the disinfection efficiency of chlorine and bromine. It should be noted that, depending on the nature of incoming mains water and the disinfectant used, the spa pool water may need to be adjusted to the ideal pH range by the use of chemical treatment.

Acidic pH adjusters include sodium bisulphate and hydrochloric acid, and alkaline pH control is achieved with sodium carbonate (soda ash).

2.2.1.2 The effect of disinfectants on pH

115. 1,3-bromochloro-5,5-dimethylhydantoin and sodium dichloroisocyanurate tend to be relatively neutral when dissolved in spa pool water and have little effect on the pH. The nature of the incoming mains water supply tends to determine the pH adjustment required.

116. Trichloroisocyanuric acid forms an acidic solution (pH3) in water and will tend to lower the pH value. An alkaline pH adjuster may be necessary to maintain the optimum pH but the degree of pH adjustment will be dependent on the nature of the incoming mains water supply.

117. Sodium and calcium hypochlorite will both raise the pH of the spa pool water, so an acid pH adjuster may be required. Again the degree of pH adjustment needed will depend on the nature of the incoming water supply.

2.2.1.3 Water balance

118. The pH, Total Alkalinity, Total Dissolved Solids, Temperature and Calcium Hardness of water are related in a complex way and are the main factors in determining the balance of the water. Balanced water is neither scale forming nor corrosive and may be measured using a number of indices such as the Langelier, Palintest or saturation. In commercial spa pools the frequency of water replacement and draining of the spa pool is likely to limit the requirement for water balancing.

2.2.1.4 Clarity

119. Cloudiness in the water is often evident if the spa pool has been left unused and may be attributable to a number of different factors. These include failure of the circulating pump, incorrect hand dosing of the spa pool with water treatment chemicals leading to a lack of disinfectant, the presence of undissolved chemicals, algal growth, incorrect backwashing procedures and bacterial overgrowth. Further advice should be sought from a suitable consultant if problems persist.

2.2.1.5 Total Dissolved Solids (TDS)

120. The measure of the concentration of dissolved materials present in the water, the majority of which have been introduced from the water treatment chemicals and from the bathers using the spa pool, is termed the total dissolved solids. This concentration reflects the management of spa pool usage and control of water replacement. A maximum of 1000 mg/l over the fill water of TDS is recommended in spa pools, above which corrosion of the spa pool water distribution system may become more apparent. Planned water replacement will normally prevent such occurrences.

2.2.1.6 Biofilms

121. The spa pool, pipework and balance tank should be constructed of materials known not to support the growth of infectious agents and which comply with BS 6920⁵⁰. It should also be possible to inspect and clean not only the surfaces of the tanks and spa pool but also the inside of the pipework and, for this purpose, appropriate access points should be included in the design or the pipes should be readily removable.

2.2.1.7 Algae

122. There are 3 common types – green, blue-green, and brown or red.

2.2.1.8 Green algae

123. Green algae are free floating; turning the spa pool water cloudy green. They are easily killed by treatment e.g. chlorine.

2.2.1.9 Cyanobacteria

124. Cyanobacteria used to be known as blue-green algae, although they are generally black in appearance. They are found on floors and walls in small dots or blotches, are resistant to algicides and often cause surface staining.

2.2.1.10 Brown or red algae

125. Brown or red algae are usually yellow or yellow brown and are sometimes found on spa pool walls, floors and steps. They may also be rust red, green or pink in colour.

2.2.2 Spa pool area hygiene

See section 2.4 1

2.2.3 Chemical storage

126. Care must be taken to ensure that chemicals are stored under the correct conditions. Acids and alkalis should be stored separately in secure, well-ventilated, dry storage areas (bunded if necessary, ie to contain spills of liquid chemicals). Each area should be marked externally with the appropriate warning sign. It is inadvisable to store spa pool chemicals with petrol or oil, e.g. a domestic spa owner should not store pool chemicals in a shed that also houses a petrol mower. Accidental mixture of these chemicals could result in an explosion or facilitate spontaneous combustion.

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Water pump strainer – needs inspection daily and cleaning if necessary

2.3 Monitoring

127. It is the responsibility of the owner to arrange routine microbiological or chemical testing. However, HSE and Local Authority inspectors do have the power to take water samples under the HSWA as may be required during inspections/investigations.

2.3.1 General monitoring

128. Poolside testing and recording of residual disinfectant and pH levels should be undertaken before the spa pool is used each day and thereafter at least every 2 hours in commercial spa pools. The chemical tests required are

On-site tests

- Colour
- Clarity
- Temperature
- Number of bathers
- Chlorine (free, total and combined) or bromine in pool
- pH

129. Laboratory analysis is not part of the daily regimen but may be required, for example, monthly. The frequency of laboratory analysis should be indicated from your local risk assessment.

Chemical tests include

- Permanganate value (4 hours @ 27°C)
- Total dissolved solids*
- Bromide/chloride depending on disinfectant
- Ammoniacal nitrogen
- Albuminoid nitrogen
- Nitrite nitrogen
- Total Alkalinity*
- Bicarbonate alkalinity
- Hydroxide alkalinity
- Total hardness*
- Calcium hardness
- Magnesium hardness
- Sulphate*
- Iron*
- Copper*
- Zinc*

* These tests can be done at the side of the spa pool, but for reliable results to show how the spa pool is being managed laboratory analysis should be used.

130. Details of standard testing procedures are provided in Appendix 3. A logbook should be available for recording the results, it should state the acceptable limits for parameters tested, together with any remedial action to be taken in the event of a test result being out of specification. Records should be kept for a minimum of 5 years as required by the Approved Code of Practice L85.

131. The total dissolved solids (TDS) should be monitored daily, and the water balance weekly if required. In areas where the water is naturally low for calcium hardness and alkalinity, basic water balance chemicals may be required to stop the water being aggressive in the spa pool. However, in commercial spa pools, water replacement frequency should be such that it obviates the need for water balance (depending on the source water). Similarly TDS monitoring may not be required if the water is replaced frequently.

132. Routine microbiological analysis should also be undertaken to ensure that optimum water treatment conditions are being maintained. While chemical analysis is of benefit to monitor the efficiency of the water treatment system in dealing with the pollution loading, it is important that it is carried out together with microbiological analysis to enable a complete assessment of the water treatment operation and management.

133. Information obtained from regular monitoring can indicate

- whether or not water replacement and backwashing are being undertaken at sufficient frequency,
- disinfectant levels are adequate,
- show whether or not the operation of the water treatment plant is coping effectively with the bather load,
- highlight any unnecessary hand dosing of water treatment chemicals,
- provide information on the condition of the filter bed, and
- provide advanced warning of failure of filter, pumps, valves etc.

2.3.2 Sampling for chemical analysis

134. A one-litre sample of spa pool water is required for a comprehensive chemical analysis in the laboratory. This should be taken in a clean one-litre polythene container, which, prior to filling, has been thoroughly rinsed with water from the spa pool to be sampled. The sample should be delivered to the laboratory on the same day as sampling. However, if this is not possible it must be refrigerated (4-8°C) until it can be delivered to the laboratory the next day.

135. The place and point of sampling, the time, the pH and the concentration of free and combined disinfectant should be noted at the time of sampling and provided to the laboratory together with the sample. Ideally the sample should be taken about 200 to 400mm below the water surface.

2.3.3 Monitoring for infectious agents

136. The spa pool manager has the responsibility for ensuring that microbiological samples are taken at appropriate intervals and the results recorded in the spa pool log book together with any remedial actions and follow up samples following an adverse report. In general, a microbiological sample should be taken based on a risk assessment, which would take into account any factors that may have an effect on water quality.

137. Regular microbiological testing will provide an assurance that operating conditions are satisfactory if

- it is performed by trained and competent personnel to prevent sample contamination;
- microbiological analysis is carried out in a laboratory accredited for the analysis to ISO17025⁵¹;
- chemical tests are performed, preferably on site, at the time of sample collection, eg pH value and the concentration of free and total disinfectant in the spa pool water, a review of the maintenance records and bather numbers for the spa pool, information on any mechanical failures, the water appearance, and other untoward events is carried out and noted on the sample submission form.

138. Microbiological samples for indicator organisms should be taken at least once a month as a routine and quarterly for *Legionella*. More frequent sampling may be required depending on the risk assessment, eg if the spa pool is being intensively used and certainly if there are any adverse health effects reported by the bathers. Spa pools that are situated outdoors have additional demands placed on the disinfection and filtration systems from environmental contamination by dust, debris etc, so it is important that such factors are taken into account when determining a monitoring schedule. If adverse health effects are suspected the enforcing authority (HSE or the Local Authority) and the microbiologist in the testing laboratory should be informed; as required they will then notify the CCDC within the Local Health Protection Unit. Microbiological sampling should also be done

- when a spa pool is first used or recommissioned,
- after a report of ill-health following spa pool use,
- if there are problems or contamination incidents, or
- alterations in the treatment/maintenance regimes.

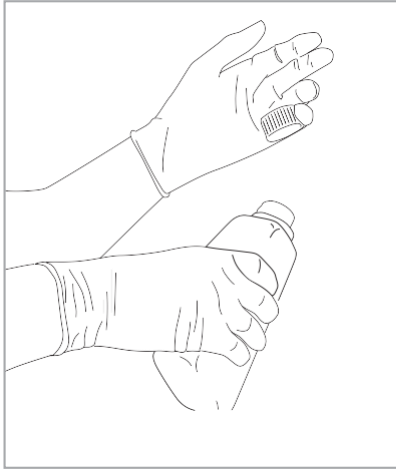
2.3.4 Microbiological tests

139. Tests for indicator organisms should include an aerobic colony count (sometimes called the total viable (colony) count or plate count), coliforms, *Escherichia coli*, and *Pseudomonas aeruginosa*. In addition, tests should be quarterly for *Legionella*. The aerobic colony count (ACC) after 24 hours incubation at 37°C will give an indication of the overall microbiological quality of the spa pool while the continued presence of coliforms and especially

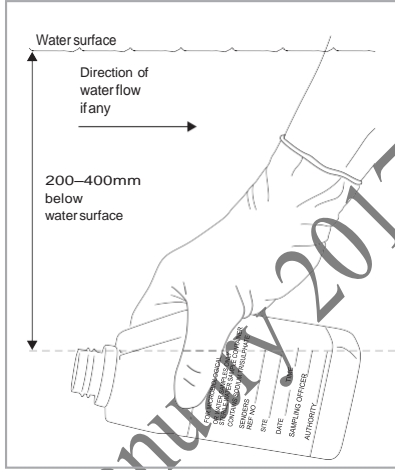
E. coli will indicate the presence of serious contamination arising as a result of a breakdown in the treatment system. The presence of the potential pathogen *P. aeruginosa* is also an indication of treatment failure with likely colonisation and biofilm formation on the spa pool filter and within other parts of the system. It is a more sensitive indicator of sustained management problems than the coliforms and may be found in their absence but is usually associated with an elevated ACC.

140. If there are health problems associated with the use of the spa pool, it may be necessary to test for other organisms, based on epidemiological evidence, such as *Staphylococcus aureus*, *Cryptosporidium*, *Giardia* and perhaps viruses. In these circumstances advice should first be sought from the local Health Protection Unit and the microbiologist.

