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68 – The handling, delivery, storage, and application of swimming pool chemicals

Chemical gassing incidents
There have been a number of toxic gas emission accidents in the past few months. In the light of this, we would urge you to review your current risk assessments and standard operating procedures in line with the PWTAG CoP given below.

Refer also to, PWTAG publication Swimming Pool Water, treatment and quality standards for pools and spas 2017 - Chapter 9 (Dosing) and Chapter 15 (Chemical Safety)

There are many potential causes of chemical gassing incidents in pools and for this reason we have tried to include all the likely risk factors. From the type of chemicals used to staff training, from delivery of chemicals to storage and application. They are all potential risk factors and none can be ignored or excluded.

Extract from PWTAG Code of Practice 2023
(Free to download from https://www.pwtag.org)

1) **Control of Substances Hazardous to Health Regulations (COSHH)**
   COSHH requires employers to control substances that are hazardous to health. These can take many forms and include chemicals, mists, vapours, fumes, gases and asphyxiating gases and microorganisms that cause diseases (**www.hse.gov.uk/biosafety/infection.htm**).
   Typical hazardous substances include:
   - sodium hypochlorite;
   - calcium hypochlorite;
   - chlorinated isocyanurates;
   - acids;
   - bromochlorodimethylhydantoin;
   - bromine;
   - microbiological organisms in pool water, for example, Legionella and Cryptosporidium (due to contamination from a failure to manage pool water quality and hot and cold water systems or a breakdown of existing control measures. Faecal fouling will also introduce risk of infection from harmful organisms).
   - Risk must be assessed for each chemical and microorganism.

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

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

These procedures must be systematically recorded to include:
- Identification of the hazards
- Identification of who might be harmed and how
- Evaluation of the risks arising from the hazards, and decisions about precautions
- Recording the findings
- Regular review of the assessments and any necessary revisions.

COSHH Regulations require suppliers of chemicals to provide a safety data sheet (SDS) for each chemical. SDSs must be provided free by suppliers before the product is delivered. Updates are also free, as are SDSs for anyone using chemicals at work.
These should be displayed in the vicinity of the chemicals. It is also the plant installer's responsibility to provide relevant information on plant safety etc. - which may include SDSs.
There will need to be SDSs for all the chemicals in the plant room including pool chemicals, cleaning chemicals, pool water testing chemicals and chemicals used in maintenance programmes.

2) Training in chemical handling

Pool operators must provide information, training and instruction for employees who work with substances hazardous to health (**www.hse.gov.uk/coshh/basics/training.htm**). This includes cleaning and maintenance staff, and lifeguards.

Pool operators should also ensure that contractors understand their responsibilities and follow procedures. Pool operators should monitor compliance with procedures and review them periodically and after any incidents. There is more information on managing contractors at **www.hse.gov.uk/managing/delivering/do/organising/managing-contractors.htm**.

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Training should include the knowledge and understanding of the chemicals necessary for staff to be alert to any changes affecting safety.

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

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

3) Danger of contamination

All chemicals generating chlorine on contact with water (calcium hypochlorite and isocyanurates and bromochlorodimethylhydantoin) need to be kept cool below 30°C, in closed containers and away from dampness and contamination by organic materials such as grease. Ammonia is particularly dangerous in contact with chlorinating agents. Some chemicals react with strong acidsand some with alkalis or even each other.

- Do not attempt to mix chemicals, even apparently similar types.
- Use chemicals only in the specific circulation feeder designed for them

4) Personal protective equipment (PPE)

Where it is reasonably practicable to do so, engineering controls, such as automatic dosing systems, must be used in preference to PPE. PPE must be used only as a last resort. But even where engineering controls and safe systems of work have been applied, some hazards might remain. If so, pool operators must identify the PPE required for specific tasks and the level of protection it provides.

Pool operators should take the advice of suppliers about what PPE is needed. Some or all of the following protective clothing should be provided on site for use by authorised, trained staff, during delivery, handling of materials, cleaning or maintenance.

