

PROCESS HAZARD ANALYSIS CHECKLIST			
Date			
Team Members			
SITE	Yes	No	NA
Do storage, use, and transfer areas have easy access for emergency response?			
Are storage, use, and transfer areas free of combustible or incompatible materials and isolated from hydrocarbons (in accordance with NFPA Standard 49, Hazardous Chemicals Data)?			
Are storage, use, and transfer areas isolated from a source of corrosion, fire, and explosion and protected from vehicle impact?			
GENERAL CONDITIONS, OPERATION AND MAINTENANCE	Yes	No	NA
Are work areas clean?			
Are adequate warning signs posted?			
Is lighting sufficient for all operations?			
Are the right tools provided and used?			
Is PPE provided and adequate?			
Are cylinders protected from vehicle traffic?			
Are cylinders and feed line areas kept free of any objects that can fall on them (e.g., ladders, shelves)?			
Are leak detectors with local and remote audible and visible alarms present, operable, and tested (or is alternate means used to measure concentrations)?			
Are emergency repair kits available for each type of cylinder present (not required if you rely on off-site emergency response)?			
Are appropriate emergency supplies and equipment present, including PPE and SCBAs (not required if off-site response)?			
Are written operating procedures available to the operators?			
Are preventative maintenance, inspections, and testing performed as recommended by the manufacturer and industry groups and are activities documented?			
HUMAN FACTORS	Yes	No	NA
Have operators been trained on the written operating procedures and the use of PPE in normal operations on the job.			
Has the City certified that they have the required knowledge, skills, and ability to do their duties safely?			
Do the operators follow the written operating procedures?			
Do the operators understand the applicable operating limits on temperature, pressure, flow and level?			
Are controls accessible and easily understood?			
Are labels adequate on instruments and controls?			
Are all major components, valves, and piping clearly and unambiguously labeled?			
Are all components mentioned in the procedures adequately labeled?			
Have operators been trained on the correct response to alarms and conditions that exceed the operating limits of the system?			

	Yes	No	NA
Are operators provided enough information to diagnose alarms?			
Are contractors used at the facility?			
Are safe work practices such as lockout/tagout, hot work and line opening procedures followed?			
Are personnel trained in the emergency response plan and the use of emergency kits, PPE, and SCBA's?			
HAZARD RECOGNITION	Yes	No	NA
Are MSDS readily available to those operating and maintaining the chlorination system?			
Do employees understand the toxicity, mobility, and ability of chlorine to sustain combustion?			
Do employees understand the consequences of confining liquid chlorine without a thermal expansion device?			
Do employees understand the effect of moisture on the corrosive potential of chlorine?			
Do employees understand the effects of fire and elevated temperature on the pressure of confined chlorine and the potential for release?			
CONTAINER SHIPMENT UNLOADING	Yes	No	NA
Is truck inspected for wheel chocks, proper position, and condition of crane?			
Are adequate warning signs posted?			
Are cylinders inspected for leakage, general condition, currency of hydrostatic test, and valve protective housing before accepting shipment?			
Are containers placed in the 6 o'clock/12 o'clock position for storage to reduce chance of liquid leak through valve?			
STATIONARY CYLINDERS	Yes	No	NA
If cylinders are stored outside, are they stored out of direct sunlight to prevent over pressure?			
Are cylinders secured by means of chocks or chains while in storage?			
Are cylinders stored away from standing water?			
Are cylinders stored so that objects cannot fall on them or strike them?			
Are cylinders stored so that a leak will not enter a lower elevation of a building or process area?			
Are cylinders stored with the valve cover or cap secured in place?			
Is easy access provided to cylinders in storage?			
CHLORINE BUILDINGS OR ROOMS	Yes	No	NA
Does the building conform with local building and fire codes?			
Is the building constructed of noncombustible materials?			
If flammable materials are stored or used in the same building, are they separated from the chlorine areas by a fire wall?			
Are two or more exits provided from each chlorine storage and process area and building?			
Is the ventilation system appropriately designed for indoor operations (and scrubbing, if required) by local codes in effect at the time of construction of major modification?			
Are the exhaust duct near floor level and the intake elevated?			
Can the exhaust fan be remotely started and stopped?			