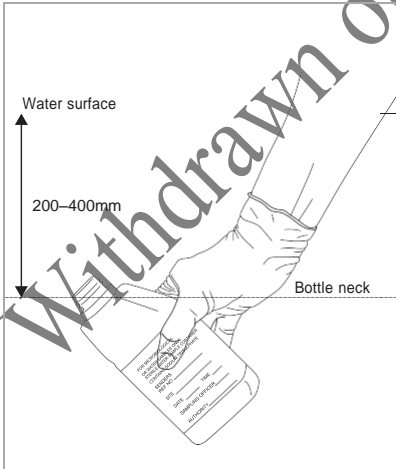
Figure 3: Illustration of how to collect a sample for microbiology



1. Aseptically removing the bottle top



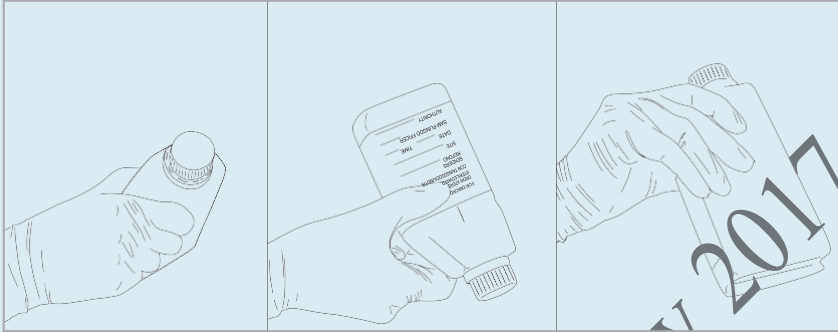
2. Immerse bottle 200–400mm below the surface, keeping bottle almost horizontal but tipped slightly to ensure neutraliser is not tipped out



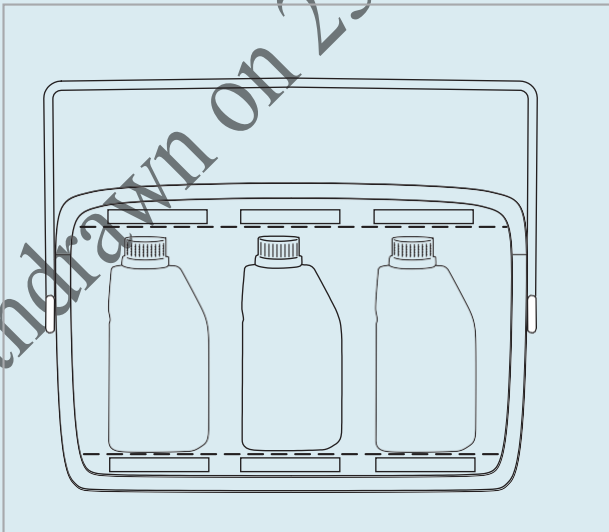
3. Tilt bottle up to approximately 45° to fill



4. Remove bottle. If the bottle is full to the brim pour off a small amount to leave 1–2cm air above the water surface. Replace the cap



5. Invert a few times to mix the contents and place the bottle in a cool box for transport



6. Transport to laboratory as soon as possible in an insulated container – process on day of collection

2.3.4.1 Sampling procedure

141. Sampling bottles must be made for this purpose and must be sterile, shatterproof and contain a neutralising agent for the disinfectant in use. Glass bottles must not be used. For spa pools using chlorine or bromine-based systems, sodium thiosulphate is a satisfactory neutralising agent and 180mg/l is usually sufficient to neutralise up to 50ppm of chlorine. A mixture of lecithin and Tween 20 can be used to neutralise PHMB, specific details and further advice should be sought from the testing laboratory. If other disinfection systems are in use, the testing laboratory must be informed before the sample is taken to ensure that the appropriate neutraliser is supplied, if an appropriate neutraliser is not available then the sample must be tested as soon as possible, the testing laboratory will need to take into account the time delay before testing is carried out when interpreting results. Samples taken for chemical examination require a separate bottle without a neutralising agent.

142. Sample bottles for microbiological testing should be either individually wrapped or disinfected by wiping with, for example, an alcohol swab before use. For routine monitoring for indicator organisms a sample bottle of 500ml should be used and for *Legionella* a sample bottle of at least 1000ml. Unlike bottles for chemical testing samples, these should not be rinsed with the water to be tested. To take the sample, the stopper or cap is first removed with one gloved hand making sure that nothing touches the inside of the bottle or cap. The collection of a sample is illustrated in figure 3. While the bottle is being plunged into

the water the long axis should be kept approximately horizontal but with the neck pointing slightly upwards to avoid loss of the neutralising agent. The bottle is quickly immersed to about 200-400mm below the pool surface, at which point the bottle is tilted upwards to allow it to fill. On removal from the water, the cap is immediately replaced, the sample shaken to disperse the neutraliser, and then sent to the laboratory without delay to enable analysis preferably on the same day and certainly within 24 hours of sampling. In transit the sample should be protected from light and placed in an insulated container maintained at approximately 2 - 8°C by freezer or ice packs. The sample container should not come in direct contact with the freezer packs. A record should be made of the pH value and the active disinfectant residual determined at the time of sampling. This and any other relevant information should accompany the sample to the testing laboratory to enable appropriate interpretation of the results

143. Routine sampling should be done when the spa pool is in use, preferably when heavily loaded or immediately thereafter.

2.3.5 Recommended microbiological standards for spa pools

144. If these indicator microbiological results are unsatisfactory a review of the records should be undertaken and the microbiological tests repeated immediately. Sampling from the balance tank may also be considered at this point. If the results show gross contamination (see Section 2.3.3) then the spa pool should be taken out of use immediately and any remedial actions implemented before resampling.

145. If results are still unsatisfactory after the repeat samples and investigation, immediate remedial action is required that may necessitate the spa pool being closed. Note: the investigation may require the help of the laboratory that does the tests, the local council Environmental Health Department, or an independent consultant.

2.3.5.1 Aerobic colony count

146. The colony count should be carried out in accordance with BS EN ISO 6222⁵² (BS 6068-4.5) but with incubation at 37°C for 24 h. These test conditions are set to isolate the range of organisms that can colonize and cause infections in bathers. The ACC can become increased where there is a higher bather load, reduced chlorine residual or where there are defects in water treatment. The aerobic colony count should normally be 10 or less colony forming units (cfu) per millilitre of spa pool water. If a colony count above 10cfu/ml is the only unsatisfactory microbiological result, and residual disinfectant and pH values are within recommended ranges, the water should be retested.

2.3.5.2 Total coliforms

147. The presence of coliforms indicates that the treatment has failed to remove this contamination. Coliforms are sensitive to disinfectant and should be absent in 100ml of spa pool water. A repeat sample should be taken whenever coliforms have been detected. A coliform count of up to 10cfu/100ml is acceptable provided that

- the aerobic colony count is less than 10cfu/ml;

- there are no *E. coli* present; and
- the residual disinfectant and pH values are within recommended ranges.

2.3.5.3 *Escherichia coli*

148. *Escherichia coli* is normally present in the faeces of most humans, mammals and birds. It is widely used as a specific indicator of faecal contamination as it is unable to grow within the environment. The presence of *E. coli* in spa pool water is an indication that faecal material has entered the water from contaminated skin, or from faecal material that has been accidentally or deliberately introduced. It also indicates that the treatment has failed to remove this contamination. *E. coli* should be absent in a 100ml sample. However, because most bathers will have some faecal contamination of their skin, particularly if they have not showered before bathing, a single positive sample may be the result of recent superficial contamination by a bather that has not yet been decontaminated by the disinfectant residual. A repeat sample should then be taken.

2.3.5.4 *Pseudomonas aeruginosa*

149. Well-operated spa pools should not normally contain *P. aeruginosa*. If the count is over 10 *P. aeruginosa* per 100ml, repeat testing should be undertaken. Where repeated samples contain *P. aeruginosa* the filtration and disinfection processes should be examined to determine whether there are areas within the spa pool circulation where the organism is able to multiply. There is a risk of an outbreak of folliculitis when the count exceeds 50cfu/100ml so the spa pool should be closed, remedial action taken and the water resampled (see Section 2.3.3).

Table 1. Legionella Sampling.

Number/litre	Interpretation
<10 ²	<ul style="list-style-type: none"> • Under control
≥10 ² to ≤10 ³	<ul style="list-style-type: none"> • Resample and keep under review. • Advised to drain, clean and disinfect. • Review control & risk assessment; carry out remedial actions identified. • Refill and retest next day and 2-4 weeks later.
>10 ³	<ul style="list-style-type: none"> • Immediate closure. Exclude public from pool area • Shut down spa pool. • Shock the spa pool with 50mg/l free chlorine circulating for 1 hour or equivalent. • Drain, clean and disinfect. • Review control & risk assessment; carry out remedial actions identified. • Refill and retest next day and 2-4 weeks later. • It may be advisable to alert the local Health Protection Unit. • Keep closed until legionellae are not detected and the risk assessment is satisfactory

2.3.5.5 Legionella pneumophila

150. Well-operated spa pools should not normally contain *Legionella* species. The microbiological results should not be considered in isolation but in the context of the management records for the spa pool.

151. The table above illustrates the guidelines for interpretation of *Legionella*.

2.3.6 Closing a spa pool

152. The spa pool should be closed following a routine microbiological test if

- the result suggests gross contamination (see above and below); or
- there is other chemical or physical evidence that the spa pool disinfection system is not operating correctly (eg if the records show that residual disinfectant values were inadequate or

erratic and frequently too low, or the spa pool water is of unsatisfactory appearance).

Where there is evidence of gross contamination the spa pool should be closed to prevent illness in users and those working near the spa pool. The appropriate enforcing authority should be contacted and competent help and advice sought.

153. The following should be considered gross contamination

- greater than 10 *E. coli* per 100ml in combination with
 - an unsatisfactory aerobic colony count (>10 per 100ml) and/or
 - an unsatisfactory *P.aeruginosa* count (>10 per 100ml)
- greater than 50 *P.aeruginosa* per 100ml in combination with a high aerobic colony count (>100 per ml)
- greater than 1000 cfu per litre *Legionella* species

2.3.7 Additional testing in outbreaks

154. In the event of an outbreak of illness associated with a spa pool additional microbiological testing will be undertaken by the appropriate enforcement agency, eg the Local Authority, following discussion with the CCDC and chairman of the outbreak control team. If disinfection is adequate

then bacterial and viral tests are unlikely to represent the conditions at the time of the infectious event. *Cryptosporidium* or *Giardia* contamination may still be detectable through examination of backwash water and filter material (although routine testing for *Cryptosporidium* and *Giardia* is not considered useful).

Table 2. Routine Microbiological Sampling

Microbiological result	Action
Colony count at 37°C > 10cfu/ml	If a colony count above 10cfu/ml is the only unsatisfactory microbiological result, and residual disinfectant and pH values are within recommended ranges, the water should be retested.
Colony count at 37°C >100cfu/ml	Check treatment system and manual testing results records immediately and implement any remedial action as required
Coliforms and <i>E. coli</i> present (>1cfu/100ml)	Occasional positive samples may occur if the spa pool has been sampled immediately after a contamination event before the disinfection system had time to be effective. A repeat sample should be taken whenever coliforms have been detected.
Coliforms >10cfu/100ml	A coliform count of up to 10cfu/100ml is acceptable provided that the residual disinfectant and pH values are within recommended ranges, there are no <i>E. coli</i> present and the aerobic colony count is <10/ml.
Coliforms present on repeat test	If coliforms are found on a repeat test it indicates that the disinfectant regime is ineffective. The spa pool systems and risk assessment should be reviewed and the spa pool taken out of action, drained, cleaned and disinfected before resampling.
<i>P. aeruginosa</i> present (>50cfu/100ml) with or without raised coliform, <i>E. coli</i> or colony count	Take spa pool out of operation and treat as above
<i>Cryptosporidium</i> or <i>Giardia</i>	Take spa pool out of operation immediately and seek advice of a public health microbiologist over the appropriate disinfection procedures

2.3.8 Summary of Checks

155. Daily

Before opening the spa pool

- Check water clarity before first use.
- Check automatic dosing systems are operating (including ozone or UV lamp if fitted).
- Check that the amounts of dosing chemicals in the reservoirs are adequate.
- Determine pH value and residual disinfectant concentration.

Throughout the day

- Continue to check automatic dosing systems are operating (including ozone or UV lamp if fitted).
- Determine pH value and residual disinfectant concentration every 2 hours.
- Determine the TDS, where appropriate.

At the end of the day after closing the spa pool

- Clean water-line, overflow channels and grills.
- Clean spa pool surround.
- Backwash sand filter (ensure water is completely changed at least every 2 days) - for diatomaceous earth filters comply with the manufacturer's instructions.
- Inspect strainers, clean and remove all debris if needed.
- Record the throughput of bathers, unless water is being changed continuously.
- Record any untoward incidents.

156. To be done at every drain and refill

- Drain and clean whole system including balance tank.
- Clean strainers.
- Check water balance after the refill, if necessary.