- Impervious chemical resistant wellington boots to BS 1870 should be worn to prevent feet and ankles becoming contaminated with accidentally splashed chemicals. Trousers should be worn outside the boots (i.e. not tucked in), to stop spilt chemicals entering the top of the boots.
- Chemical resistant aprons or overalls to BS 1870 should be worn to protect the front of the body whenever chemicals are dispensed.

- Chemical resistant rubber or PVC, gauntlet style gloves to BS 1651 should be used for all handling procedures. Sleeves should extend over the gloves to prevent the entry of chemicals. After use, the outside of the gloves should be washed before removal and then both hands and the inside of the gloves washed with soap and water.
- Safety goggles or face shield to BS 2092 should be worn to protect the face when handling any chemical.
- Dust respirators are appropriate when handling granules and powders.

Respirators

Full-face respirators fitted with a combined acid gas and particulate filter should be on site. This will provide suitable eye and respiratory protection and should be used whenever minor leakages of chlorine gas may be encountered.

However, these respirators cannot be relied upon in a major chlorine leak. Canister respirators can deal only with low concentrations of toxic gases. Pool operators must have suitable emergency procedures for more serious leaks, where appropriate in consultation with the fire authorities.

- A respirator and fitted combined B2P3 filter should be sited immediately outside the chlorine plant room, with a further respirator near to hand at any point where a leak of chlorine gas may be anticipated. In both cases adequate, clean storage accommodation should be provided for the respirators.
- When a respirator is used it is essential that a good seal is achieved between the respirator and the user's face and suitable training in this technique should be provided for all authorised staff.
- The combined filters have a limited life and therefore each use should be recorded in the daily logbook. The manufacturer's instructions will provide guidance on the filter life
- Canisters need to be replaced in accordance with the expiry date marked on them. The period of exposure should be recorded and when the exposure limit is reached the canister should be replaced

5) Chemical spillage

In any emergency a quick but calm reaction is necessary.

- Personnel and the public should be protected.
- Only personnel that know the product and have been trained to handle spills should be allowed in the area.
- Appropriate protective equipment should be worn when dealing with a chemical spill

Whatever the cause, the approach to any spill is to:

- follow the emergency action plan
- protect the public

- protect staff
- contain the spill
- stop the leak
- clean up the spill
- protect the environment.

Large spillages
If the spillage is over 45 litres (10 gallons) the area should be immediately evacuated; sources of ignition removed; maximum ventilation provided.

- If the risk to people or environment is considerable, emergency services should be called.
- Only personnel with proper respiratory and eye/skin protection should be permitted in the area.
- Spillages should be dammed and absorbed with dry sand, soil or other inert material – not combustible absorbents such as sawdust.
- The absorbed material should then be collected in containers, sealed securely (with a vent) and delivered for disposal according to local regulations. Containers with collected absorbed material should be properly labelled with correct contents and hazard symbol.
- The spillage site should be washed well with water and detergent; being alert to the potential for surfaces to become slippery.
- The site of the spillage should continue to be ventilated.
- Spillages or uncontrolled discharges into watercourse, drains or sewers should be notified immediately to the Environment Agency or other appropriate regulatory body.

Small spillages
If the spillage is under 45 litres, it can be diluted with large quantities of water and then if local regulations allow, run to drain with copious amounts of water. Otherwise, it should be absorbed and disposed of as above.

Leaks in the piping or discharge hose
The primary valve at the base of the storage tank should be closed. In leaks in piping or hoses, closing a valve between the leak and the source of the material will minimise the loss.

Leak in the bulk storage tank, or its primary valve
The tank should be emptied as quickly as possible into other suitable containers – which might be an IBC. The supplier of the tank should be notified. Lowering the level of the product in the tank stops or reduces the leak. The material should then be drummed and returned to the supplier for recycling. Uncontaminated spillages may be able to be used in the pool.

