POOL WATER TREATMENT ADVISORY GROUP

OUTDOOR INTERACTIVE WATER FEATURES (IWF)

TRAINING SYLLABUS

This syllabus is based upon the PWTAG publication Swimming Pool Water and the PWTAG Code of Practice. These must be read in conjunction with the outline below which deals primarily with the knowledge, understanding and training requirements for staff responsible for the operation of feature water.

THEORY

1. **What is an IWF**
    a. Types of IWF
    b. Types of IWF pad and finish
    c. How IWF work - the recirculation cycle:
        i. circulation system
        ii. Two tank system
    d. Filtration
    e. chemical disinfection

2. **Pollution and Hygiene**
    a. Pollution from bathers - why people are the main source of pollution bathers:
        i. skin scales, sweat, urine, mucus from the nose and chest, saliva, hair, faecal matter, cosmetics, suntan lotion
    b. Pollution not from bathers:
        ii. indoor and outdoor pools, dust, floating debris, grass, dirt (soil/stones) precipitated chemicals, sand from filters, by-products of chemical treatment
    c. Pre-swim hygiene:
        iii. toilets and showers – the value of pre-swim hygiene
    d. When not to swim – exclusion policies
    e. Babies and toddlers – swim nappies

3. **Management, regulation and training**
    a. Staffing structure and management systems – their impact on water quality
    b. Health and Safety – the legal requirements

c. HSG 179 – the written procedures (PSOP and method statement)
d. COSHH – substances hazardous to health in a pool, chemicals and microorganisms
e. Confined spaces – and its application
f. O&M manual and schematic drawing
g. Training – who, when and how much is needed
h. PWTAG Code of Practice – Swimming Pool Technical Operations' role in written procedures
i. European Standards, BS EN 152881 Design and Operation of Swimming Pools

4. Design

There are factors which need to be considered in the design process.

- User group children
- Disability requirements including access and space for wheelchairs, nappy changing facilities, appropriate waste disposal and handwashing
- Staff facilities including changing rooms, showers, toilets, lockers and office
- User numbers allowing $1m^2$ per bathers assumes a depth of 0-1.35m
- Accessibility and cleanability of the pad, its environment and associated equipment such as balance tanks and pad features.
- Alarms and accessible space for resuscitation equipment
- Staff visibility of the IWF and surrounds
- Management of water temperatures quality (the warmer water increases the potential for immediate surrounding area air pollution)

Recommendations:

- Deck-level systems give optimum water quality and ease emergency evacuation and cleaning.
- No single depth. The design should ensure that there are no stagnant areas on the IWF pad and that all areas are accessible for cleaning.
- Any step entry should be into the pad with maximum riser 150mm, minimum tread 300mm and minimum step width 600mm.
- Ramp access into the pad uses more space but can be appropriate for certain patient groups, including independent wheelchair users.
- Changing rooms should include at least one with wheelchair accessibility. There should be enough changing room space to permit a full group use of the pool. There should be a minimum shower provision of 1 per 6 people per hour. Separate wet and dry areas help maintain infection control standards.
- Showers should be positioned appropriately for infection prevention and control; pre-immersion and post-bathing showering should be facilitated, and privacy to remove costumes provided.
- The plant room should be close to the IWF and designed to ensure sufficient space for safe access and maintenance, safe handling and storage of chemicals. Access into the plant room should not be via the pad area.
- There should be cleaning and storage space for all ancillary equipment

- Design issues impacting on water quality
- Awareness of BS EN 15288 1 & 2, the design, management and operation of swimming pools
- Sport England design guide
- Changing rooms:
    - toilets and showers
    - baby changing facilities
    - floors in wet areas
- Safe access – including people with disabilities
- The plant room – location, size and access
- Chemical store

5. Hydraulics and water circulation

a. Bather load – calculating the factors for safety and water quality
b. Circulation rate – calculations
c. Turnover period – calculations and alignment with PWTAG standards
d. Hydraulic design – different design solutions
e. Surface water removal – focusing on removing pollution:
    - deck-level
    - channels
    - skimmers
f. Balance tanks – purpose, design and maintenance dirty and clean tanks
g. Outlet and inlet safety – the entrapment: PWTAG Code, BS EN 13451–1 and 3
h. Circulation pumps – the principles, variable speed drives
i. Valves – types, uses and safe operation
j. Flow meters and pressure gauges – calibration, maintenance
k. More than one IWF – separate treatment systems
l. Ensuring the complete pad is covered by the supply of filtered and chlorinated water.