157. Monthly

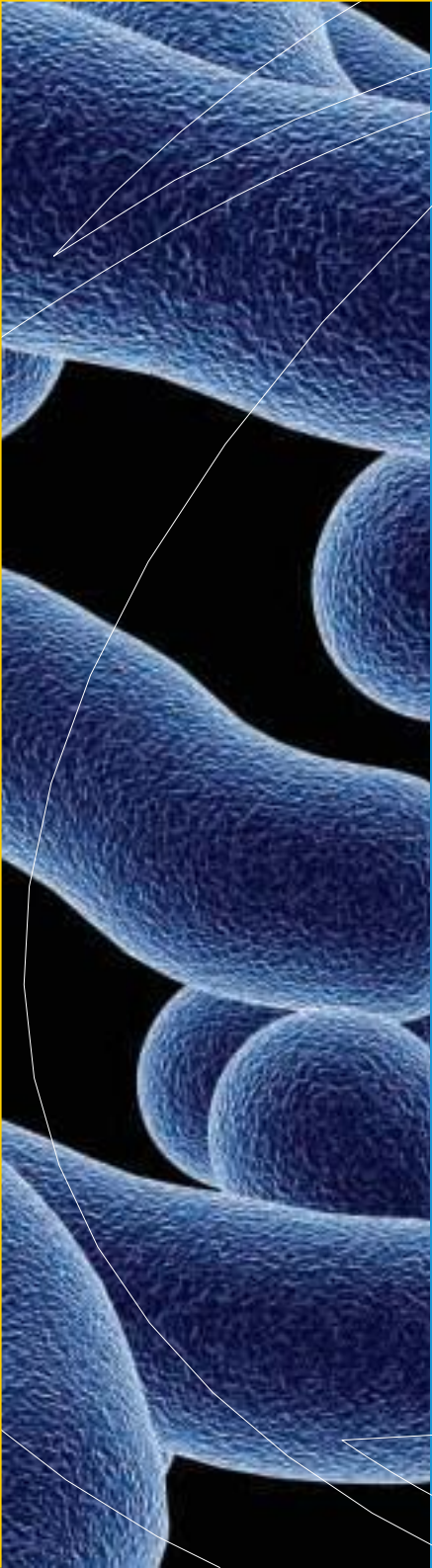
- Microbiological tests for indicator organisms.
- Full chemical test (optional).
- Clean input air filter when fitted.
- Inspect accessible pipework and jets for presence of biofilm; clean as necessary.
- Check residual current circuit breaker / earth leakage trip is operating correctly.
- Check all automatic systems are operating correctly eg safety cut-outs, automatic timers etc.
- Disinfectant/pH controller - clean electrode and check calibration (see manufacturer's instructions).

158. Quarterly

- Thoroughly check sand filter or diatomaceous earth filter membranes.
- Where possible clean and disinfect airlines.
- *Legionella* tested by laboratory.

159. Annually

- Check all written procedures are correct
- Check sand filter efficiency.



2.4

Cleaning and disinfection

2.4.1

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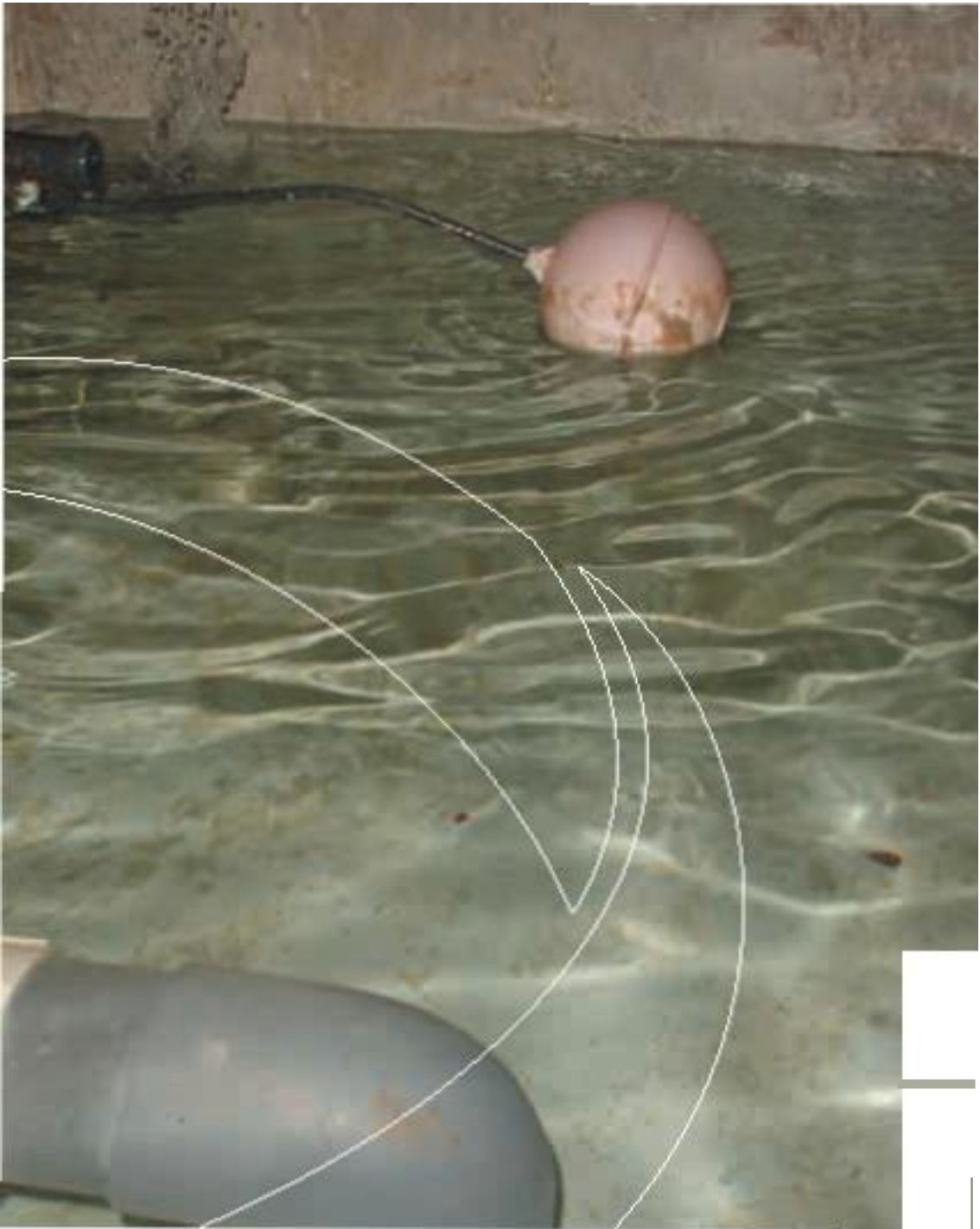
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2.4 Cleaning and disinfection

2.4.1 Cleaning

160. Dirt from around the spa pool must not be allowed to enter it. It is essential to maintain the spa pool, the balance tank, associated components, and the surrounding walkways in a good hygienic condition by the implementation of regular cleaning procedures.

161. The spa pool water line, overflow channels, strainers and grills, and the surrounding area should be cleaned regularly, ideally on a daily basis using a solution of free chlorine, with a concentration of 5-10mg/l. If the water line, or overflow channels require an abrasive cleaner, a small amount of sodium carbonate or bicarbonate can be placed on a damp cloth and applied sparingly. The areas around the spa pool (ie outside it) are often difficult to clean and a hose may need to be employed in conjunction with brushing of the floor surfaces.

162. The materials described in paragraph 161 are compatible with spa pool water treatment. Some other cleaning materials may have a chlorine/bromine demand (ie neutralise these disinfectants) and any carry-over into the spa pool water may react with the residual disinfectant and/or be incompatible with the fabric of the spa pool and surrounding area. Some cleaning agents may interfere with the sensors/probes of automatic controllers. Thus if other special cleaning materials are being considered for use they must first be shown to be compatible with the pool water treatment and spa materials.

163. It should be noted that flexible hoses can become colonised with bacteria including *Pseudomonas aeruginosa* and *Legionella* and therefore will need regular disinfection by filling and soaking with a solution containing 10 -50mg/L of free chlorine for 1-5 hours and wiping the outside with a chlorine solution.

164. The whole system should be drained and cleaned at least once per week. At this time the inside surfaces of the balance tank should be cleaned in the same manner as those of the pool (paragraph 161 above) paying particular attention to the water line and not forgetting to clean and disinfect the underside of the lid as this can become a focus for microbial growth.

165. The areas behind the headrests can also harbour growth so these should be removed each time the pool is drained down and the headrest and the area behind it carefully cleaned.

166. If covers are used on the spa pool these should be cleaned inside and out once a week using a solution of 10 mg/L of free chlorine. Covers should be stored dry in a clean area while not in use.

167. Once a month, when the pool is drained down the jets should be removed. The jets and pipework behind them, and elsewhere where the pipework is accessible, can then be inspected for the development of biofilm and cleaned as necessary.

2.4.2 Routine disinfection

168. A variety of disinfectants (eg chlorine and bromine releasing chemicals, PHMB) are used in spa pools. The spa pools may either be treated individually or as part of a combined swimming pool water treatment system of the type found in leisure complexes. The nature of the incoming mains water supply needs to be taken into consideration before a selection of the disinfectant can be made.

169. Various features, eg the elevated temperatures, amount of sunlight present, high turbulence caused by the hydrotherapy jets and/or aeration, and high organic loading due to heavy use patterns, may influence the maintenance of disinfectant levels. Where chlorinating disinfectants are used a free chlorine residual of 3-5 mg/l should be maintained in the spa pool water and for bromine 4-6 mg/l of total active bromine. The efficacy of the disinfectant is directly related to the pH of the water (see figure 2). These values are only correct for water at pH 7. In commercial spa pools the introduction of water treatment chemicals must be automatically controlled. Hand dosing should NOT be used except in emergencies such as plant failure or for shock treatment.

170. The process of disinfection using a chlorinating agent results in the formation of free and bound (combined) chlorine. Combined chlorine has slow and little disinfectant effect. It is formed by the reaction of free chlorine with organic materials arising from bather pollution eg urine and perspiration. The efficiency of the disinfection system to cope with the bather load is reflected by the concentration of combined chlorine. The ideal combined chlorine concentration is 0mg/l, however, a concentration of less than 1mg/l is normally considered acceptable. Above this level irritation to the mucous membranes of the eyes and throat may occur.

171. Disinfection using a brominated chemical results in combined bromine being formed as the predominant and effective disinfectant. Free and combined bromines are not usually differentiated between when monitoring the spa pool water disinfectant concentration, since combined bromine is still an effective disinfectant.

172. For spa pools that form an integral part of a leisure pool system, where chlorinating disinfectants are used in conjunction with ozone the residual disinfectant concentration required in the spa pool water will be dependent on spa pool design and attaining satisfactory microbiological results. The microbiological results should indicate low colony counts and the absence of *Pseudomonas aeruginosa* and *Legionella* bacteria.

173. Problems have been encountered with microbiological contamination of the deozonising filter media, eg carbon. Low residual disinfection concentration can encourage microbiological growth, both in the spa pool water and subsequently in the filter media. Care must therefore be taken to ensure that a satisfactory residual disinfectant concentration is attained which will not permit microbial growth. In addition it may be necessary to backwash activated carbon or hydroanthracite filters with water chlorinated to 10mg/l by addition of chlorine to the strainer basket or better still through the balance tank.

174. No disinfectant will work effectively if there is accumulation of organic matter in the strainers, filters and pipework etc.

2.4.2.1 Removal of algae

175. If algal growth on the pool surfaces becomes a problem, raising the concentration of disinfectant in the pool to around 10mg/l will effectively kill green algae, whereas blue-green and red algae usually require scrubbing in conjunction with this elevated concentration of disinfectant. If problems persist an expert should be consulted.

2.4.3 Disinfectants

176. **Note:** for all chlorine-based products the active disinfectant is hypochlorous acid.

2.4.3.1 Sodium hypochlorite

177. Sodium hypochlorite is usually supplied as a solution having a

concentration of 12-15% available chlorine. It should be stored under cool conditions and used within its expiry date (a maximum of three months). Using sodium hypochlorite will raise the pH of the spa pool water.

2.4.3.2 Calcium hypochlorite

178. Calcium hypochlorite is supplied in powder, granular or tablet form, and must be dissolved in a suitable reservoir/feeder before being injected into the spa pool water. In hard water areas more frequent backwashing of the filters may sometimes be required to minimise the occurrence of blockages in the filtration and distribution pipework due to the deposition of calcium salts. Using calcium hypochlorite will also raise the pH of the spa pool water.

2.4.3.3 Chloroisocyanurates

179. These are commonly used in domestic spa pools and are available as slowly dissolving tablets (trichloroisocyanuric acid) or rapidly soluble granules (sodium dichloroisocyanurate). Trichloroisocyanuric acid should be delivered via a dosing unit. However, care must be taken to ensure that the controller is compatible with cyanuric acid at concentrations in excess of 20mg/l. Sodium dichloroisocyanurate is only suitable for dosing directly into the spa pool water and normally should only be applied in this way as an emergency measure. Using dichloroisocyanurates will usually have little or no effect on the pH of the spa pool water, although this can depend on the source of the water. Using trichloroisocyanuric acid will tend to lower the pH.

180. The use of chloroisocyanurates results in the addition of cyanuric acid to the spa pool water and its concentration should be maintained below 200mg/l by dilution with fresh water. Cyanuric acid concentrations above 200mg/l can encourage algal growth and may prevent the release of free chlorine into the spa pool water (see above).

2.4.3.4 Solid bromine based disinfectants

Bromochlorodimethylhydantoin

181. The first solid tablet 'bromine' donor was 1-bromo-3-chloro-5,5-dimethyl hydantoin, known as BCDMH. This is a slow dissolving tablet, designed to be used in a 'soaker' feeder, where a portion of the circulating water is by-passed through the Brominator (feeder). BCDMH can also be used in a pre-filled 'granular' feeder device, which may float (with or without additional minerals) or be plumbed in to the circulation system. It must be added from a suitable dosing unit and ideally injected prior to the filter.