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Cleaning up other material in the containment bund
Sodium hypochlorite is best diluted by about 10 times and then neutralised with sodium thiosulphate pentahydrate. Heat is generated in all neutralisation reactions.

Dry chemicals
These should be gently swept up using a clean, dedicated dust pan and brush (after the operator has put on the respirator and other protective clothing) and placed in a clean, dry, plastic container for subsequent disposal. The affected area should then be washed down with copious amounts of water.

6) Toxic gas leaks

There should be an emergency action plan (EAP) for dealing with any major release of toxic gas. The procedure should include arrangements for:

- Evacuation of areas if there is a fire or toxic gas emission. This should specify designated safe areas, and assembly points . The provision of emergency foil blankets for bathers evacuated straight from the pool. The procedure should also identify responsible staff whose duties during area evacuation include:
  - responsibility for a specific area
  - ensuring roll calls are undertaken to identify anyone missing
  - communication of missing people to central emergency services
- The possibility that Control of Major Accident Hazards (COMAH) regulations will apply where threshold quantities of dangerous substances identified in the regulations are kept or used. Further information is available at **www.hse.gov.uk/comah/index.htm**.
- Co-ordination with emergency services, including informing them immediately of hazardous substances present (unless they already have this information).

7) Chemical safety information on site Pool operators should provide employees with adequate information, instruction and training following the advice provided on the package labels and, where appropriate, in Safety Data Sheets;

8) First Aid

This should include equipment for dealing with the consequences of direct contact with chemicals - for example, by providing eyewash bottles and emergency drench showers.

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

- Where staff could be subject to severe exposure to a harmful chemical, emergency drench showers should be provided. The delivery of water should be at high volume but low pressure to reduce the risk of injury or further contamination. The volume should be sufficient to immediately drench the person (for showers, typically 75 l/min, for eye-wash 1.5 l/min) and there should be sufficient flow to last around 15 minutes. Simply using hoses connected to mains water is not suitable.
- Employees must have been trained in the proper use of such equipment and it should be maintained in accordance with the manufacturer's instructions and tested weekly.

9) Delivery of chemical

When materials are delivered, make sure there is enough space for maneuvering and parking close to the storage area. Take precautions (for example supervision, warning signs, or barriers) to protect the public or workers who may have access to the delivery area. Move materials into storage as soon as possible, and do not leave them unattended in a public area.

Offloading

Pool operators must have safe systems of work in place to ensure that bulk deliveries of chemicals are properly managed. This will include:

- a delivery procedure agreed with the supplier and haulage company;
- procedures to ensure that incompatible materials are effectively segregated;
- designated pipework with connections that are easily identifiable and unique in size and/or shape so as to prevent inadvertent misconnection;
- making sure employees wear any required Personal Protective Equipment (PPE);
- making sure emergency procedures are in place if there is a spillage.
- It is essential that all deliveries proceed only when a trained staff member is available to receive and check the materials.

There are important procedures to follow with offloading chemicals.

- All staff involved should have specific training in delivery of chemicals, dealing with spillages and manual handling.
- Unloading should not be on the public highway. Where this is unavoidable, local authority permission should be sought and suitable warnings provided.
- In general, cylinders and other containers of over 25kg will be delivered either on vehicles with a tail lift, or on platform vehicles with a slide or skid that allows containers to be lowered to the ground. A delivery dock at the same height as the delivery vehicle is an acceptable alternative, as is a forklift truck.
- The driver may need help offloading (and no delivery should go ahead if there is no-one to receive it).

- The responsibility for offloading and onloading is joint between customer and driver.
- The driver's responsibility ends when the container reaches ground or dock level.

- No container should ever be dropped to the ground.
- The safe working load (SWL) of any lifting apparatus used should not be exceeded; regular inspection, testing and certification should be observed.

Bulk delivery of sodium hypochlorite and hydrochloric acid

For bulk deliveries, a written delivery procedure should be agreed with the supplier, in accordance with hazard data sheets.