PIPING AND APPURTENANCES	Yes	No	NA
Do piping specifications meet Chlorine Institute Pamphlet 6 requirements for the service?			
Do you require suppliers to provide documentation that all piping and appurtenances are certified "for chlorine service" by the manufacturer?			
Are piping systems properly supported, adequately sloped to allow drainage, and with a minimum of low spots?			
Is all piping protected from all risks of excessive fire or heat?			
Is an appropriate liquid expansion device or vapor pressure relief provided on every line segment or device that can be isolated?			
VOLUNTARY PRACTICES AND DESIGN STAGE REVIEW ITEMS ("NO" ANSWERS DO NOT NEED CORRECTIVE ACTION)	Yes	No	NA
Have you avoided locating storage, use, and transfer areas uphill from adjacent operations?			
Are storage, use, and transfer areas located away from sewer openings and other underground structures?			
Are storage, use, and transfer areas downwind or separated from most operations and support areas and ventilation intakes based on prevailing wind direction?			
Are storage, use, and transfer areas located away from residences and facility boundaries?			
Is ambient working area temperature normally comfortable?			
Are windssocks provided in a visible location?			
Are equipment and containers inspected daily?			
Is the system designed to operate at lowest practical temperatures and pressures?			
If chlorine demand is low enough, is the system designed to feed gaseous chlorine from the storage container, rather than liquid?			
Have the length of liquid chlorine lines been minimized (reduces quantity of chlorine in lines available for release)?			
Are low-pressure alarms and automatic shut-off valve provided on chlorine feed lines?			
Are vent-controlled spill collection sumps provided and floors sloped toward sumps for stationary cylinders?			
Are curbs, sumps and diking that minimize the surface of potential spills provided for stationary cylinders?			

COMMENTS FROM VARIOUS SECTIONS

Example

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WHAT IF...	CAUSES	POSSIBLE RELEASE SCENARIO	SAFEGUARDS
A chlorine cylinder is dropped during transport to the Chlorine Building?	Hoist cable breakage.	Minimal if any, the cylinder should not rupture if dropped.	Hoist inspected annually, cable replaced annually.
A chlorine cylinder is dropped from the hoist during cylinder changes?	Hoist cable breakage.	Minimal if any, the cylinder should not rupture if dropped.	Hoist inspected annually, cable replaced annually.
A chlorine main cylinder valve develops a leak while the cylinder is in operation?	Gasket leak, packing nut leak, bad threads on valve or connecting nut.	Possible 0.44 lbs/minute for 60 minutes – 17.1 lbs total release.	Use of a gas detector and alarm, packing nut inspected each hook up, effective written procedures for cylinder changes and operation.
A chlorine leak develops while testing the main valve connection during cylinder hookup?	Gasket leak, packing nut leak, bad threads on valve or connecting nut.	Possible 0.44 lbs/minute for 60 minutes – 17.1 lbs total release.	Use of a gas detector and alarm, packing nut inspected each hook up, effective written procedures for cylinder changes and operation.
The pigtail tubing connecting a cylinder to the chlorine gas piping develops a leak?	Excessive wear.	Possible 10.5 lbs/minute for 60 minutes – 317 lbs total release. Not likely – regulator closes when vacuum is lost.	Effective training program, use of gas detector, effective preventive maintenance program, tubing replaced annually.
The pigtail tubing is connected to the lower main cylinder valve (liquid) rather than the upper main cylinder valve (gas)?	Lack of training.	Minimal unless corrosion occurs.	Active training program, two persons change cylinders at all times.
The lower main cylinder valve (liquid) develops a leak while the cylinder is in service?	Malfunction of the valve, packing nut leak.	Possible 10.5 lbs/minute for 60 minutes – 317 lbs total release.	Use of gas detector, written cylinder changing procedures, supplier cylinder inspections.
The gas header or manifold develops a chlorine leak while it is pressurized?	Normal wear or corrosion.	Possible 46.8 lbs/minute for 27 minutes – 1,268 lbs total release. Not likely – regulator closes when vacuum is lost.	Use of gas detector, inspection of manifold, could use secondary manifold hook up.
The pressure reducing valve vent becomes stuck in the open	N/A		