6. Filtration

IWF's should have a medium rate filter with the use of a coagulant. This is important in relation to management of Cryptosporidium, an organism which can be found in the water after faecal contamination.

Optimal filtration always is important. A turnover period of 20 minutes or less is required to maintain good conditions. Circulation rate of 0.5 m^3/user/hour is recommended

a. Clarity of water – importance#
b. Filtration rates – pros and cons:
    - medium-rate
    - high-rate
c. The sand bed – grades and depths
d. Underdrains – how they work, how they are best constructed

e. Other types of filter:
    - bags and cartridges
    - pre-coat
    - carbon
    - glass
    - membrane
    - zeolite
f. Backwashing – the principles:
    - This should be done in accordance with the manufacturer's recommendations. It should be done when there is no one on the pad and at the end of the pool use day to allow time for the filters to settle. The frequency is usually determined by the variation of pressure gauge readings (pressure drop/loss of head) and in any event, should be at least weekly. Backwashing and cleaning the filters more frequently than recommended actually reduces filter efficiency.
    - how to backwash, fluidisation of the bed, air scour, the rinse cycle
    - strainer basket – part of the process
    - when to backwash – PWTAG Code and guidance
g. Filter design – materials, sizes and fittings Filter maintenance – the annual programme
h. Coagulation
    - what it is
    - how it works – agglomeration and flocculation
    - high-rate filters – and coagulants
i. Coagulants:
    - dosing – quantities and rates
    - injection – where to apply

7. Primary disinfection

There is no satisfactory substitute for chlorine-based disinfectants in IWF. There are various useful adjuncts to assist chlorination, mainly ultraviolet and ozone, but these cannot substitute for the main disinfectant.

Bromochlorodimethylhydantoin (BCDMH) has been well documented in 1983 as causing skin irritations and there is also some evidence (from spa pools) that it does not disinfect as well as hypochlorite and is not recommended.

a. Suitability and compatibility of disinfection types
b. What is disinfection – in a swimming pool setting
c. Oxidation – what it is, and does
d. CT rates – an appreciation
e. Choosing a primary disinfectant – chlorine, hypochlorite, chlorinated isocyanurates, bromine (soft water, hard water, costs and impurities)
f. the chemistry of chlorine disinfection – an understanding:

- how chlorine forms a residual – hypochlorous acid and hypochlorite ion
- the effects of pH on disinfection – the values to pursue and why
- breakpoint chlorination – understanding the crucial role of breakpoint
- chlorine plus ammonia – urea, chloramines
- nitrogen trichloride – its causes
- organic chloramines – how they are caused, their effects and removal

g. Free and combined chlorine - the relationship and target levels
h. pH value - its influence on disinfection and the options
i. Electrolytic generation of chlorine – the systems and applicability
j. Chlorinated isocyanurates – when and how to use:
    - cyanuric acid – awareness of influence of residuals; outdoor pools
    - residual values – PWTAG guidance
    - Other forms of residual disinfection and new treatments
k. the importance of dilution – why disinfection and filtration is not enough

8. Secondary disinfection

a. When secondary disinfection should be considered
b. The effects of secondary disinfection
c. Dealing with Cryptosporidium
d. Ozone – what it is, how it is applied, the pros and cons
e. UV – what it is, how it is applied, maintenance and monitoring, pros and cons