- Pipework should be clearly labelled and specific to the delivery of that product, to prevent delivery hoses being incorrectly connected. It is important that any other chemical delivered in bulk has a separate, different size or type of connection. Pipework fill points should be clearly labelled and locked when not in use.
- Bulk tanks can be connected to day tanks either by gravity or pumping, but there should be separate fill routes and/or pumps for each chemical.
- Incompatible materials (for example acid and alkali), if delivered in the same vehicle, should be effectively segregated.

The whole process should be the specific responsibility of a nominated member of staff. That supervisor should have had suitable training on the product and its operation, and:
have a clear knowledge of the offloading procedures and handling precautions

- supervise the offloading operation throughout
- make sure the correct product is being delivered and that the quantity supplied corresponds to that ordered and the identification marking on the tank
- make sure that there is room in the tank for the full quantity being delivered
- pay particular attention to the level in the bulk tank, before and during offloading
- check that the drain valves on the storage tank filling line are closed
- instruct the driver to connect the flexible hose to the correct intake pipe; check that the connection has been made correctly, and that there is no restriction to flow
- sign the discharge consent notice before instructing the driver to start pumping; and stop the driver from pumping if the procedure goes wrong in any way, or when the correct amount has been offloaded
- when the right amount has been offloaded, close the valve on the filling line; when drainage stops, instruct the driver to disconnect the flexible hose
- deal with any spillages and drainage.

Bulk and day tanks should be in separate bunds sized to take 110% of the volume of the tanks.

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Transport from offloading area to store

- Chemical containers should not be left unattended at the offloading site, especially where it is open to the public. In any case, materials should be stored away in a cool place as soon as possible – especially sodium hypochlorite, whose decomposition is accelerated by sunlight (causing pressure rise within the container). Sodium hypochlorite should always be stored in supplied containers with a built-in vent or vent cap.
- Containers should be kept upright, and never rolled.
- Containers over 18kg should be risk assessed for handling. Nothing over 25kg should be lifted by one person; or even two, ideally. Instead, custom- built wheeled carriers should be used, with warning labels.

10) Chemical storage essentials

- Each chemical should be stored separately from all other chemicals
- All containers, and filling, feed and delivery lines, should be clearly labelled – including corrosive warnings as appropriate.
- Disinfectant and ancillary chemicals should not be stored in the same room/area as any other chemicals or materials – in particular, kept away from petrol, oils, solvents, fertilisers, other strong acids or alkalis, ammonia and its compounds, and cleaning materials.
- Dilution should be by adding the chemical to water, not the other way round.
- The accidental addition of acid to hypochlorite is the commonest cause of chlorine release incidents in pool buildings. PAC added to hypochlorite has a similar effect.
- All containers should be kept securely closed, cool and dry (and out of direct sunlight).
- Chemicals supplied in paper or plastic sacks should be placed in plastic bins before opening, and securely closed after use.
- Containers should ideally be returnable; if not, they should be flushed out with plenty of water before disposal to general rubbish as empty uncleaned packaging which does not require a waste disposal licence.
- Products no longer required should be safely disposed of.
- Chemicals should be stored in containment structures or devices designed to control spillages. They can be permanent (e.g. bunds), portable (e.g. drip trays) or built into equipment (e.g. double skinned tanks).
- Safety data sheet (SDSs)s should be available at the point of storage.

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11) Chemical store

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

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

12) Dosing principles

- To ensure good quality water, automatic dosing is best for all pools, and essential for public pools
- Manually operated and monitored dosing systems should also be backed up by good management of operation, monitoring and record-keeping.
- Trying to compensate for inadequacies in treatment by shock dosing is bad practice
- Dosing pumps should be designed to fail safe and shut themselves off if the circulation system fails
- pH adjusting chemicals are best dosed downstream from the filters – where possible, after the heat exchanger.
- It is important that disinfectants and pH value adjusting chemicals are well mixed with the water at the point of dosing.
- Hand dosing (i.e. putting chemicals directly into the pool) is rarely justified in pools. (Dichloroisocyanurate – and rapid-dissolving calcium hypochlorite can be exceptions.)
- Dosing systems, like circulation, should continue 24 hours a day to maintain stable conditions for bathers.
- Alkaline chemicals can block injection fittings, when used with hard water; regular cleaning will be necessary.
- Where appropriate, day tanks should be used to reduce the chance of major accident through over-dosing. Day tanks reduce the amount of chemical that can be incorrectly dosed into the system should there be a failure. They should be bunded so spillages are contained.