182. This is probably one of the most frequently used disinfectants in spa pools in the UK, although generally it is more expensive than the chlorine based alternatives. The use of BCDMH has been associated with a rapid onset skin rash, but only when the water was not being replaced as recommended.

Other solid bromine disinfectants

183. Other brominated hydantoins have been introduced more recently. The most popular is a mixture of 60% BCDMH, 27.4% 1,3-dichloro-5,5-dimethyl hydantoin (DCDMH), 10.6% 1,3-dichloro-5-ethyl-methyl

hydantoin (DCEMH) and 1.0% sodium chloride. The additional chlorine in this mixture means it is more acidic and dissolves faster than pure BCDMH.

2.4.3.5 Non-halogen disinfectants

184. A disinfection system based on PHMB (poly hexamethylene biguanide hydrochloride) has been used as a three-part system, where the second part is hydrogen peroxide and the third an effective algicide, for many years in swimming pools.

185. A version for spa pools, still based on PHMB and a three-part system but with different additional parts, has now been introduced. All three parts must be used as instructed to ensure safe, clean water. PHMB has no effect on pH and the residual disinfectant is maintained at 50mg/L.

2.4.3.6 Ozone with residual disinfection

186. Ozone may be used in conjunction with residual disinfection. The type of ozonisation used depends on the spa pool installation. Where spa pools are installed as an integral part of a leisure pool water treatment system, water treatment is sometimes combined with that of the main leisure pool and ozone treatment would normally be followed by deozonisation prior to residual disinfection. Free chlorine residuals will still need to be maintained between 3-5mg/l, bromine at 4-6mg/l, PHMB at 50mg/l and isocyanurates at 3-5mg/l to ensure adequate disinfection.

187. Alternatively, trickle stream ozonisation is used sometimes where the ozone is not removed by a deozonisation bed prior to the addition of the residual disinfectant. The ozone should be at such a concentration to ensure that 0.01ppm ozone is not exceeded in the atmosphere above the spa pool water. The residual disinfectant may be any of those mentioned earlier. The ozone generator should be checked daily to ensure it is operating correctly. The system must be maintained and cleaned as specified in the manufacturer's instructions.

2.4.3.7 Ultraviolet light

188. Ultraviolet light has been shown to have a killing effect on bacteria. However, as with ozone, it only renders the water bactericidal at the point of use and therefore additional (residual) disinfection by an oxidising disinfectant (eg residual chlorine or bromine) is required to prevent cross contamination in the spa pool water and to deal with the effective breakdown of bather pollution. The system must be maintained and cleaned as specified in the manufacturer's instructions.

2.4.3.8 Other disinfectants

189. There are a variety of other types of disinfectant available on the market. It is important that the manager is satisfied that the disinfectant used has been independently proved to be capable of providing satisfactory chemical and microbiological water quality and satisfies the Biocidal Products Regulations^{11,12}.

Withdrawn on 23 January 2017

2.5

Design and construction

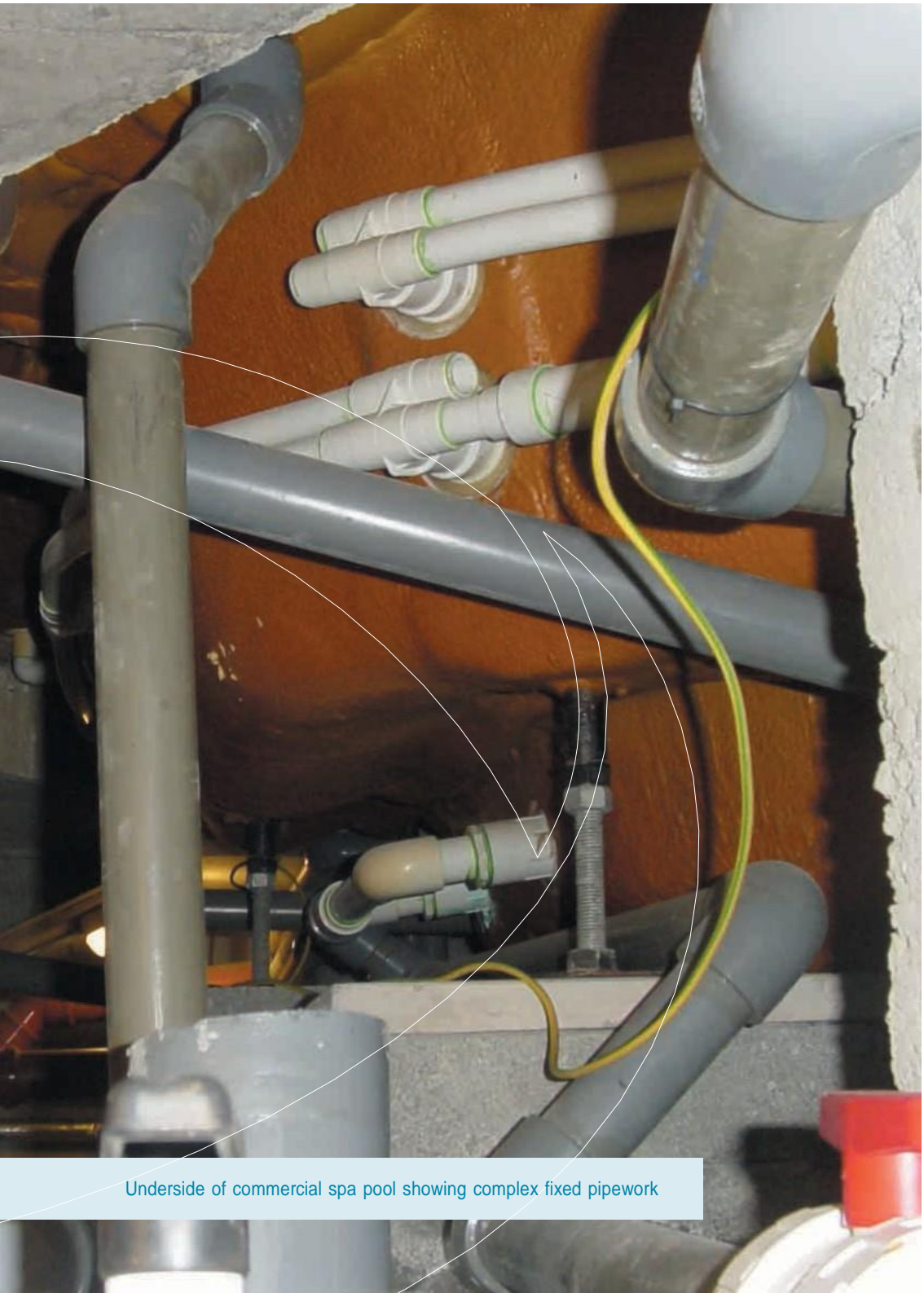
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Underside of commercial spa pool showing complex fixed pipework

2.5 Design and construction

2.5.1 Specific design issues

2.5.1.1 Pipework

190. *Legionella* have been shown to colonise water fittings and pipework, and this is facilitated by poor water-flow or by the presence of dead-legs i.e. areas where water is stagnant or is becoming stagnant. In a recent investigation of an outbreak of Legionnaires' disease associated with the use of a hotel spa pool, it was found that a piece of redundant pipework still connected to the spa pool had probably acted as a continuing source of infection. Pipe made of plastic may readily support microbial growth; the ability to support growth depends on the composition of the particular material^{53,54,55}. The use of flexible corrugated plastic pipe also increases the surface area for growth and can create areas that are difficult to clean in the valleys between the ridges of the corrugations. Corrugated pipe should therefore be avoided as much as possible. All non-metallic materials used in the construction of the spa pool that come into contact with water continuously or intermittently should be suitable for use in contact with potable water and comply with BS6920⁵⁰, which includes a test to show that the material does not support microbial growth. Materials satisfying these requirements are listed in the Water Regulations Advisory Scheme's *Water Fittings and Materials Directory* (this document is updated twice a year, so refer to WRAS website [www.wras.co.uk] for latest version).

191. Pipework should be designed to minimise the length of pipe runs, the surface area for growth and the number of pipe fittings. Provision should also be made in the design to facilitate ease of access to all pipework for maintenance, draining, cleaning and disinfection. Ideally it should be possible to remove pipes to enable them to be cleaned internally or replaced should they become heavily colonised.

2.5.1.2 Design

192. Overall spa pool design must conform to the appropriate Regulations, eg the Electricity at Work Regulations 1989³⁷, Water Supply (Water Fittings) Regulations 1999¹³, for maintaining safety and the chemical and microbiological quality of the water.

193. Water treatment systems are an integral part of the architectural, structural and mechanical design and must be addressed from the very start of the project. For example, water treatment plant design must take into account

- bathing load,
- circulation rate,
- turnover period,
- choice of treatment/disinfection system,
- circulation hydraulics,
- balance tank,
- plant room,
- filtration (eg sand, diatomaceous earth, commercial cartridges, ground glass [AFM]),
- chemical treatment and storage areas,
- operation,
- mains water quality, drainage and dilution, and
- access for operation and maintenance.

194. It is important to ascertain the anticipated maximum bathing load from the client prior to making calculations for pipework, pump and filter sizing. The circulation/filtration pump must be sized along with the filter to achieve the turnover period specified and the filter must be capable of maintaining the spa pool water in a clean and pleasant condition when the spa pool is being used at the full limit of the design bathing load.

195. Spa pool design has become a dynamic business with the constant introduction of new ideas. As a consequence spa pools come in many shapes and sizes with many different configurations of shells, jets, pumps, filters, valves, heaters and controls. All too often these design changes are made without consideration of their effect on the risk of microbial growth.

196. Despite this, the nature of the hazard remains unchanged. Of particular importance is the length of pipework associated with each individual spa pool and the associated large surface area of pipework available for potential colonisation by bacteria with the resultant formation of biofilm. For example, a single modern spa pool may contain as much as 75m of flexible and fixed pipework with a total available surface area of over 550m². The use of flexible corrugated pipework is not recommended (see Section 2.5.1.1).

2.5.1.3 Manufacture

197. Most modern spa pools are manufactured from a seamless acrylic sheet, which is vacuum thermoformed

on a specific workstation. This is then reinforced with laminated layers of fibreglass before drilling and plumbing. Full functional and water testing is carried out to ensure the spa pool operates correctly to its maximum capability and that safety standards have been met and recorded. During these tests it should be remembered that whenever a spa pool is filled - even unheated on display with no prospect of bathers using it – the water should be disinfected as usual. Otherwise there is a risk of infection for people in the vicinity. Since it is virtually impossible to remove all of the water in the system after testing there is a risk of the spa pool being contaminated with *Legionella* and other infectious agents that could subsequently colonise the system before delivery. It is important, therefore, that the water used for testing contains chlorine (3-5mg/l) or another appropriate disinfectant, that as much water as possible is removed after testing, and that the spa pool is disinfected as soon as it is installed.

2.5.1.4 Construction

198. Spa pools in common use are either constructed in concrete or more commonly prefabricated in acrylic or fibreglass. Any of these may be fully or partially tiled.

199. The structural support for prefabricated commercial spa pools may be in the form of adjustable legs supplied by the manufacturer, brick supports built on site, or less likely, back-filled and concreted in. In every case, prefabricated spa pools should have minimal movement or flexing of the shell, as this will cause damage to the laminated construction.

200. Hot tubs, self contained (portable) spa pools and various other mainly domestic types of spa pool are available but are not suitable for the heavy bather use usually associated with public spa pools.

201. The design of a spa pool shell for commercial use will conform to one of two basic principles. Conventional (rim) types have the water level 150mm to 200mm below the top to accommodate the bathers. Overflow (deck-level) designs maintain the water level at a constant height while the excess water is transferred to a balance tank to be replaced as the bathers leave the spa pool. All new commercial spa pools should be of an overflow design.

202. Whichever type of spa pool is provided, its surface must be smooth and free from defects or projections and it must be easy to drain and clean. Overflow channels and balance tanks must also be accessible and easy to clean.

203. All steps into the spa pool together with the surrounding area should be of a anti-slip pattern. A handrail, that cannot easily be removed, should be fitted to assist bathers upon entry/exit.

204. Most balance tanks are manufactured from GRP, have smooth internal surfaces and fully removable lids. This is essential for cleaning, which needs to be done inside and out to help minimise the growth of infectious agents. Full access to the balance tank facilitates cleaning, which should be carried out whenever the spa pool is drained, to avoid build up scale or scum

on the water line. If the balance tank is 'buried' beneath the floor around the spa pool, then there must be at least two entry hatches and the lid must be completely clear of the tank, otherwise the area will have to be managed as per the Confined Spaces Regulations 1997⁴³. See Section 1.1.5.5 for more information on working in confined spaces.