9. Dosing chemicals

a. Principles – key requirements when dosing chemicals
b. Components – the system design and infrastructure
c. Dosing practice – where, when and how
d. Hand dosing in emergencies
e. Diluting chemicals – how and when to dilute
f. Dissolving dry chemicals
g. Dose strength – calculations
h. Day tanks – use, construction and fittings
i. Dosing pumps – type, construction and capacity
j. Pipework – construction and application
k. Valves and fittings – that may be incorporated into the dosing system
l. Calibration – checking the dosing rate
m. Faults – fail safe systems
n. Automatic control – optimising dosing treatment:
    - closed loop – how the control works
    - sample mixing – representative sample
    - sampling – where to sample from

- calibration – independent analysis of the sensor to verify the desired effect
- sensors – amperometric, redox, pH value
- controllers – the levels of sophistication

o. Circulation feeders – what they are and how they work:
- Trichlorinators
- Brominators
- calcium hypochlorite

p. CO2 installation and dosing requirements
q. Super-chlorination

10. Pool water chemistry

a. Source water quality
b. Alkalinity – the effect on pH
c. Hardness – PWTAG guidelines, grout and scale
d. Dissolved solids – Corrosion, erosion and PWTAG guidelines
e. Water balance – what it is
f. Disinfection by-products – the health effects:
- nitrogen trichloride – effects, monitoring and mitigation
- THMs – role of humic acid, monitoring and removal

11. Testing and controlling pool water chemistry

a. Comparator and photometer – how to use them
b. How to sample and test for:
- free chlorine
- combined chlorine
- pH

c. Chlorine disinfection:
- testing frequency
- disinfectant residual tests – PWTAG Code and standards
- understanding effects of free chlorine on chloramines
- interpreting test results
- acting on chlorine residual results
- monitoring

d. pH value – measuring and checking:
- alkaline disinfectants – effects on pH
- acidic disinfectants – effects on pH

e. Alkalinity
f. Hardness
g. Dissolved solids – measuring and control
h. Langelier and water balance – measuring and control – in context
i. Documentation and record keeping and storing test results
j. Bromides:
- measuring and control

- interpreting and results

k. Documentation

l. **Tests should be from a feature outlet furthest from the supply line.**

12. Healthy users – the health risks

a. Infectious hazards, including transmission:
   - gastro-intestinal infections – Shigella, Escherichi coli, Cryptosporidium
   - foot infections – verruca and athletes foot
   - skin infections – molluscum contagiosum, Staphylococcus aureus and MRSA
   - eye infections – including Acanthamoeba

b. Non-infectious hazards:
   - respiratory irritation – including Legionella and asthma
   - skin irritation – bromine, Pseudomonas aeruginosa, folliculitis
   - ear infections, including otitis externa

13. Preventing Outbreaks

a. What goes wrong – definition of an outbreak
b. Problems that have led to outbreaks
c. Dealing with a faecal incident – The PWTAG Code, technical note and NHS UK Cryptosporidium Reference Unit: Guidance for Investigators and Health Professionals:
   - solid faeces
   - runny faeces
   - procedure for medium-rate filters
   - procedure for high-rate filters
   - prevention
   - blood and vomit

14. Microbiological testing

For IWF's microbiology testing, should be based on the risk assessment but be at least weekly for routine parameters and quarterly for Legionella testing (depending on risk assessment) due to the higher risk user groups. Testing should be done before the pool is used for the first time and if it has been shut down for any reason.

The basis for microbiological testing is to validate and verify that the pool water treatment is able to cope with the maximum bather load and any contamination arising from pool use. Testing should be done after the IWF has been used. There is no point in carrying out microbiological testing first thing in the morning or if the pool has not been used as the disinfection system will not have been challenged. The advantage of testing nearer the beginning of the week rather than the end is that there will be time to act on an interim report if there is a positive high level of aerobic colony count. **Tests should be from a feature outlet furthest from the supply line.**

a. Sampling – must include chemical tests for temperature, disinfectant reserve and pH
b. Aerobic colony counts (TVC)
c. Coliform and E coli – potential faecal or environmental pollution
d. Pseudomonas aeruginosa – the reasons for testing
e. Legionella – testing from a feature spray nozzle
f. Test requirements – monthly analysis
g. Interpreting results – assessing microbiological quality
h. Remedial action
i. Gross contamination and closure of the pool
j. Quality assurance