Dosing components

- As different chemicals are usually incompatible, the dosing systems as well as the tanks should be kept separate and bunded separately. There should be separate pumps for transferring each chemical from its supply container to the day tank.
- All systems should be fail safe: no fault should create dangerous conditions.
- All chemical pipework, suction and delivery lines and tanks should be labelled to meet regulations and to identify the exact contents.

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- Pipes should be labelled with the direction of flow as well as coded for their contents.
- Suction lines, dosing pumps, delivery lines and injection points should be as close as possible to the flow and return pipework, to avoid extended systems.
- Dosing can best be achieved by using a chemical loop system (see *Swimming Pool Water*).
- Sodium hypochlorite is best dosed when the dosing pump is under flooded suction with some means of removing any oxygen gas that has collected through degradation of the hypochlorite before pumping.
- Pipe runs should be as short as possible.
- All materials should be corrosion-resistant – externally as well as internally – and able to withstand the pressure in the system.
- Pipe runs containing strongly aggressive chemicals should be double contained (sleeved) where leakage could damage people or plant.

Where to dose

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

Circulation feeders

Circulation feeders, which hold tablets of disinfectant, should be used only in accordance with the manufacturers' instructions. Although feeders are used for a variety of chemicals, it is vitally important that each feeder should be used only for what it is designed to feed – and never for a second chemical. Using the wrong chemical – calcium hypochlorite in a trichlorinator, for example – can destroy the feeder by a combination of chemical and heat attack. And if calcium hypochlorite and chlorinated isocyanurate get mixed as a result of putting both in the same feeder, nitrogen trichloride gas will be produced – with potentially explosive results, which can be fatal for the operator.

- Ensure the feeder is compatible with the chemical being dosed.
- Feeders should not be used for any chemical or size of tablet other than that specified.
- Trichlor tablets in use should be kept completely submerged and should be fully used up prior to extended periods of circulation shut down.
- If the pool circulation is shut down for some time, the tablets should be removed from the feeders. Rather than leaving them wet and exposed, when they will tend to produce chlorine fumes, they should be put in water.
- Feeders should not be sited near a heat source: trichloroisocyanuric acid, for example, will explode on over-heating.

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13) Chemical dosing operations

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

- Chemical dosing systems monitors and automatic controls should be interlinked with the circulation pumps and the circulation of water through the system, so that dosing stops if there is pump failure or significant loss of pumping rate. These systems should always fail to safety and require manual restart when circulation is restored.
- Further protection is provided against the effects of continued dosing when water circulation fails if chlorine disinfection is dosed pre filter and pH correcting chemicals dosed post filter.
- Written procedures should be established for day tank filling, mixing or diluting chemicals and cleaning injectors. There should also be built-in safeguards to cover those periods when the plant is not attended.
- If the plant is to be shut down for longer than 60 hours, valves in filling lines between the day and bulk tanks should not be closed, as decomposition products might otherwise build up. After such a shutdown, the whole of the dosing system should be flushed through gently with low-pressure water.
- Blockage of sodium or calcium hypochlorite injection points can be minimised by adding sodium hexametaphosphate to the dosing tank.

Injection fittings for alkalis – including hypochlorites – should be withdrawable for descaling.
Dosing systems that avoid injection points are best.

- All injection fittings should incorporate a non-return valve to prevent pool water from entering the chemical dosing system – particularly when the plant is shut down.

14) Preparing dosing chemicals

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