

## 9.0 Equipment Cleaning and Repair

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### 9.0 Equipment Cleaning and Repair

#### 9.1 General

Because phosgene is a highly toxic material, extraordinary caution is required when working on or entering equipment used in phosgene service. Cleaning and maintenance are potentially hazardous activities that should be performed only by workers who are thoroughly familiar with the dangers involved and the precautions necessary for safe performance of the work. For this reason, the importance of proper training, an understanding of hazard recognition, and a soundly planned approach to each job cannot be overemphasized.

The following sections provide an overview of procedures and techniques used to prepare phosgene equipment for maintenance and return the equipment to service, and offer information on issues that might arise during the repair work itself.

#### 9.2 Preparation for Inspection or Repair

When a phosgene system is to be cleaned or repaired, empty the system of process liquids and gases containing phosgene. Following equipment shutdown, companies have transferred remaining liquids and gases to other process equipment in the plant either by pumping or by pressuring off with a dry, inert gas, such as nitrogen, supplied at a pressure higher than that on the equipment to be cleared. Once this has been accomplished, companies have found it useful to valve in the system and vent the remaining pressure to a destruction or decomposition device, such as a caustic scrubber. During depressurization, the frosting of piping, etc. which has been in liquid phosgene service indicates it still contains liquid. External application of heat can expedite the clearing process and may be a necessity when cold weather retards or even prevents evaporation of phosgene

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at atmospheric pressure. However, heating a closed system containing liquid phosgene may produce excessive pressure so close monitoring helps protect against potential risks.

After the equipment has been depressurized and is liquid-free, companies have pulled the equipment under vacuum and installed steel slip blinds at the isolation points to prevent phosgene from leaking back through the blocked valves from other parts of the system (note: if plans call for the use of purging for clearing purposes, the vent line would be left unblinded). Consider locating the blinds as close as possible to the isolating block valves because a leaking valve may fill the space between the blind and the valve with liquid phosgene, which will then be released when the blind is removed. An alternative is to install processes with double block and bleed arrangements so the space between one valve and the valve with the slip blind can be checked for phosgene and evacuated if necessary prior to removal of the blinds. It may be advantageous to connect the vacuum to a high point on the system, but not at a drain valve if at all possible, because low points are prone to pluggage. When removing full face blinds or plugs located on bleed valves where the vacuum connection would be made, exercise appropriate caution because liquid phosgene can be trapped behind them. Before installing blinds, it may be important to verify that the system is under vacuum by reading an appropriately ranged pressure gauge or by cracking open a bleed valve.

After blinds are installed, companies have used a dry, inert gas to purge the remaining phosgene vapors to the vent system. For larger systems which are solid-free, the use of heated inert gas can sometimes be more effective at purging. Once the system is clear, the vent line itself can be blinded to help complete the isolation. For difficult-to-clear equipment, additional options for consideration include flushing with water, weak aqueous ammonia, caustic or anhydrous ammonia (only done after the blinds have been installed and the system vented). Water flushing, following the use of ammonia or caustic, serves an important function to help eliminate those contaminants. Dispose of the resulting vent or waste stream in an environmentally responsible manner consistent with relevant requirements.

Safety should always be the primary consideration when clearing phosgene process equipment. The use of air-supplied respiratory protection (see Section 4.5 for additional information) is necessary for any activity where exposure to phosgene is a concern. Clear

appropriate areas of unprotected personnel whenever performing work requiring breathing air.

Prior to beginning maintenance work, plant operations personnel can help verify that the equipment has been cleared of phosgene by cracking open a bleed valve and checking for the presence of phosgene using a detection badge or other hand-held detection device. The system may need a slight positive pressure in order to check for the presence of phosgene. It is important that the system is depressurized completely before maintenance loosens the first bolt.

As part of the evaluation, keep in mind that process solids that come into contact with, or are suspected of coming into contact with, phosgene may contain trapped phosgene. When solids are agitated, crushed, or blasted, there is potential for phosgene to be released.

The preceding information on clearing relates to equipment being removed from service for relatively major repairs expected to take a considerable amount of time. Aspects of the information may be useful to address minor repairs, such as gasket replacements, instrument replacements, leaking plugs and valve packing, as well as some valve replacements. Even after the equipment has been cleared of liquid, depressurized, and pulled under vacuum, use appropriate precautions during the performance of repair work. (See *e.g.*, *Section 4.5 on Personal Protective Equipment (PPE) for additional information*).

If phosgene equipment requires welding or burning, evaluate use of special preparation procedures because phosgene impregnated into the surface of the metal can be liberated by the high localized temperatures produced. This process can involve washing out the equipment with hot water and/or steaming it out to remove the residual vapors.

In preparation for vessel entry, companies have cleared the inert gas used for purging by flushing with atmospheric air. For example, an air horn or similar air-moving device has been used. Flexible ducts connected to a vacuum source discharging to a destruct system may be useful if the exiting air is contaminated.

### **9.3 Equipment Repairs**

The repair of equipment that has been in phosgene service merits special precautions to avoid accidental exposure. Due to the

increased possibility of accidental releases, it is beneficial to avoid attempting repairs while the equipment is still in operation unless authorized to do so using appropriate safe work procedures. Even after clearing, it is possible for phosgene vapors or liquid to remain trapped in gaskets and valve packing, behind pluggage in piping, inside damaged level displacers or agitator gearboxes, etc. This phosgene can be released during disassembly for repairs or, for example, simply by operating a valve. For this reason, performing repairs using appropriate PPE even on “cleared” equipment reduces potential risks.

