



THE CHLORINE INSTITUTE

Pamphlet 17

*Packaging Plant Safety
and Operational
Guidelines*

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1. INTRODUCTION

1.1 SCOPE

The purpose of this pamphlet is primarily to provide both operational recommendations and safety information for employees at facilities that package 100-lb and 150-lb cylinders and ton containers of chlorine. The members of The Chlorine Institute have developed these recommendations through a task group, with a review and final acceptance by the Institute's Health, Environment, Safety and Security Issue Team. This pamphlet describes what are believed to be safe methods for carrying out the numerous operations of a chlorine packaging plant. However, they are intended only as recommendations and are not necessarily meant to exclude other procedures designed to safely do the same task.

Many of the operations included in this pamphlet are covered by governmental regulations, applicable Fire and Building Codes and/or standards established by organizations such as the Compressed Gas Association (CGA). The applicable requirements, codes and standards must be reviewed by the facility and any departure from these requirements should be thoroughly analyzed and documented.

Recommendations for security at packaging plants are contained in the *CI Security Management Plan for the Transportation and On-Site Storage and Use of Chlorine Cylinders, Ton Containers and Cargo Tanks*, available to CI members.

1.2 CHLORINE INSTITUTE STEWARDSHIP PROGRAM

The Chlorine Institute exists to support the chlor-alkali industry and serve the public by fostering continuous improvements to safety and the protection of human health and the environment connected with the production, distribution and use of chlorine, sodium and potassium hydroxides, and sodium hypochlorite; and the distribution and use of hydrogen chloride. This support includes attention to the security of chlorine handling operations.

Chlorine Institute members are committed to adopting CI's safety and stewardship initiatives, including pamphlets, checklists, and incident sharing, which will assist members and members' customers in achieving measurable improvement. For more information on the Institute's stewardship programs, visit CI's website at <http://www.chlorineinstitute.org/>.

1.3 DEFINITIONS

In this pamphlet, the following definitions apply unless otherwise noted:

ANSI	American National Standards Institute, Inc. - http://www.ansi.org/
Aqua ammonia solution	Also known as ammonium hydroxide (NH ₃ [aq]), ammonia water or aqueous ammonia, it is a solution of ammonia in water. 26° Baumé (about 30 weight percent ammonia at 15.5°C) is the typical high concentration commercial product. Household ammonia ranges in concentration from 5 to 10 weight percent ammonia.

Baumé	The Baumé scale is a hydrometer scale developed by French pharmacist Antoine Baumé in 1768 to measure density of various liquids.
CANUTEC	Canadian Transport Emergency Centre - Operated by Transport Canada to assist emergency response personnel in handling dangerous goods emergencies.
CFATS	Chemical Facility Anti-Terrorism Standards (6 CFR, Part 27)
CFR	Code of Federal Regulations
CGA	Compressed Gas Association, Inc. - http://www.cga.org/
CHLOREP	The Chlorine Emergency Plan - A chlor-alkali industry-wide program formalized by the Chlorine Institute in 1972 to improve the speed and effectiveness of response to chlorine emergencies in the United States and Canada. Responsible for trained emergency teams from chlorine producing, packaging and consuming plants on constant 24-hour alert to assist in handling potential or actual chlorine emergencies. Typically activated through CHEMTREC or CANUTEC. - http://www.chlorineinstitute.org/CHLOREP/index.cfm
CHEMTREC	Chemical Transportation Emergency Center – An American Chemistry Council division dedicated to assisting emergency responders deal with incidents involving hazardous materials - http://www.chemtrec.com/Chemtrec/
chime	The circumferential rim in the shape of a lip on each end of a ton container.
condemn	To scrap as no longer fit for service.
container	Both cylinders and ton containers when used collectively.
cylinder	Any shipping container with a capacity not exceeding 150 lbs (68 kg) of chlorine that is authorized by regulations for the transportation of chlorine.
DHS	U.S. Department of Homeland Security - http://www.dhs.gov
DOT	U.S. Department of Transportation - http://www.dot.gov/
dry air	Air free from oil and foreign matter, dried to a dew point of -40°F (-40°C) or below and measured at an atmospheric pressure.

