

# Chemical storage tank systems: good practice guide

## Operation, inspection and maintenance: Part 2

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Part 2 of this article continues the discussion on operation, inspection and maintenance of storage tank systems. The CIRIA guide aims to provide a general good practice guidance for the selection and design, manufacture, installation, operation and maintenance of chemical storage systems. It is intended for use by any sized company.

### Cleaning

Cleaning of chemical storage systems can be a hazardous activity, and is important for the long life of a system. Some good practice guidance on cleaning of systems is given below:

- Depending on the nature and scale of cleaning, specialist contractors may be required. This is particularly true for inside tanks which are classed as confined spaces, thus special training and apparatus are required.
- Specialist cleaning machinery is available for certain cleaning tasks such as machines for lowering into tanks and wall climbers.
- Take great care when cleaning, access may be difficult and require specialist equipment such as scaffolding or access vehicles. Cleaning may also be awkward especially around pipes and connections.
- Ensure cleaning fluids used are compatible with the chemicals stored or spilled.
- Always wash down the area affected by a spill as soon as it has been cleared. Remember that the water used is likely to have been contaminated.
- Cleaned surfaces may be slip hazards whilst drying, particularly on impermeable surfaces such as in bunds. Clearly mark these with warning signage for other site operatives.
- As part of the cleaning programme include vents, meshes, grills, sumps etc. These can collect debris and become blocked, or their performance affected so should be cleared on a regular basis.
- Sand blasting or high pressure water jetting should only be undertaken from a stable platform, and only when tanks are empty. This will help to avoid loss from holes that may be punctured in the tank by point jetting.
- Great care should be taken when using steam or hot water for cleaning. After cleaning, cooling steam can create a vacuum in systems if vents are left shut, are blocked or do not have a vacuum break. Always ensure that a vacuum break system is operated before commencing steam cleaning.

- Washing water should be disposed in to the site effluent treatment system or a holding tank for appropriate disposal. Only discharge to the public sewer if regulatory consent is gained from the sewerage undertaker, and then in accordance with the discharge consent limits. If the sewerage undertaker refuses to allow the discharge to the sewer because of the potential risks posed by the chemical, the operator must store it in accordance with the Environmental Protection (Duty of Care) Regulations 1991 for subsequent removal by a “registered waste carrier”, and comply with any criteria that may apply for that chemical.

Spilt chemical and contaminated rainwater may require appropriate off site disposal. This should be done in accordance with the Environmental Protection (Duty of Care) Regulations 1991 and undertaken by a registered waste carrier who will be able to ensure that correct procedures are followed.

### Inspections and integrity testing

An overview of good practice on most aspects of inspections and integrity testing can be found in EEMUA159 *Users’ guide to the maintenance and inspection of above ground vertical cylindrical steel storage tanks*.

#### Aspect: Considerations/Useful Guidance

##### Frequency and level of inspection

- Should always be undertaken by a suitably qualified, competent inspection engineer, and in accordance with manufacturer and best practice guidelines.
- Frequency of testing should be determined as a result of risk assessment and risk ranking of various factors, such as:
  - tank age;
  - tank history;
  - known corrosion;
  - current and previous chemical duties;
  - construction materials; and
  - fittings and connections.#
- High risk tanks should be inspected on a more frequent basis than those with a lower risk rating.
- Whatever the output of the risk assessment, the inspection frequency should take into account the recommendations in the following:
  - Engineering Equipment and Materials Users Association (EEMUA) 159 *Users’ guide to the maintenance and inspection of above-ground vertical cylindrical steel storage tanks*; or
  - HSE PM75 *Glass reinforced plastic vessels and tanks: Advice to users*.
- The level of inspection should be graded to reflect the detail of inspection required.

Several factors that should be carefully considered:

- Containment (i.e. the tank) is the most important part of the system.

- The tank base is the most critical area.#
- If a dip stick is or has been used, the area below the dipping point is a key area of concern for the baseplate.
- 100 per cent coverage by ultrasonic, electromagnetic or infra red testing is recommended for testing for pitting (note IR testing should only be used to identify potential weak spots in tank walls for further testing by ultrasonic or electromagnetic techniques).

#### General

- When undertaking internal inspections, the procedure should be empty-clean-inspect-test. Provision must be available for the transfer of system contents prior to this procedure.
- Plastic tanks can be subject to UV degradation. When conducting visual inspections be vigilant for warning signs such as cracking or 'crazing'.
- Water or solids build up in the base of tanks may be difficult to detect if the tank bottom is not level.
- Acid/air and oil/water interfaces can be key areas of corrosion due to moisture dilution of acids and biological (bacterial) degradation respectively. Careful attention should be paid to these areas, and it should be remembered that these areas may constitute a significant part of the tank wall due to fluctuations in volume.
- Pipework should be subject to a planned inspection regime, including visual inspection and non-destructive testing as appropriate.
- Insulation is a key area for potential corrosion, particularly at the base of tanks, around pipe connections and the roofs of tanks (see design section). Special attention should be paid to these areas.
- External brackets and fixings can also be key corrosion points, and thus require careful inspection.
- Vents, valves and gauges should be subject to regular testing. Special care should be taken when inspecting and testing vents and valves to ensure that they have not become blocked, corroded, or subject to solids build up, and that they are fully functional. This should include internal inspection.
- Electrical systems and electronic monitoring and control systems should be tested in accordance with manufacturers' recommendations; and always by a suitably qualified and experienced engineer.#
- The integrity of electrical continuity and earthing systems (and cathodic protection where used) should be tested in accordance with appropriate standards, and always by a suitably qualified and experienced engineer. Where cathodic protection is used, the effects on buried structures in the near vicinity should be checked.
- Magnetic Particle Inspection is not suitable on aluminium components. Testing should be carried out using by visual inspection, X-ray, ultrasonic or dye penetration tests.
- The impermeability of bunds should be tested by (at least partial) water filling wherever practicable, without causing damage to the installed equipment, as well as visual inspection. Pumps within them should be included in the inspection and testing regime.
- Bunds should always be inspected following a spill and tested if the spill is significant.
- The decision about whether a tank or system component is suitable for continued use or should be repaired, replaced or scrapped, should always be made by a competent person.
- Access to a tank or vessel for inspections and maintenance requires risk assessment as the tank or vessel is a confined space, which could have residual traces of the chemical stored or its fumes.