205. Balance tanks usually have level switches for minimum and maximum alarms etc and these may require access from outside the tank to facilitate replacement (level switches may be broken during cleaning). Care must be taken to ensure that there is adequate access to the tank surround.

2.5.1.5 Plant space and location

206. Ideally the water treatment plant should be located as near as practicable to the spa pool with suction and delivery pipe runs and chemical dosing lines as short as possible. External access to the plant room should be sufficient to allow for initial installation and refurbishment at a later date.

207. The plant and its associated maintenance may vary but sufficient space and easy access is required to ensure that all routine functions such as inspecting the treatment equipment and cleaning the balance tank can be carried out adequately.

208. At an early stage in planning the allocation of plant room space is important and should be considered along with requirements for chemical storage and other plant maintenance.

209. Plant space and chemical stores should be provided in accordance with CIBSE guides⁵⁶ and Chapter 18 of PWTAG's *Swimming Pool Water Treatment and Quality Standards*⁵⁷.

210. The water treatment plant should normally comprise as a minimum

- balance tank;
- circulation pump(s) with integral strainers;
- medium rate filter(s);
- booster pump;
- aerator pump;
- automatic controller;
- disinfectant dosing system;
- pH adjustment dosing system;
- heat exchanger.

211. Where ozone generation plant is installed mechanical ventilation may be necessary to achieve 10 air changes per hour. Extract should be at low level and in accordance with HSE EH38⁵⁸ and CIBSE TM21 *Minimising pollution at air intakes*⁵⁹.

212. Chemical storage areas should be separate for acids, alkalis, and disinfectants. They should be lockable, dry, cool and have provision for heat and frost protection.

2.5.1.6 The water treatment system

213. For a commercial overflow spa pool water is drawn through the filters from the balance tank and circulated back to the spa pool. The balance tank is replenished from the incoming mains water supply, from water displacement arising from the introduction of bathers into the spa pool and from the low

suction point. The water is continuously circulated, filtered and chemically treated (24h/day) and heated before being returned to the spa pool via the inlets. Water within the spa pool should be at such a level that continual overflowing occurs into the level deck channel creating an effective surface skimming action, this then returns to the balance tank. There may also be a secondary circuit that draws water from the spa pool footwell and reinjects it into the spa pool. The heater and chemical dosing units should be adequately interlocked to "fail-safe" if the water stops circulating.

214. In domestic spa pools the water is drawn directly from the spa pool via a surface level skimmer to the filter and chemical dosing. Additionally a low suction point is used for the secondary circuit to feed water back into the spa pool via the jets.

215. All suction outlets from the spa pool should be duplicated to reduce the entrapment of hair or any part of the bathers' bodies and connected to more than one fitting. Fittings are also of an anti-vortex design for the same reason. It is not recommended that separate suction pipes be run to the plant room and valved but, if they are, it is essential that all suction valves are open while the pump is running to avoid deadlegs.

2.5.1.7 The balance tank

216. A balance tank is required to take up the displacement arising from bathers entering the spa pool and initially provides a source of backwash water. Ideally the balance tank should be free standing or part of the main spa pool shell. It is important therefore that the balance tank is correctly sized and located, and incorporates suitable and safe access for cleaning and maintenance purposes. The interior surface of the balance tank should be smooth to facilitate cleaning and disinfection, and the tank and spa pool should be easy to rapidly drain completely to facilitate cleaning. The tank should have a lid that can be easily cleaned on both sides. Both stand alone and cast *in situ* balance tanks should be fully enclosed and in both cases the lid or inspection hatch should be easily removable to facilitate access to the tank.

217. There should be sufficient water capacity within the balance tank when the spa pool is unoccupied to provide for a filter backwash. The backwash volume should be based on the flow rate and time period recommended by the filter manufacturer and should allow for all filters to be backwashed consecutively.

218. The average displacement allowance per bather is 0.075m^3 . The total bather displacement can be obtained by multiplying this allowance against the maximum bather capacity for the spa pool.

219. A low water level in the balance tank should cause the circulating pump to stop automatically in order to protect the system.

2.5.1.8 Circulation

220. Intensively used spa pools should be designed with a surface draw off of at least 80% of the circulation volume. This is achieved by the installation of a level deck system. Skimmers are not considered to be suitable for heavily used commercial spa pool application. Pumps should be sized to provide a turnover of 6 minutes.

2.5.1.9 Filtration

221. Filters for commercial use will either be permanent sand filters or diatomaceous earth. When using sand filters care must be taken to ensure that sufficient water, whether from the spa pool, balance tank or both, is available for adequate backwashing as prescribed by the manufacturer. Diatomaceous earth filters require less backwashing than sand filters but managers should be aware that these filters require the regular replenishment of diatomaceous earth after backwashing, which can increase the maintenance and running costs. A simple means of adding the diatomaceous earth should be installed. It is not ideal to add this via the balance tank. Simple paper cartridge filters are not recommended for commercial spa pools, but are suitable for use in domestic spa pools. Highly efficient cartridge filters are now being produced for commercial use – see specialist advice for further information. Filter pumps will have a coarse strainer basket which must be examined daily, cleaned if necessary, and in any event cleaned at least once a week.

222. Commercial spa pools should only ever be designed on a minimum of a medium rate filtration ie $10\text{-}25\text{m}^3/\text{m}^2/\text{h}$ to enable them to cope with the high bather pollution.

223. Filtration rates of between 25 and $50\text{m}^3/\text{m}^2/\text{h}$ are only considered to be satisfactory for lightly loaded residential or domestic spa pools.

2.5.1.10 Heating

224. The operating temperature of the spa pool is normally in the range of 35°C to 40°C . The heat exchanger should be sized such that when raised with fresh water the temperature can be raised at a rate that will not involve thermal change sufficient to cause damage to the shell or any tiling. Specific details are given for tiled pools in BS 5385 Part 4 1992⁶⁰, which suggests a maximum rate of 0.25°C per hour.

2.5.1.11 Chemical dosing and control systems

225. There are a wide variety of automatic control systems available incorporating either redox, amperometric or photo ionisation (PID) detectors. Both amperometric and PID controllers are more specific for chlorine and bromine, and are considered to provide better control than redox. It is essential that these are maintained following the installation of the controller. Care must be taken when considering the use of an automatic controller with Trichlor to ensure its suitability and compatibility with cyanuric acid.

226. Chemicals added to the spa pool water as a solution are normally added by positive displacement metering pumps. These can normally be adjusted to vary the volume of the chemical dosed per stroke and the number of strokes per hour.

227. Where chemicals are added as solid tablets such as trichloroisocyanuric acid (Trichlor), calcium hypochlorite or bromochlorodimethylhydantoin, they are introduced via a sidestream dispenser.

228. Many complex systems are used for testing and dosing spa pool water. Managers should familiarise themselves with their own system, understand the principles involved and the standards of water purification they are designed to achieve.

2.5.1.12 Booster jets

229. The jet or booster pump takes its water from the spa pool and delivers it directly back to the jets. The action of the water through the venturi in the jet creates a suction, which, when the air controllers are open, allows air to mix with the water to increase the massage effect. The air controllers may be sited on the spa pool or valved in the plant room. The pump is operated by an air switch near the spa pool or remotely by the attendant, an automatic timer should shut the system down after a short time, usually ten or fifteen minutes.

230. Ideally the pipework and certainly the jets should be readily demountable (the latter from inside the spa) and accessible for cleaning and disinfection.

2.5.1.13 Air blower system

231. Most spa pools also have an air massage system consisting of a series of air holes or injector nozzles in the floor and seats. An air blower delivers air to these outlets and is operated in the same manner as the booster jets. The air intake must be from a satisfactory source – warm air may be required.

232. The air holes in injector nozzles and associated pipework are often traditionally buried in the insulation and inaccessible. When the air blower system is not operating water will fill the air system up to the level of the water in the spa pool. Since there is no water circulation through the air system the disinfectant can rapidly become depleted. Condensation will also form in any pipework above the water level, encouraging the growth of biofilms and fungi. The air system can therefore become inadequately disinfected and act as a focus for the growth of infectious agents that are then difficult or virtually impossible to disinfect and remove adequately. This pipework should be designed to be readily demountable and accessible for cleaning and disinfection.

2.5.1.14 Spa pool water make up supply

233. In accordance with the Water Supply (Water Fittings) Regulations 1999¹³ make up supply to the spa pool should be via a make up tank and not direct from the mains water supply. Ideally make up should occur directly into the balance tank and the supply pipework should be sized to ensure that quick filling of the spa pool can be

achieved upon draining. It is satisfactory to fill a spa pool from an adjacent swimming pool, but do not transfer the used water from a self-contained spa pool back into a swimming pool.

2.5.1.15 Location

234. Planning where to locate a spa pool is a key consideration in keeping the water clean. Allowing suitable access for maintenance cleaning and disinfection, for example, is fundamental to operating a spa pool within the recognised safety standards.

235. Of particular importance is the location and positioning of any balance tank. The balance tank should be located in a position that facilitates easy cleaning and disinfection, and key to this is ease of access.

236. Wherever the spa pool is located it is essential that a solid foundation be provided. If located outdoors the positioning of trees and gutters should be such that debris cannot readily fall into the spa pool. If the spa pool is to be placed indoors the room will need to be well ventilated as spa pools give off a large amount of moisture, which can damage walls and ceilings over time – dehumidification equipment may be required, managers should seek professional advice.

2.5.2 Basic design features

2.5.2.1 Design bathing loads

237. The design bathing load is the maximum number of bathers who use the spa pool in any one-hour, each hour consisting of three 15 minute bathing sessions followed by a five-minute rest period. The design bather load should be approximately ten times the capacity of water in the spa pool system when measured in cubic metres. Practical experience with a particular spa pool and a full risk assessment are needed to confirm that this bather load gives satisfactory water quality.

2.5.2.2 Water replacement

238. For stand alone commercial spa pools the SPATA standards⁴² recommend that the spa pool water should be replaced with fresh water when:

The number of bathers =
100 x the water capacity
measured in m³;
or

The number of bathers =
half the water capacity
measured in gallons.

In heavy use commercial situations stand alone spa pools are likely to need draining and water replacement at the end of each day.

239. For spa pools that are incorporated with the swimming pool water treatment system dilutions of pollutants is much greater and the recommended standard for swimming pools of 30 litres per bather per day should be applied to the whole swimming pool and spa pool system combined.

2.5.2.3 Physical operation

240. With effective skimming and filtration systems, there should be a maximum water turnover time of 15 minutes for domestic spa pools, and a 6-minute turnover time for commercial spa pools. The turnover time is the time taken for the entire spa pool water volume to pass through the filters and treatment plant and back to the spa pool. Sand filters in commercial spa pools should be backwashed on a daily basis but in domestic spa pools fitted with sand filters the frequency may be reduced. Filters should always be backwashed before the pressure rises above normal clean operating pressure by 0.35bar (5lbs/in²). Diatomaceous earth filters should be backwashed and recharged according to manufacturers instructions. Domestic spa pool users are advised to keep two sets of cartridge filters to ensure there is one set available to use whilst the other is being cleaned.

2.5.2.4 Dehumidification

241. In considering the use of spa pools in commercial applications special attention must be given to the dehumidification/ventilation of the area around the spa pool. It must be realised that the level of evaporation from the surface of the spa pool, which is greatly increased the moment the jets/airblower are operated, is very high and probably much greater than any single equipment system can cope with economically. It is important to acknowledge this from the outset and to provide equipment systems/control that will lower the humidity when the spa pool returns to the quiescent condition. The following is a minimum requirement

- The use of “control timers” to limit prolonged operation of the jets/airblower when the bath has been vacated. The timers usually limit the continuous operation to no more than 15 minutes.
- An air temperature of 1 degree C above the water temperature and a maximum relative humidity of 60-70% is typically required. Ventilation should be set at a rate of 10-15 litres per second per square metre of wetted area. Where outdoor air input is used as the only means of controlling humidity the chloramines are exhausted along with the humid air. Central plant incorporating heat recovery and/or heat pump dehumidification to allow recirculation of air may be utilised. However, the economies of such systems require detailed consideration and experience has shown that recirculatory systems, even those operating on ozone with residual chlorination, can operate under conditions that cause severe corrosion and loss of performance in a short timescale.
- The use of a cover overnight and at other times when the spa pool is out of use.

242. In addition, where the spa pool is very large or where it is operated in a confined space, a wall-mounted dehumidifier should be provided. This will not only provide a level of dehumidification but will also contribute to the space heating which will in itself help to reduce the formation of condensation.