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position?			
The chlorine gas pressure exceeds the normal working gas pressure?	Excessive temperature in the Chlorine Building, malfunction of the pressure reducing valve.	Possible 10.5 lbs/minute for 60 minutes – 317 lbs total release.	Fire prevention equipment, temperature controlled room, effective preventive maintenance program.
The pigtail tubing is disconnected from a cylinder before the cylinder and gas piping are evacuated of chlorine gas?	Lack of training.	Minimal if any.	Short pipe runs, use of SCBA during cylinder changes, effective training program.
A chlorine gas leak develops at the connection to the vacuum regulator?	Corrosion or deterioration of the piping.	Possible 46.8 lbs/minute for 27 minutes – 1,268 lbs total release.	Effective preventive maintenance program and inspections.
A chlorine leak develops in vent line inside the Chlorine Building?	Brittle or deteriorated tubing.	Minimal if any.	Effective preventive maintenance program and inspections.
A fusible plug opens on a cylinder releasing chlorine gas from the cylinder?	Excessive heat, fusible plug thread leak.	Possible 46.8 lbs/minute for 27 minutes – 1,268 lbs total release.	Temperature controlled room, use of leak repair kit.
Empty chlorine cylinders are repressurized during cylinder change operations before they are disconnected?	Lack of training. Vacuum demand regulator failure.	None.	Effective training program, two persons change cylinders at all times. Replace/repair regulator.
A chlorine leak develops in one of the chlorinator components (e.g. pressure relief valve, rotameter, differential regulating valve, etc.) while it is operating	Deterioration of the components.	Possible 10.5 lbs/minute for 60 minutes – 317 lbs total release.	Effective written operating procedures, effective preventive maintenance program, use of the gas detector.
A chlorine solution leak develops	Deterioration of the piping.	Possible gassing off of some	Leak enclosed in the building,

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in a chlorine solution line in the Chlorine Building?		chlorine from solution.	effective preventive maintenance program..
A chlorine solution leak develops in a chlorine solution line outside the Chlorine Building or at a feed point location?	Deterioration of the piping.	Possible gassing off of some chlorine from solution.	Effective preventive maintenance program.
A chlorine gas line or connection is broken during work being performed on the system?	Lack of training.	Possible 10.5 lbs/minute for 60 minutes – 317 lbs total release. Not likely regulators close when vacuum is lost.	Effective preventive maintenance program.
A chlorine solution line or connection is broken during work being performed on the system?	Lack of training.	None.	Effective training program.
The chlorine gas sensor fails to signal a leak to the gas detector?	Malfunction of sensor, electrolyte in sensor contaminated.	None.	Sensor is tested periodically, sensor is replaced based on the manufacturer's recommendations.
The gas detector fails to indicate a chlorine leak in the Chlorine Building?	Malfunction of the controls or components.	Depends on location of leak.	Sensor tested twice a month.
The exhaust fan is operating when a chlorine leak occurs?	Lack of training, operator error.	Depends on the location of the leak.	Effective training program and written procedures.
The air intake louver is open when a chlorine leak occurs?	Malfunction of the louver.	Minimal if any.	Effective preventive maintenance program, effective training program.
A chlorine leak occurs during normal operating status checks?	Gasket leak, packing nut leak, deterioration of the piping.	Depends on the location of the leak.	Effective preventive maintenance program, effective training program.