- It is almost impossible to make safe access from a roof accessway. Additionally, removal of incapacitated personnel from the interior via a roof hatch can only be achieved with extreme difficulty.

Large tanks should be fitted with low level access ways.

## Control and monitoring systems

### Aspect: Considerations/Useful Guidance

#### General

- Where electric, electronic or programmable electronic systems (E/E/PES) are used in safety related applications, their operation maintenance and modification must comply with the requirements of BS IEC 61508: 2000 *Functional safety of electric/electronic/programmable electronic safety-related systems*.

#### Stock monitoring systems

- A good method of predicting potential leaks by identifying consecutive losses when comparing stock delivered and stock used.
- Generally used on smaller installations, as the variance in volume due to changes in pressure and temperature are less than those in larger systems although can be applied to larger systems with careful consideration of limitations and assumptions.
- Stock trend analysis is development of more simplistic stock monitoring that allows detailed computer analysis of stock monitoring data, with allowances made for expansion and contraction and other variables.
- Use of some form of stock monitoring is always recommended as good practice.

#### Gauging systems

- Should be maintained in line with the manufacturers guidelines by a suitably qualified engineer.
- Special care should be taken with computer-controlled systems, as software problems can give spurious readings.
- Computer systems should always be backed up by a manual system, which should be checked in conjunction with computer outputs to check for anomalies.
- Be wary of complacency when operating control and monitoring systems, particularly automated and computerised systems.

## Refurbishment, retrofitting and relining

### Aspect: Considerations/Useful Guidance

#### General

- Can be a cost effective alternative to direct replacement particularly when direct replacement of components may be impractical, or there may be high health & safety risks associated with the works.
- Risk assessment should always be undertaken when considering the options. Unacceptable risks may be associated with access, particularly where cranes or other large lifting devices are required.
- Refurbishment, retrofitting and relining should only be carried out by reputable organisations that can provide recorded evidence of code compliance, life expectancy, limitations to use and inspection parameters.
- It is also important to consider whether the system component in question is suitable for refurbishment or re-lining.

## Refurbishment and retrofitting

- Undertake a risk assessment for the work to be carried.
- Use/set up appropriate PTW system to ensure all checks are in place before any work commences.
- Ensure that the system component has been drained/emptied of any liquid/gas prior to commencing work.
- If work involves entry to a confined space (this includes a tank), ensure that the method statement is in accordance with current health & safety guidelines/legislation.
- Only use hotworks equipment (equipment that could create heat/spark/naked flame) if it is safe to do so (i.e. in a non-explosive/non-flammable environment).
- Ensure adequate containment and emergency equipment is in place to deal with accidental spills and leaks (including emergency equipment for maintenance personnel).
- Always check that the materials being used for refurbishment or retrofitting are compatible with the chemicals that will be stored in the system.
- Always check that, where unlike materials are to be used in the refurbished system, an allowance for differential expansion and preferential corrosion has been made.
- If refurbishing tank bases and foundations, it is always safer to relocate the tank onto a new base or (where practical) away from the existing base temporarily, than it is jacking up the tank and working under it.

## Relining

- Can be achieved by use of two main material types, steel (either Carbon or stainless, dependent on original tank construction) or synthetic resin.
- Relining should always be carried out by a specialist, suitably qualified contractor.
- Always ensure the tank is cleaned and gas free before entry and before any physical work is undertaken.
- Always create safe access into the tank for the relining works, ideally by means of access near the base of the tank. This access should always be of a diameter such that an incapacitated operative wearing breathing apparatus can be taken through, without undue difficulty.
- If new access is required, it should be formed by cold cutting the tank wall following cleaning and de-gassing. A neck and flange should then be welded onto the wall of the tank in order that a hatch can be fitted following the works.
- Always allow adequate curing time for resin materials.
- Ensure the work areas are clean and free of debris following completion of the work.
- Always integrity test system components before re-commissioning.
- Only straight pipeline runs should be re-lined. Care must be taken with regard to the compatibility of materials, differential expansion and integrity of construction.

### ABOUT THE ORGANISATION

CIRIA is a membership based organisation that works with the construction and related industries, government and academia to provide performance improvement products and services in the construction and related industries. Founded in 1960, CIRIA currently engages with around 500 subscribing organisations. Activities include collaborative projects, training, events and publishing. Visit: [www.ciria.org](http://www.ciria.org) to find out more.

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