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2.6

Whirlpool baths

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Filter backwash control valve – note sight glass to observe backwash (with kind assistance of Esporta Ltd)

2.6 Whirlpool Baths

243. Whirlpool baths are designed for one or two users and are intended to be filled and emptied after each use. Whirlpool baths are usually fitted with a few jets, which can be angled in use and removed for cleaning. In addition there is usually an air track in the floor of the bath, powered by an air blower system or alternatively air may be introduced to the water jets by the Venturi effect. As with spa pools the pipes and pumps associated with the water and air circulation system can become colonised and infections, particularly due to *Pseudomonas aeruginosa* have resulted from their use.

2.6.1 Design of whirlpool baths

244. The same design criteria should be applied to whirlpool baths as to spa pools. All water from pipework and air blower system should drain out with the rest of the bath water between uses. Pipes should be fitted so that they cannot sag and create pockets where water may remain between uses. Synthetic piping materials should be WRAS approved for contact with hot water. Flexible and corrugated pipes should be avoided. For ease of cleaning the jets should be readily removable and pipes easily accessible and removable.

2.6.2 In use hygiene and cleaning

245. Bathers usually use soap and water to clean themselves and sometimes wash their hair in the bath. The jets and air system should not be used when this soapy water is in the bath as it will tend to foam and leave residue in the pipes around the bath. Whirlpool baths are sometimes associated with beauty salons where skin treatments such as mud or seaweed may be applied. These should be washed off before entering the bath otherwise they may coat the insides of the pipes and encourage microbial growth.

246. The surface of the bath, like any other bath, should be wiped clean after use. In addition, although the whirlpool bath is designed to drain, there will still be damp in the pipework. Jets should be removed regularly – at least weekly on residential and daily on commercial (eg Hotel) whirlpools - and thoroughly

cleaned, preferably washing off if necessary in a solution containing 10-50mg/L of chlorine.

247. In addition, and at the same frequency, the whirlpool bath should be filled with cold water and dosed at 20 ppm of chlorine for at least 2.5 hours to disinfect the system, and then drained, refilled and drained again. The water in the whirlpool bath should be generally free from black and other particulate matter after use of water and air jets: if not, then the cleaning regime needs to be repeated and may need to be carried out more frequently or otherwise modified.

248. The use of a proprietary whirlpool bath cleaner is recommended but care should be taken, by examination of the Material Safety Data Sheet to ensure that the surfactants etc. are suitable for use in contact with humans. Expert Advice may be required.

249. A number of commercial products are currently being developed and evaluated to improve upon those currently available whirlpool bath pipework cleaners. Such products are sold by hot tub and spa or swimming pool dealers.

2.6.3 Whirlpool baths in healthcare settings

250. Whirlpool baths are sometimes installed in health care settings. Advice should be sought from the local infection control team but extra precautions to ensure disinfection between uses are warranted and pools designed specifically for therapeutic use should be used. Baths with an air track embedded in the floor or sides of the bath should be avoided as such systems are difficult to disinfect adequately. Complicated designs should also be avoided as they are more likely to become colonised and are difficult to disinfect reliably. The disinfection regime applied to baths in health care facilities should be regularly monitored for its effectiveness by collecting samples for microbiological analyses just after filling the bath in the normal manner with fresh water. The frequency of testing and the microbiological standards should be the same as those recommended for spa pools.

2.7

Hiring and other commercial uses

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Holiday Home and shared Spas
and Hot tubs. 91

2.7.2

'Party Rental' or 'Entertainment Spas'. 91

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SPA RULES

For your health, good spa hygiene and the comfort of fellow users:

- Only enter pool after using the toilet and then showering
- Do not exceed 6 bathers in the pool together
- Users must be capable of keeping their head above water when sitting
- No children under 12 years
- Users under 18 years must be accompanied by an adult
- Do not submerge your head
- Do not enter after a heavy meal
- Do not use the pool under the influence of alcohol or drugs
- Do not exceed 15 minutes in the pool at a time
- No glass or sharp objects permitted in the pool area
- Consult your doctor before use if you are receiving medical treatment or have a long term illness

2.7 Hiring and other commercial uses

2.7.1 Holiday Home and shared Spas and Hot tubs

251. A normal domestic spa or hot tub is designed for use by a family up to twice a day in a private residential situation. Where a spa pool is supplied for use at a holiday home (LET), it needs to have a continuous chemical feeder built into the spa to continuously treat it with disinfectant.

252. If there are a number of premises sharing a spa, then a commercial spa is required, preferably of a deck level (overflow) design with separate filter, and continuous chemical feeder system. Deck level spas require a balance tank which takes up extra space as well as a separate filter (usually sand or diatomaceous earth).

253. The whole system will need regular (at least weekly – depending upon bathing load –) shock treatment, drain down and cleaning (see sections 2.3.8 and 2.4.1).

2.7.2 'Party Rental' or 'Entertainment Spas'

254. Domestic spas are not designed for continuous bather use. If they are to be rented out for parties or similar occasions they need to be carefully managed.

If the use is likely to be greater than for normal domestic use (see 2.7.1 above) a spa designed for commercial use should be used. Under section 8 of the HSWA, the responsibility of the hiror (the person providing the pool for hire) is to ensure, so far as is reasonably practicable, that the hirer and other users are not exposed to risks to their health and safety at the point of hire. The hirer should be given sufficient instruction to enable them to use the pool safely. After each period of hire the hiror should ensure that the pool is completely drained, cleaned, refilled, disinfected and drained again. When stored, the pool including the insides of the pipework

should be dry. Before hire it should be disinfected again. The hiror should confirm the effectiveness of the maintenance regime of the pools they provide for hire by routine microbiological testing.

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Appendices

And other references

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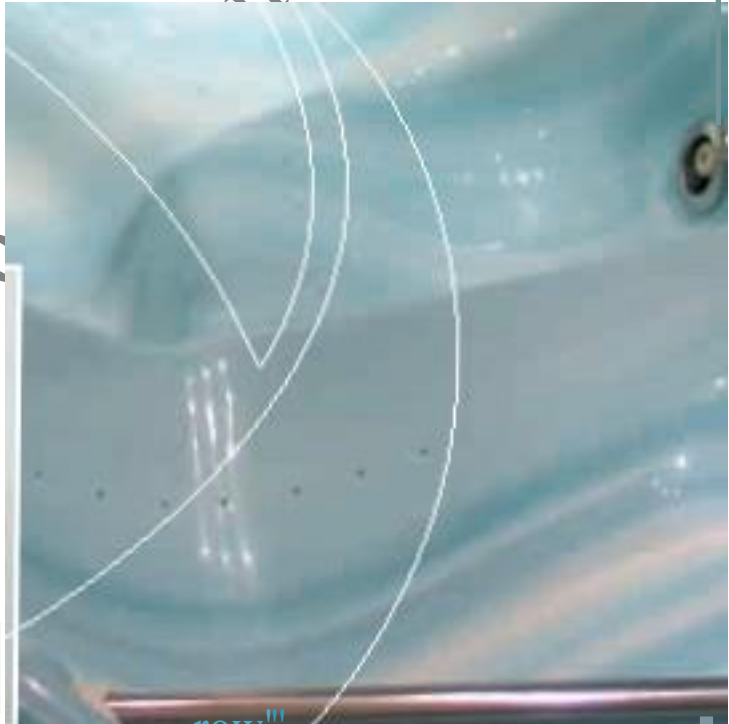
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Appendix 1 Audit checklists

1. The following checklists are designed to help the responsible person audit the arrangements that they have in place to control the risk of infection from the spa pools they are responsible for.

2. This is a check on the responsible person's knowledge of the system and also the knowledge of those who play a role in controlling the risk from the system, for example, water treatment contractors. There would be no value in asking a third party to complete this audit, because the responsible person should have been appointed because they have 'sufficient authority, competence and knowledge' of the systems in the workplace.

3. The checklists are not risk assessments. The checklists have been prepared on the basis that the employer has already identified that there is a risk system(s) in the workplace and that they need to put in place (or review) the measures that prevent or control the risks of infection. However, the first checklist addresses a number of issues relating to the risk assessment so that the responsible person can audit the assessment process itself.

4. The system checklist takes the user through the recommended measures in this guidance and the *Approved Code of Practice and Guidance on the Control of Legionella bacteria in water systems* (L8)⁵ so that the responsible person can audit the arrangements they have in place or intend to put in place. A negative answer to any of the questions indicates that

there is a need to review the arrangements that are in place.

5. The checklists do not give guidance on how to achieve control, this should be done after consulting L8 and this guidance for detail on control measures and how they are put in place and monitored.

6. Using the system checklist requires a physical inspection of the system as well as examining the management procedures and paperwork in place and talking to those who may have responsibilities for aspects of the control regime.

7. The checklists only cover spa pools, the employer will also need to assess whether there are other sources of risk in the workplace and put in place appropriate control measures.

Checklist 1 -The risk assessment

1. Have you included?

- Name of auditor
- Date of audit
- Date of review (see Checklist 1 question 9 below)
- Action required (list)
- Dates Completed

2. Did you consider whether you could eliminate the risk?

Note: Your primary duty under the Control of Substances Hazardous to Health Regulations is to prevent the risks of exposure, although this may not be possible when running a spa pool.

3. Have procedures been put into place to ensure that control measures being used are maintained, examined and tested?

4. Did the risk assessment consider the need to monitor exposure?

5. Did the risk assessment address the need to plan for foreseeable accidents, incidents and emergencies?

6. Was the risk assessment carried with competent help and advice?

7. If there are more than 5 employees in your organisation, did you record the significant findings of the assessment?

8. Did you consult employees about the assessment and the control measures?

9. Have you identified the circumstances, which would require a review of the assessment?

Note: Your assessment should be reviewed regularly - at least every two years, and whenever it is suspected it is no longer valid, for example if there is a significant change to the system.

[Managing the risks - Roles and responsibilities](#)

10. Has a 'responsible person' been identified in writing?

Note: If risks have been identified, there needs to be someone to take charge of managing the control regime.

11. Is there a nominated deputy?

12. Are contact details for these persons readily available (in the event of an emergency)?

13. Are the roles and responsibilities of all your staff involved in the control regime clearly defined in writing?

14. Have they all received appropriate training?

15. If external contractors are used, are their roles and responsibilities clearly defined in writing?

Note: The demarcation between contractor and occupier needs to be defined, ie who does what. But remember that using contractors does not absolve you of the responsibility for ensuring that the control regime is carried out.

16. Have you checked the competence of contractors?

Note: For example, you should ask about experience and qualifications, how their staff are trained, and whether they are a member of a professional organisation/recognised trade body, for example the Legionella Control Association. You can find out about the health and safety performance of companies by checking HSE's enforcement databases (<http://www.hse.gov.uk/notices> and <http://www.hse.gov.uk/prosecutions>)

17. Have you considered all other health and safety issues (eg COSHH assessments for handling of water treatment chemicals, working in confined spaces, electrical safety and ease of access to parts of the system)?

18. Are appropriate records being maintained?

19. Have you provided relevant health and safety information to users eg in the form of posters or notices?

Checklist 2 - Spa pools

1. Record details of pools below (ie make, model, year of manufacture, type) - you should complete a checklist for each pool.

Managing the risks - The written scheme

2. Is there a written scheme for controlling the risk from exposure to disease causing micro-organisms?

Note: If your assessment has shown that there is a reasonably foreseeable risk of exposure to Legionella bacteria or other hazardous biological agents, there needs to be a written scheme in place to control that risk.

3. Does the scheme contain an up-to-date plan of the system (a schematic plan is acceptable)?

4. Does the plan show

- all system plant, eg water softeners, filters, strainers, pumps, non return valves
- all standby equipment, eg spare pumps
- all associated pipework and piping routes
- all associated storage/balance tanks
- any chemical dosing/injection points
- origin of water supply
- any parts that may be out of use temporarily?

5. Does the scheme contain instructions for the operation of the system?

6. Does the scheme contain details of the precautions to be taken to control the risk of exposure to *Legionella* and other disease causing micro-organisms?

7. Does the scheme contain details of the checks that are to be carried out (and their frequency) to ensure that the scheme is effective?

Design and construction

8. If you are fitting a new system, do any of the materials or fittings used in the water systems support the growth of micro-organisms?

Note: The Water Research Centre publishes a directory, which lists materials and fittings acceptable for use in water systems. (www.wras.co.uk)

9. Are low corrosion materials used?

10. Is all pipework accessible for maintenance, draining, cleaning and disinfection?

11. Is the balance tank easily accessible for cleaning and disinfection?

Operation and maintenance

12. Is the system in regular operation?

13. Are there procedures in place to operate standby equipment on a rotational basis?

14. Is there an operations manual for the spa pool?

Water treatment programme

15. Is there a water treatment programme in place?

16. Are chemicals/biocides used to control microbiological activity? If no, list methods used below.

17. Are chemicals dosed automatically? If yes, are the pumps and associated equipment calibrated regularly (monthly)?

Note: Although there is no requirement for automatic dosing, you should consider issues associated with manual dosing - the health and safety risks, for example manual handling and exposure to chemicals, to staff who carry out manual dosing as well as the management of the process to ensure that the frequency and rate of application are maintained.