15. IWF chemical safety

a. Material safety data sheets – provision and use
b. Risk and COSHH assessment – the process and elimination
c. Delivery:
    - access
    - unloading
d. Bulk deliveries and storage
e. Transporting chemicals
f. The chemical store
    - Siting
    - fire risk
    - spillage
    - ventilation
g. Storage of disinfectants and other chemicals including:
    - sodium hypochlorite
    - calcium hypochlorite
    - BCDMH
    - chlorinated isocyanurates
    - sodium bisulphate
    - CO2
    - hydrochloric acid
    - sulphuric acid

16. Plant maintenance

a. Servicing and frequency
b. Calibration
c. Daily monitoring and maintenance, fault finding

17. Cleaning

a. Floor surfaces – dirt, slips trips and falls and bacteria
b. Around the IWF and surrounds – PWTAG technical note

c. Scale removal
d. IWF pad – cleansing control, mould and Pseudomonas aeruginosa
e. Transfer channels and balance tanks
f. The pad and features regular maintenance and inspections.
g. Features and pad – the need to cleanse under structures
h. Stainless steel – preventing corrosion and scale formation
i. Swimming aids – prevention of Pseudomonas aeruginosa
j. Safeguarding the fabric of the IWF, pad and ancillary buildings – preventing steel corrosion cracking, pool grout, filling and emptying IWF in relation to balance tanks.
k. Algae

18. **PPE and plant room emergency procedures**
    a. the regulations – assessment, provision and use
    b. Harmful effects – the potential risks to health from chemical exposure
    c. PPE – what to use and when, use of MSDS
    d. in an emergency – what to do for chemical contact/inhalation/ingestion
    e. Emergency showers and eye baths
    f. Toxic gasses, fires and explosions
    g. Spillages – PWTAG Code and technical guidance (sodium hypochlorite calcium hypochlorite etc.)
    h. PWTAG Code and emergency procedures – chemicals emergency part of the EAP

19. **Training of staff generic and site specific**
    a. Chemical Safety
    b. NOP and EAP-Hazards
    c. Alarms

Supplementary Notes

1. **Governance**

An Interactive Water Feature, particularly outdoor has more potential hazards and risks of infection than a conventional pool:

a. IWF can vary greatly in potential temperatures. Approximately 20°c - 34°c. The pad can act as perfect solar heat source.
b. The potential loading of these water features can be substantial and difficult to control.
c. The potential for ingress of pathogenic microorganisms which may include potential pathogens such as Legionella, Pseudomonas aeruginosa and Cryptosporidium which can be far greater than a conventional pool.
d. The risk of legionella pneumophilia to both users and spectators can be high.
e. The introduction of cosmetics, lotions can provide an ideal source of nutrients for pathogens
f. Examples mammal faecal and urine debris, blown in dirt, walked in soil etc. In parks grass cuttings blown into the circulation system

1.1 **Water safety plan**

In IWF it is advisable to apply a that a Water Safety Plan (WSP) should be developed to identify and manage the risks from all types and uses of water within the water feature environment. In the context of an IWF this would be the Pool Safety Operating Procedure (PSOP) which includes the Normal Operating Plan (NOP) together with the Emergency Action Plan (EAP). The first step in the development of a WSP is to appoint a Water Safety Group (WSG). This is a multidisciplinary group which, for a hydrotherapy pool, will typically include representatives from the feature pool engineers and the qualified pool plant supervisor or similar contractor and a manager responsible for cleaning services for the feature and the area surrounding it, together with changing and shower areas. The WSG take overall responsibility for ensuring that there is suitable training, competence, risk assessment and management of all water used for user's spectators and staff. The development of the PSOP will facilitate this (see below).

1.2 **Pool log**

The log should contain details of chemical disinfection, water quality monitoring, water temperature, water appearance, backwashing, microbiological testing, together with any unusual occurrence or problem.