At times, equipment that is still contaminated must be transported from the unit to another location for decontamination. In such cases, consider the feasibility of blinding off or plugging all process-exposed sections. If this is not possible, another option is to transport the equipment by a person wearing appropriate PPE and clearing all other personnel from the route.

If equipment must be taken to the facility’s shop or sent out of the plant for repair, consider decontaminating the equipment as soon as possible using special procedures to eliminate the possibility of an unexpected release. The procedures may require disassembly and cleaning using steam, hot water or other cleaning agents as appropriate. Vendors who handle such equipment must be thoroughly knowledgeable of the hazards of handling phosgene and with the decontamination procedures used.

Sometimes welding on phosgene equipment has to be done in the field without benefit of complete decontamination. If so, review whether the welder has air-supplied respiratory protection and whether the area has been cleared of unprotected personnel.

After welding on piping or equipment in phosgene service, risks can be reduced by evaluating whether the work was done properly and will not result in premature or unexpected failures. To this end, all welds can be tested prior to placing the piping or equipment in service. *(See Section 6 for further information on testing).*

A number of companies require that all parts and materials to be used in phosgene service are designed and specifically approved for such use. *(See Section 6 for further information on parts and materials).* A detailed procedure for cleaning and packaging repaired valves for phosgene service serves an important function because failure of these valves to properly seal when required could have significant consequences.

Threaded fittings used in phosgene service (e.g., plugs, pressure gauge nipples) create increased potential for leaks and are necessarily thinner because of the requirement to taper the joints for threading. As a result, threaded fittings tend to be generally avoided if at all possible, but when they must be used, some risks can be reduced by coating the threaded fitting with approved pipe sealant before being installed in order to help avoid leakage. As one example, a number of companies employ fluoropolymer-based thread sealants in their phosgene service.

If a vessel used in phosgene service must be inspected or repaired internally, OSHA guidelines for vessel entry are available. If the vessel has been cleared by dry-gas purging only and has not been washed out, evaluate appropriate PPE to protect against the possible presence of ferric chloride and hydrochloric acid coating the interior surfaces.

#### **9.4 Preparation for Service**

A phosgene system that has been open to the atmosphere needs to be extensively dried before being returned to service. Severe internal corrosion to steel piping and other equipment can result if significant moisture is allowed to remain inside the system. Drying the system to an appropriate dew point temperature before the system's return to practice helps prevent this possibility. Drying has been done using a purge of dry inert gas, such as nitrogen. Heating the purge gas will facilitate the procedure. If a steam exchanger is used, consider whether the gas pressure is higher than the steam pressure on the exchanger. This action will help prevent moisture from contaminating the purge gas if the exchanger leaks. To aid evaporation, consider keeping the phosgene system maintained as close to atmospheric pressure as possible (or slight vacuum) during the drying process. External heating of the equipment being dried can help aid in the drying process. Nitrogen bleeds have been established at dead legs, including instruments such as pressure transmitters and differential pressure flow transmitters. Dew points can be taken at a number of different locations to help ensure the entire system has reached the desired dew point.

Equipment that has undergone minor repairs using the vacuum method described in the previous sections may contain a small amount of atmospheric moisture. It may not be practical or possible to purge this moisture from the system or, if it can be purged, to obtain a dew point due to contamination with phosgene. Such

equipment can sometimes be returned to service without problems. However, companies may wish to keep the frequency of this type of repair to a minimum and to do whatever drying is possible under the circumstances because some corrosion and sludging are likely.

Small sections of piping which need to be dried before installation have for example been flushed with acetone and then nitrogen purged. Another method has been to steam purge internally until the piping is very hot then purge immediately with nitrogen.

Note the importance of removing grease, oil and other foreign material from lines and equipment before returning to service. Piping components contaminated with oil, grease, or other hydrocarbons are potentially reactive with phosgene. Products of reaction could lead to unexpected pressure buildup in a closed system.

When drying is complete, consider whether all atmospheric bleeds have been plugged, capped or blinded to prevent phosgene leakage or a release due to accidental valve operation. To reduce risks, the system can be checked for leaks (after removing any blinds) by first pressurizing it with a dry, inert gas to operating pressure, blocking it in, and watching for a pressure drop. This process will help indicate any large leaks, but small leaks might only be found through other methods. Options that have been used include those such as checking each flange, etc. with a soap and water solution and watching for bubbles or by charging the system with a sensitive gas such as helium or helium/nitrogen combination and then leak checking flanges, etc., with an appropriate electronic leak detection device. After all leaks have been repaired and the equipment passes pressure tests, it can typically be depressurized and returned to service.

It is possible for leaks to occur after equipment has been returned to service, especially if the equipment is in liquid phosgene service. Frequent equipment checks (using phosgene badges or handheld phosgene monitors for example) for several hours after startup help identify such leaks. The use of special washers such as a disk spring to prevent loosening of bolting due to thermal cycles on the equipment can be helpful in preventing leakage. A desirable attribute of an appropriate disc spring is that it should apply clamping pressure along a continuous arc pattern, rather than concentrating it at one point.