Monitoring

General:

18. Are the safe operating limits for each parameter, which is being measured, known and recorded in the operating manual?

19. Is the corrective action for out of limit situations known and included in the operations manual?

20. Are results of all tests and checks recorded, together with details of any remedial action taken (if required)?

21. Is there a daily:

- check to make sure that the system is operating as described in the operations manual

- check made of the cleanliness of the water in the system
- back-wash of the sand-filter
- clean of water-line, overflow channels, grills, and spa pool surround?

Biocides

22. Is the control level required known and recorded in the operations manual?

23. Is the rate of release/rate of addition of biocide known and recorded?

Microbiological

24. Are microbiological tests for indicator organisms carried out on a monthly basis?

25. Are samples for *Legionella* taken on at least a quarterly basis?

26. Are all microbiological results recorded so that trends over time can be seen?

27. Have the circumstances when more frequent sampling may be required been identified and recorded?

Cleaning

28. Is there a written procedure for regular cleaning of the system?

29. What is the frequency (see sections 2.3.8 and 2.4.1)

30. Have the circumstances when emergency cleaning and disinfection of the spa pool been identified?

31. Are procedures in place for chosen method of cleaning and disinfection?

Appendix 2 Trouble shooting guide

DO NOT ADD CHEMICALS TO SPA POOL WATER BY HAND DOSING WITHOUT HAVING RECEIVED PROFESSIONAL ADVICE AND THEN ONLY WHEN THE SPA POOL IS NOT BEING USED FOR BATHING.

Issue	Remedial actions
pH out of limits (ie less than 7.0 or greater than 7.6)	Close spa pool and check acid/alkali dosing units (ie operation and calibration). Recheck pH once any faults have been rectified. If pH is still out of limits, pool will need to be emptied and refilled with mains water to reach pH 7.2 (NB additional disinfectant may need to be added to achieve this pH.)
Disinfectant out of control limits (chlorine<1mg/l or >5mg/l; bromine<2mg/l or>6mg/l)	If below minimum concentrations required for control, close spa pool and retest using dilution technique. (Also close if chlorine/bromine exceed 10/12mg/l respectively; for levels between 5/6 and 10/12, retest). Check dosing units (including calibration of automatic controller if fitted) are working properly eg they contain adequate disinfectant, flow rate is appropriate, there are no kinks/air locks/blockages in pipework. High levels of disinfectant can be lowered by partial replacement of pool water, once the underlying fault has been rectified.
Cloudy spa pool water	Close the spa pool and check operation of: <ul style="list-style-type: none">• circulation pump,• sand filters• disinfectant dosing unit., and• pumps If cloudiness is as a result of excessive microbial growth, pool will need to be shock dosed with chlorine before being brought back into operation. Any algal deposits will also require physical removal.
Dirt/grease around overflow channels	Ensure that affected areas are cleaned on a regular basis with appropriate cleaner that is compatible with water treatment chemicals used
Presence of hardness salts on overflow channels and spa pool surrounds	Check pH control of water (ie is this consistent over time), and seek further specialist advice. Presence of such deposits may also be as a result of hand dosing of water treatment chemicals. This should not be carried out without proper advice.

Appendix 3 Spa pool water testing procedures

(Note: if testing is to be carried out using a comparator the person conducting the tests cannot do so if they are red/green colour blind. All staff using such equipment should be tested for red/green colour blindness.)

These tests should be done daily before use (domestic spa pools) or on a regular basis throughout the day (commercial spa pools and domestic/commercial spa pools on display) using the following procedures. **Note:** Manufacturer's instructions should always be carefully followed and only **the correct manufacturer's reagents** should be used **with each kit; do not mix and match.**

Testing for residual disinfectant concentrations Total active bromine

Bromine can be determined using a suitable comparator and standard DPD No. 1 test tablets.

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Rinse out plastic cell marked DPD with spa pool water.
2. Add a small amount of spa pool water to be tested to the cell, so that it just covers the bottom.
3. Add one standard DPD No. 1 test tablet to the DPD cell, without touching the tablet, by carefully tearing the foil.
4. Crush the tablet with the crushing rod, and mix with the small amount of water already in the cell. (Watch out for colour developing/disappearing as this will indicate whether bleaching out is occurring.)
5. Fill the cell, with the water to be tested, up to the 10ml mark and stir contents gently with the rod.

6. Place the cell in the right hand compartment of the comparator (with the viewing glass facing you).
7. Fill the empty cell with the spa pool water to be tested and place in the left hand side of the comparator.
8. Read at once against the blank using a standard bromine disc (covers the range 1-10mg/l).

DESIRED RESULT 4-6 mg/l

If the colour forms and then disappears as the water is added, if no colouration develops, or a reading of 10mg/l or above is obtained then bleaching out of the colour may have occurred and a further test must be undertaken once the spa pool water has been diluted.

Dilution test:

Pour the sample of spa pool water to be tested into a measuring vessel. Add a volume of mains tap water equivalent to 3 X the volume of the sample. Put the lid on the vessel and shake it. Carry out the DPD1 test for active bromine using this solution.

The dilution described results in a 4-fold dilution of the sample. The reading obtained should therefore be multiplied by four to give you the residual concentration of active bromine in the spa pool water.

If the active bromine concentration is still high, it may be necessary to carry out a further dilution. i.e. X 6 (1 part spa pool sample + 5 parts of mains tap water) or X 8 (1 part spa pool sample + 7 parts of mains tap water) to provide a reading within the scale.

Eg if a comparator reading of total bromine of 2mg/l is obtained on a sample diluted X 4, then the true value of total bromine in the spa pool water is 8mg/l.

Free chlorine

This may also be estimated using a suitable comparator and appropriate DPD No. 1 test tablets:

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Rinse out plastic cell marked DPD with spa pool water.
2. Add a small amount of spa pool water to be tested to the cell, so that it just covers the bottom.

3. Add one DPD No. 1 test tablet to the DPD cell, without touching the tablet, by carefully tearing the foil.
4. Crush the tablet with the crushing rod, and mix with the small amount of water already in the cell. (Watch out for colour developing/disappearing as this will indicate whether bleaching out is occurring.)
5. Fill the cell with the water to be tested to the 10ml mark and stir gently with the rod.
6. Place the cell in the right hand compartment of the comparator (with the viewing glass facing you).
7. Fill the empty cell with the spa pool water to be tested and place in the left hand side of the comparator.
8. Read at once against the blank using a standard chlorine disc (covers the range 0.5-6mg/l).

DESIRED RESULT 3-5 mg/l

At high concentrations of chlorine bleaching can occur. If no colouration develops, or a reading of 6mg/l or above is obtained a further test must be undertaken after diluting the spa pool water (see previous test for details of how to do this).

Total and Combined Chlorine

These are measured using a standard comparator and DPD No. 1 and DPD No. 3 test tablets (or a DPD4).

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Determine the free chlorine concentration as above.

2. After recording the disc reading add one DPD No.3 test tablet to the free chlorine test solution and crush to dissolve. Allow to stand for 2 minutes.
3. Place in the right hand compartment of the comparator and read against a standard chlorine disc.

The second reading represents the total residual chlorine concentration.

By deducting the free chlorine reading (DPD1) from the total chlorine reading (DPD1 & DPD3), the combined chlorine concentration is determined.

Note: if a total chlorine reading of 6mg/l or more is obtained then a dilution test is required.

The ideal combined chlorine value is nil, but up to a value equivalent to 1/3 of the total chlorine would be acceptable.

pH using a comparator and phenol red tablets

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Fill the plastic cell marked pH to the 10ml mark with water to be tested.
2. Add one phenol red tablet and crush with the rod and stir gently to thoroughly mix the solution.
3. Place the cell in the right hand compartment of the comparator (with viewing glass facing forward).
4. Fill the empty Phenol Red cell with spa pool water to be tested and place in the left hand compartment of the comparator.
5. Compare the colours using a standard phenol red disc (covers the range 6.8-8.4)

DESIRED RESULT 7.0-7.6

If the result is equal to or lower than 6.8 or equal to or greater than 8.4 this test will not be able to give an accurate value. To obtain a more accurate pH value the spa pool water will need to be adjusted using sodium ash/sodium carbonate if the pH was low or dry acid/sodium bisulphate if the pH was high, to bring the readings within the desired range.

Cyanuric acid using the Twin Tube test kit

Note: all cells must be scratch-free, clean, and dry on the outside before being put into the comparator.

1. Separate the inner and outer tubes and fill the outer tube to the top black line with spa pool water.
2. Add one cyanuric acid tablet to the water in the tube and crush with the rod.
3. Place the lid on the tube and shake until the tablet has dissolved completely.
4. Insert the square graduated tube into the outer tube and then viewing from the top, move the inner tube up and down until the black spot in the bottom is just no longer visible.
5. Read the graduation marks on the inner tube at the level with the top solution in the tube. This figure gives the concentration of cyanuric acid present in the spa pool water.

If the figure is found to be between 80 and 100mg/l, repeat the test in the following manner:

1. Fill the outer tube with spa pool water to the bottom line.
2. Using tap water, fill the outer tube to the top line.
3. Continue the test using the procedure described above.
4. Multiply the reading by 2 to give the final concentration of cyanuric acid in solution.

If the initial reading prior to multiplication is still between 80 and 100mg/l, then further dilutions of the sample should be made.

THE CONCENTRATION OF CYANURIC ACID IN THE SPA POOL WATER SHOULD BE MAINTAINED BELOW 200mg/l.

Please note:

- DPD No. 1 test tablets are slightly poisonous and should be kept out of reach of unauthorised personnel, and stored under cool conditions. (Please refer to the Material Safety Data Sheet [MSDS] with the tablets for more information on how to use safely.)
- Water containing DPD or phenol red tablets should not be poured into the spa pool but flushed down an external drain.
- All testing equipment should be safely stored when not in use.
- The DPD and pH cells should only be used for the specific test as mixing the cells can give rise to false readings, even when the cells are regularly washed out.

Photometric and other test kits are commercially available. All testing equipment should be kept clean and well maintained.

Manufacturer's instructions should always be carefully followed and staff should receive sufficient information, instruction and training in order to undertake any testing in a competent manner.

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A chemical which lowers pH value (increases the acidity) when added to pool water	
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A measure of the acid content of water	
Aerobic colony count	139, 146, 147, 153
Aerosols	4, 21, 54, 102
A suspension in a gaseous medium of solid particles, liquid particles or solid and liquid particles having negligible falling velocity	
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A mechanical device for inducing air into ducting in the spa	
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A system whereby air is induced into ducting and released into the water through small orifices or where it is induced from the side of the spa into hydrotherapy jets.	
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Small, usually aquatic, plants which require light to grow, often found on surfaces exposed to light	
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A chemical compound which destroys algal growth.	
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A chemical which raises the pH value (reduces the acidity) in pool water- also called a base	
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A measure of the alkaline content of water	
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An electronic device for measuring the current produced in water due to the presence of oxidising agents such as Bromine, Chlorine or Ozone.	
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A cover for a suction fitting which is designed to eliminate or minimise the formation of vortices and the risk of entrapment of parts of the human body.	
Approved Code of Practice (L8)	9, 19, 41, 47, Appendix 1
Automatic controller	162, 210, 225
An electronic system to maintain correct disinfectant and/or pH level. A chart recorder may be incorporated to give a permanent and continuous record of these parameters. Manual back up is required.	
Backwash	154, 155, 173, 178, 216, 217
The process of reversing the flow of water through the filter to clean the filter media	

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- Bacteriological** see microbiological
- Balance tank** 46, 57, 121, 144, 156, 160, 164, 173, 193,
201 – 205, 207, 210, 213, 216 – 219, 221, 233, 235
- Tank fitted in circulation system of overflow spas to balance water displaced by bathers and to provide additional water volume in heavy use situations, to maintain a constant level in a commercial spa.
- Balanced water/index** see Langelier index
- Bather** capacity
218
- Bather loads** 26, 56, 133, 146, 170, 237
- BCDMH** 181 – 183
- The abbreviation for the dry organic compound 1-Bromo-3-Chloro-5, 5-Dimethylhydantoin, a bromine based spa & pool water disinfectant.
- Biocide** 16
- A compound which destroys bacteria. Term usually applied to formulations based on organic compounds.
- Biofilms** 25, 56, 73, 107, 123, 139, 157, 167, 196, 232
- A community of bacteria and other micro-organisms, embedded in a protective layer with entrained debris, attached to a surface
- Booster pump** 210, 224
- For pumping water at high pressure, normally sized for maximum performance through hydrotherapy jets. Also to provide high pressure jets of water within the body of the spa for body massage.
- BPR** 16
- The Biocidal Products Regulations 2001
- Bromine** 114, 123, 141, 162, 168, 169, 171, 181, 183, 186, 225
- An element used to destroy and inhibit bacterial, viral and algal growth in addition to oxidising unwanted organic matter. A member of the halogen family.
- Active bromine** 169, Appendix 3
- Bromine that is readily available for killing bacteria and algae. It is measured by DPD No. 1 (see below) and includes free bromine and some bromamines.
- Combined bromine** 171
- Bromine which has reacted with nitrogen to form bromamines.
- Total bromine** 160, App 3
- All the active or combined bromine compounds as measured in pool water by DPD No.1 plus DPD No. 3.
- Bromine demand** 162
- The amount of active bromine required to destroy and oxidise bacteria, algae or other organic materials.
- Bromine residual** 186, 188
- The bromine remaining in an active state after the water's bromine demand has been satisfied.
- Free bromine** 171
- Bromine present in the form of hypobromous acid (HOBr). One of the active species present in bromine treated pool water. In addition to being an effective bactericide and oxidiser it is also noted for its viricidal properties.

