Phosgene Safety Practices
for design, production and processing

Part 2
Key elements of safety practices - long version

Section 4: Maintenance and inspection

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4 Maintenance and inspection

4.1 Maintenance

It is advisable to have a documented maintenance process describing how to maintain, repair and inspect equipment which has been in phosgene service. All activities can be done by either company or contractor personnel.

Having a contractor qualification process to select the appropriate contractor meeting the company requirements is important, as is utilizing only qualified contact personnel who have been thoroughly trained, know plant safety guidelines and who actively participate in plant emergency drills.

It is important that prior to working on phosgene-containing equipment the equipment be flushed with solvent, purged with nitrogen and evacuated. (See also Part 2 - section 3.2.3) Using an elephant-trunk/spot-ventilation system to remove residual fumes when opening flanges, is recommended. This can also be accomplished by applying vacuum from both sides of the flange.

It is important to consider the proper PPE for the maintenance activity, i.e. considering equipment and line opening under breathing air.

For safety reasons it is important that equipment leaving the phosgene plant for repair or disposal be free of phosgene and residual solids as phosgene can be trapped in solids. Equipment may have to be partially disassembled and gaskets removed to verify the absence of phosgene. Documentation by the plant personal is advisable.

It is recommended to have a decontamination room inside the plant, equipped with elephant-trunk/spot-ventilation system where valves, pumps etc. can be safely disassembled.

4.2 Inspection

4.2.1 General

In-service inspections are advisable for all technical equipment in phosgene units.

Technical equipment inspections are regulated by the codes, standards, rules, regulations of each country and company specific requirements and apply to items such as:

- Pressure vessels and heat exchangers
- Piping (for which recurring inspections are required)
- Pressure relief devices

In-service inspections can be performed using the **time based** methodology or the **risk based** methodology (RBI). Both methodologies are commonly used. Inspection intervals are generally defined by the local regulations, but inspection intervals and the extent of inspection for the RBI methodology may vary for any one given item depending on the associated likelihood of failure/criticality.

Tests (leak tests, pressure tests, performance tests) and inspections of the technical equipment are best performed in accordance with the local rules and regulations and/or company standards. The P&IDs can be used as the basis of scheduled inspections with testing and inspection results documented.

4.2.2 Time based inspection (classical method)

There are four inspection types:

- Internal inspection for pressure vessels
- External Inspection
- Shop test of relief devices and inspection of rupture disks
- Testing of piping

The testing of piping may be:

- a pressure test or adequate non-destructive inspection methods such as radiographic examination
- ultrasonic wall thickness measurements,
- a leak test
- an external inspection

It is recommended that a wall thickness program be in place with special attention given to exterior corrosion under insulation.

The inspection interval is according to local or company regulation but normally less than once every 5 years between internal inspection dates.

These intervals are an established requirement for the time based inspection methodology and apply to phosgene service equipment unless the local rules and regulations require shorter inspection intervals.

4.2.3 Risk Based Inspection (RBI)

Knowledge/Risk Based Inspection methodology uses a risk basis approach for prioritizing and managing the efforts of an inspection program. RBI permits the shift of inspection intervals and maintenance resources, to provide a higher level of coverage on the high risk items with an appropriate level of coverage on lower risk items.

A potential benefit of the RBI program is the increase in unit operating times while improving, or at least maintaining, the same level of risk. RBI provides a methodology for determining the optimum combination of inspection methods and frequencies. Each available inspection method can be analysed for its relative effectiveness in reducing the estimated amount of failure frequencies.

4.3 Equipment preparation for repair, maintenance or disposal outside the unit

4.3.1 General

Equipment referenced in this section is defined as any apparatus that has been in contact with phosgene such as centrifugal pumps, vacuum pumps, reactors, heat exchangers, piping/piping components, as well as PCT equipment, such as control valves, pressure gauges, mass flow meters and PAT analyzers, among other things.

This section also applies to all equipment that will be discarded or scrapped. It is important that any apparatus leaving the unit be decontaminated and certified as phosgene free.

See also Part 3 section 3.2.3. “Standard procedures for de-phosgenation, clearing and cleaning of phosgene-containing equipment”.

4.3.2 Work description

- It is best if complete decontamination can occur within the plant unit boundaries or inside a special decontamination facility. Decontamination of equipment in situ is preferred.
- Consider the use of phosgene indicator paper or portable detection devices. Decontamination will usually consist of using ammonia/water (or similar) to wash the individual components and be specified in a written procedure.
- Depending on the plant unit requirements and availability, a dedicated room (decontamination chamber) equipped with an air exhaust system and a stationary breathing air supply system is recommended.
- It is best that equipment be disassembled to the point where it can be verified that no phosgene remains. This may require the opening of components that appear to be intact, but where there are no means to verify that the component is phosgene free. Parts that may be included in this category are canned motor pump stators and bellows portions of manual or control valves, gaskets, among other things. It is important that plant personnel critically evaluate all parts to be sent out to ensure that even intact components do not contain phosgene.
  Note: If in doubt, equipment or equipment components may have to be disassembled to gain access to areas that may be contaminated with phosgene.
- It is good practice that equipment being sent to an offsite repair facility have the following information attached to the outside of the container:
  - Information concerning phosgene emergency procedures.
  - Phosgene MSDS or equivalent.
  - Methods to identify improperly decontaminated material.
  - Other information considered relevant.
- Decontamination Steps to Consider:

  The following are specific decontamination steps to consider based on previous plant experiences or “best practices”.
  - It is best to remove soft parts (gaskets, packing, seat ring gaskets, bushings, valve linings, plug liner (plug valve), etc); from equipment to ensure no pockets of phosgene exist.

- Pay special attention to bellows and multiple bellows to ensure that they are phosgene free.

(Abbreviations and acronyms)

KBI	Knowledge Based Inspection (also known as RBI)
MSDS	Material Safety Data Sheet
PAT	Process Analyzer Technology
PCT	Process Control Technology
P&IDs	Piping and Instrumentation Diagrams
PPE	Personal Protective Equipment
RBI	Risk Based Inspection (also known as KBI)