1.3 **Staff training**

All those involved in the day-to- day operation and maintenance of the IWF should be appropriately trained, for example by attending a pool plant operators course which meets the requirements of this syllabus and the PWTAG code of practice. If there are any problems related to health or infection the local organisations' infection control team should be notified. The WSG meetings should regularly include a review of the PSOP including the IWF records, discuss any potential hazards, maintenance and remedial work required, and future developments.

1.4 **Outbreaks and illness**

Any health problems with users, spectators, staff should be reported at once to the WSG and immediately to the designated environmental Health Officer if there is a suspected outbreak of illness, for appropriate advice.

2. PSOP

For IWF PSOP should incorporate all aspects of the WSP including:

a. an asset register for all water outlets, equipment, components etc which use or are in contact with water. This is to ensure there is a risk assessment and management/maintenance plan in place for each asset
b. up-to-date schematic diagrams to facilitate the risk assessment process and so that those not familiar with the pool and associated treatment plant can understand the system and flow dynamics
c. a risk assessment of all water used in the IWF area from point of entry of source water to the point of use, which includes microbiological, chemical and physical hazard assessment
d. a scheme of control which has been developed from the risk assessment
e. a monitoring programme to verify the controls remain effective
f. supplementary systems including governance arrangements, training, competence checks, supervision requirements, communication channels, and plans for managing predictable untoward events.
g. These would include dosing pump failures, faecal fouling or vomiting, cardiac arrest, slips, trips and falls, adverse monitoring results and cases of infection associated with the pool. Written protocols should be developed and readily available for predictable events.

3. Design

The design of a IWF will be as challenging as for any other pool. But there are important additional considerations that need to be considered when designing an IWF.

The design of the IWF should consider the health and safety of all users, the physical and clinical needs of users, spectators and of the staff and be agreed by the WSG. It should accommodate the needs for complete visibility of the IWF, alarm systems and safe access for resuscitation teams to all areas. There should be sufficient space to facilitate patient showering, IWF access and movement around the features, and storage and cleaning of equipment like wheelchairs and any ancillary aids. The IWF should be pleasant, inviting in appearance, and safe against physical, microbiological and chemical hazards.

Attention should be given to the type of pad, normally slip resistant concrete or rubber crumb finish, in relation to cleansing to ensure safe hygienic conditions. The latter finish can be challenging due to the potential biofilm growth within and below the rubber crumb material.

4. Hygiene and safety

Good hygiene and safety awareness is essential for IWF pools due to the potentially warm environment, the open-air nature and loading by bathers and spectators of the pad.

- Safety needs to be ensured.
- All bathers have adequate and use toilet and then shower facilities, preferably with soap, prior to entering the IWF. The shower facilities need to accommodate these parties prior to entering the pad. There should also be disabled provision.

- No outdoor shoes should be worn on the IWF pad; they should be covered or removed to prevent the introduction of dirt and other contamination to the pad area.
- Surrounding walkways adjacent to the pad should be regularly cleaned and it is essential at the end of the day all areas related to the pad should be cleansed.
- All staff should have appropriate training including emergency evacuation procedures, which should be practised at least annually.
- All static features equipment should be cleansed at least weekly in chlorinated water. Special attention should be given to all water shower type fittings which spray water in line with legionella risks. These can easily become colonised with Pseudomonas aeruginosa or moulds and be source of infection if then used to provide sprays via the feature pumps. within the pool water. A major cleansing programme is required at the start of the season. At the end of the season all features should be completely drained and cleansed as far is reasonably practical. A comprehensive risk assessment is required to ensure that the potential for biofilm, Pseudomonas aeruginosa, and legionella pneumophilia are eliminated.
- Overflow channels, the features pad and grilles (including their undersides) should be cleansed at least weekly.
- All cleansing should include both disinfection and physical cleaning.
- End of day cleaning should be completed to ensure no potential food or food containers are cleared to prevent attracting animal scavenging on the pad and surrounding areas.

5. **Water treatment**

Maintaining water quality because of the special conditions presented by potentially heavy periods of use by users, the water demand the same careful attention as that of intensely used large public pools.