BCDMH	181 – 3
Brominator	181
A dispensing device for feeding bromine into a spa or pool recirculating system.	
Cartridge filter	221, 240
A replaceable filter used in domestic spa pools and constructed from pleated paper or wound fibres, through which water is passed for filtration.	
Calcium hardness	118, 129, 131
Calcium hypochlorite	168
CDM	15
The Construction, Design and Management Regulations 1994	
Chemical analysis	83, 132 – 4
Chemical balance	see Langelier index
Chemical dosing	57, 206, 213-9, 225
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Chemical storage	57, 126, 208, 212
CHIP	14
The Chemicals (Hazard information and Packaging for Supply) Regulations (2002)	
Chloramines	241
Chlorine	114, 128, 141, 161 – 70, 173, 176 – 83, 197, 201, 225, 247, App 2
An element used in disinfection a member of the halogen family	
Chlorination	161 – 70, 241
The process of treating pool or spa water with chlorine. Chlorine can be added to pool & spa water in a variety of commercially available forms as gas, solutions or solids (granules or tablets).	
Free chlorine	161, 163, 166, 169, 170, 180, 188, App 3
Chlorine dissolved in water to form hypochlorous acid and Hypochlorite ion.	
Combined chlorine	170, App 3
Chlorine which has reacted with nitrogenous impurities in the water to form chloramines. Chlorine in this form reacts only slowly with bacteria and other micro organisms.	
Total chlorine	Appendix 3
The total sum of the free and combined chlorine in the water.	
Chlorine demand	162
The amount of chlorine which is used up when a dose of chlorine is added to the pool water by reacting with impurities and pollution.	
Chlorine residual	146
The amount of chlorine remaining in the pool & spa water after satisfying the chlorine demand. The chlorine residual can be expressed as free chlorine residual, combined chlorine residual or total chlorine residual.	
Chloroisocyanurates	179 – 80
Clarity	119, 128, 155
Cleaning materials	16, 162
Cleaning procedures	160 – 167

Cloudy pool water	119, 123
Coliform	147
A bacterium belonging to the Enterobacteriaceae that produces β -galactosidase	
Colony counts	139, 146 – 7, 153, 172
Combined bromine	171
Combined chlorine	170
Commercial spa	11, 22 – 3, 106, 118, 128, 131, 169, 199, 201, 220 – 2, 238, 240, 252
Competence	62-66, App 1
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Construction	15, 57, 190, 198 – 205, App 1
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Control of Substances hazardous to Health (COSHH)	5 – 11, 41, 50, 74
Corrosion	120, 241
Cryptosporidium	35, 140, 154
Cyanuric acid	179, 180, 225, 227, App 3
Dead leg	190
A length of pipe connected to the water system down which there is no flow	
Definitions	22-26
Dehumidification	236, 241 – 2
Deck level overflow system	201, 252
A system with perimeter overflow channels for the removal of surface water forming a part of the recirculation system. Typically used in commercial spas.	
Diatomaceous earth (D.E.) filter	158, 193, 221, 252
A filter using Diatomaceous Earth as a filtering medium.	
Decks and surrounds	24, 201, 213, 220, 252
Areas surrounding spas, which are specifically constructed and installed for use by bathers.	
Deozonising filter media	173
Deozonisation	187
Designers	85 – 94
Design of spa	190 – 242
Design bather load	237, 257
Disinfectants	176 – 89
Disinfectants, effect on pH	115 – 117
Disinfectant levels	133, 169
Disinfection of water	168 – 189
Domestic spa	5, 23-4, 126, 179, 214, 223, 240, 251, 254, App 3
Dosing systems	8, 155
D.P.D.	App 3
A chemical reagent used in pool water test kits to measure the bromine, chlorine and ozone residuals in the water. Normally supplied in the form of tablets.	

Disinfection	168 – 89
The destruction of bacteria and micro organisms to a level not normally considered harmful to health.	
Electrical systems	44, 97, App 1
Enforcement	11,12, 86, 154, App 1
Environmental Health Officer (EHO)	21
Escherichia coli	139, 147, 148,153
Filter	24, 133 – 9, 154-9, 173 – 4, 178, 181, 194-5, 210, 213-4, 217, 221, 240, 251
A device that separates particulate matter from water by circulation through porous medium.	
Filtration	57, 102, 108 – 9, 138, 149, 178, 193, 221 – 3, 240
Filtration rate	223
The rate of filtration of water in a given time i.e. cubic metres per square metre of effective filter area per hour (or gallons per square foot of effective filter area per hour).	
Filtration systems	138, 240
Flotation tank	27
Foot spa	27
Free bromine	179
Free chlorine	170 – 171
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Health effects	138
Heat exchanger	210
Hepatitis A virus	35
Herpes virus	36
Hiring	23, 254
Holiday home	251 - 253
Hydrotherapy jet	24, 26, 169
An inlet fitting which blends air and water, creating a high velocity turbulent mix.	
Hydrotherapy pool	27
Hygiene	245 – 9
Hypochlorite	117, 177 – 8, 227
Inorganic chlorine compounds used for pool water disinfection. Commercially available forms are sodium hypochlorite solution, calcium hypochlorite granules and tablets (lithium hypochlorite is not permitted).	
Hypochlorous acid	176
The active form of chlorine which destroys bacteria and reacts with pollutants most rapidly.	
Immersion time	31, 112

Importers	12, 86-95, 98
Infections	2, 4, 28-38
Injuries	13, 45, 48
Installers	10, 11, 21, 97
Jets, airblower	25, 102, 241, 247
L8	9 – 11, 50, 99, 130
Laboratory analysis	129
Langelier index	118
Index applied to pool water to assess whether it has corrosive or scale forming tendencies. The equation used to calculate the index takes into account the pH, alkalinity, calcium hardness, total dissolved solids and temperature of the water.	
Legionella	4, 30, 54, 75, 77, 99, 107, 138 – 40, 150 – 3, 158, 163, 172, 190, 197, App 1
Legionella pneumophila	150
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Mycobacteria	3, 32
Mycobacterium avium	32
Natural spa	33, 38, 106
Naegleria fowleri	33
Overflow design	201
Overflow spa	23, 213
Overflow System	23, 161, 201, 252

A system with perimeter overflow channels for the removal of surface water forming a part of the recirculation system. See balance tank.

Ozone 155, 172, 186 – 8, 211, 241

A tri-atomic form of oxygen with powerful oxidising properties; used as a water disinfectant and purifying agent in conjunction with another residual disinfectant.

Ozone with residual disinfection	172, 186 – 188
Palintest	118
Parts per million (ppm)	141, 187, 247
A ratio for expressing chemical concentration. In water, parts per million has the same numerical value as milligrams/litre (mg/l)	
Periodic checks	155 - 59
pH	57, 104, 113 – 8, 128, 135, 137, 142, 146 – 7, 154 – 5, 157, 169, 177 – 9, 185, 210, App 2, App 3
A logarithmic scale of units, 0-14, which measures the balance between acidic and alkaline (basic) compounds in water.	
pH adjuster	114 – 7
pH, effect on disinfectants	113 – 4
PHMB	141, 168, 184 – 6
Poly hexamethylene biguanide hydrochloride	
Physical operation	111, 240
Phenol red	App 3
A chemical reagent used in pool water test kits to measure the pH of the water in the range 6.8 – 8.4 only. Usually supplied in the form of tablets or solutions.	
Pipework	25, 56, 121, 157, 167, 174, 178, 190 – 1, 194, 196, 230 – 3, 244, 246
Pollution	105, 110, 132, 170, 188, 211, 222
Pontiac fever	30
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Pool water testing	127 – 151, App 3
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Water fit for human consumption.	
Pseudomonas aeruginosa	3, 29, 31, 139, 149, 153, 163, 172, 243
Public spa	200
Pumps	56, 119, 133, 194 – 5, 210, 215, 219 – 21, 226, 229, 241, 243, App 1 & 2
Purification	108 – 9, 213 – 228
The process of cleaning water by filtration and chemical treatment.	
Record keeping	10, 79-85
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Sampling, microbiological	127, 132 – 3, 136 – 154, 250, 254
Sampling, chemical	134 – 5
Sampling routine	128 – 151
Saturation index	118

Scaling	118, 204
Hard deposits, which can block pool pipework and form on pool water surfaces. Caused by the precipitation of calcium and magnesium carbonate from hard water.	
Shock dosing	151, 169, 253, App 2
A term usually applied to the process of adding a higher than normal dose of disinfectant to pool water to control algae growth or destroy bather impurities.	
Skimmer	214, 220
A device designed to remove surface water, forming part of the recirculation system.	
Skin infections	4, 28, 37, 112
Skin problems	112
Skin rashes	31, 182
Sodium dichloroisocyanurate	115, 179
Sodium hypochlorite	177
Staphylococcus aureus	37, 140
Statutory duties	5, 6
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Structural support	199
Suppliers	10, 14, 21, 86-98
Swimming Pool and Allied Trades Association (SPATA)	45, 238
Swimspa	26
Symclosene	see trichloroisocyanuric acid
Testing, microbiological	57, 127, 137 – 143, 250, 254, App 3
Testing, chemical	56, 127 – 35
Test reagent	App 3
A chemical or mixture of chemicals which, when added to a sample of water produces an observable reaction. Measurement of this reaction determines a desired parameter of the sample.	
Thermal effects	42 – 3
Time in pool	112, 229, 241
Total alkalinity	118, 129
The quantitative analysis of the mix of bi-carbonates, carbonates and hydroxides in water. Whilst too high total alkalinity causes pH to resist adjustment, too low T.A. makes it difficult to maintain.	
Total dissolved solids (TDS)	120, 131, 155
The sum of the weight of soluble material in water expressed as mg/l. High levels cause turbidity.	
Total viable colony count	see aerobic colony count
Training	8, 52, 63-66, 83, App 1, App 3
Treatment, water	10, 57, 77, 98, 103, 108 – 25
Trichloroisocyanuric acid (trichlor)	116, 179, 227
Trichloro-1,3 5 triazenetron	see trichloroisocyanuric acid
Trickle stream ozonisation	187
Troclosene sodium Di-hydrate	see sodium dichloroisocyanurate

Trouble shooting	App 2
Turnover time	111, 240
The period of time required to circulate a volume of water equal to the total volume of water in the system. In spas this is usually expressed in minutes.	
Types of spa	22 – 27
Ultra violet light (UV)	155, 188
Ventilation	211, 241
Water balance	110, 113, 118, 131, 156
Water clarity	119, 128, 155
Water displacement	213 – 18, 226
The volume of water displaced by each bather entering the spa. The water displacement is approximately 0.06m ³ (13 gallons) per bather.	
Water line	161, 164, 204
Water purification	108 – 111, 228
Water quality	10, 107, 111, 113 – 25, 136, 189, 193, 237
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Water treatment	10, 98, 103 – 4, 108, 113 – 126, 213 – 228, 239, App 1
Whirlpool bath	25, 243 – 249

Withdrawn on 23 January 2011

Sources of Information

The manufacturer should provide detailed advice on the management of their spa pool.

General advice on management of spa pools can be obtained from:

- the Institute of Sport and Recreation Management (ISRM),
- the Institute of Leisure and Amenity Management (ILAM),
- the Pool Water Treatment Advisory Group (PWTAG),
- the Swimming Pool and Allied Trades Association (SPATA), and
- the British and Irish Spa and Hot Tub Association (BISHTA)

SPATA publish detailed guidance on constructing and installing commercial spa pools, and BISHTA guidance on self-contained spa pools.

(See page 119 for contact details.)

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BS EN 13451-8. Swimming pool equipment. Additional specific safety requirements and test methods for leisure water features. BSi.

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www.tso.co.uk

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