dry chlorine	Chlorine that does not meet the definition of “dry” will be considered “wet” and will have a moisture content that can cause a rapid corrosion of steel. See CI Pamphlet 100 for a complete definition and technical summary. The term “dry chlorine” is sometimes incorrectly used to describe a dry chlorinating compound (usually calcium hypochlorite or the chlorinated isocyanurates). This is a misuse of the term and is discouraged by the Institute.
eduction tube/pipe	Eduction tubes (siphon tubes) or pipes are used in both ton containers and rail car tanks for loading and unloading. Ton containers utilize an eduction tube from each valve to withdraw either liquid or gas, depending on the valve used and the orientation of the container. In the case of rail cars, eduction pipes are typically constructed to extend downwardly from the valve at the top of the car and terminate adjacent the bottom of the car, sometimes in the vicinity of a bottom sump area.
EPA	U.S. Environmental Protection Agency - http://www.epa.gov/
fusible plug	A non-reclosing pressure relief device, installed in a cylinder valve or directly into a ton container, designed to function by the yielding or melting of a plug of fusible metal at a temperature lower than the temperature at which a full cylinder or container might rupture.
ICC	International Code Council - http://www.iccsafe.org/
Institute	The Chlorine Institute - http://www.chlorineinstitute.org/
MSDS	Material Safety Data Sheet
NGT(CL)	National Gas Taper (NGT) threads for chlorine (CL) valves are specified in Federal Standard H-28 and CGA Pamphlet V-1.
OSHA	Occupational Safety and Health Administration - http://www.osha.gov/
PPE	Personal protective equipment
ppm	Parts per million
pressure relief device (PRD)	A pressure and/or temperature activated device connected to a pressurized container or system used to prevent the pressure from exceeding a predetermined maximum.
psig	Pounds per square inch gauge. Psi is often used incorrectly instead of psig.
PTFE	Polytetrafluoroethylene. A synthetic fluoropolymer with numerous applications. Commonly known as Teflon®.

RQ	Reportable quantity; a weight assigned by the U.S. Environmental Protection Agency to certain hazardous chemicals that is used to define spills reportable to the National Response Center. Spills equal to or exceeding this weight must be reported within a maximum of 24 hours. The RQ for chlorine is 10 lbs.
reject	To designate as not fit for service in present condition; may be re-qualified either by additional testing to verify adequacy of the container for continued service or by reheat treatment, repair, or rebuilding to correct the defect as specified in 49 CFR Parts 100 to 185.
SCBA	Self-contained breathing apparatus
SERC	State Emergency Response Commission
staging area	A specific area designated for holding returned shipping containers until they are ready for evacuation and further operations.
tare weight	The weight of the empty cylinder or ton container including valves and fusible plugs but excluding the valve protective housing.
ton container	A Class 106A container or a Class 110A multi-unit tank car tank with a typical capacity of 2,000 lbs of chlorine, or a similar container with appropriate exemptions authorized by DOT and TC regulations for the transportation of chlorine. For the purposes of this pamphlet, the term "ton container" will apply to both U.S. tons and metric tons unless otherwise noted. Use of the term "ton cylinder" should be discontinued because, by definition, there is no cylinder with a capacity exceeding 150 lbs of chlorine.
TC	Transport Canada - http://www.tc.gc.ca/en/menu.htm
valve protective housing	A detachable bonnet, hood, or cap that fits over the valve(s).

1.4 DISCLAIMER

The information in this pamphlet is drawn from sources believed to be reliable. Safety suggestions are based on the accident experience of members of The Chlorine Institute. The Institute and its members make no guarantee, jointly or severally, in connection with the information or safety suggestions herein.

Moreover, it should not be assumed that every acceptable safety procedure is included or that abnormal or unusual circumstances may not warrant or require modified or additional procedures.

The user should be aware that changing technology or regulations may require a change in the recommendations herein. Appropriate steps should be taken by the user to assure that the information is current.

These suggestions should not be confused with federal, state, provincial, or municipal regulations, or with national safety codes or insurance requirements.

1.5 APPROVAL

The Institute's Health, Environment, Safety & Security Issue Team approved Edition 4 - Revision 2 of this pamphlet on May 20, 2011.

1.6 REVISIONS

Suggestions for revisions should be directed to the Secretary of the Institute.

1.6.1 Significant Revisions in Current Edition

Revision 2 of this pamphlet removes references to the fusible plug melt temperatures and replaces that language with a regulatory reference. Revision 2 also addresses and clarifies Section 3.11.1 concerning cylinder repairs and the requirements of 49 CFR 180.212.

1.7 REPRODUCTION

The contents of this pamphlet are not to be copied for publication, in whole or in part, without prior permission from the Institute.

2. **PACKAGING PLANT DESIGN AND MAINTENANCE**

2.1 GENERAL

In a chlorine packaging plant, DOT regulated containers are filled to a specified weight with liquid chlorine. Typically, the chlorine is transferred from a pressurized tank car into these containers, which must be inspected, and maintained before filling. The container valves and fusible plugs should be inspected and replaced if necessary. The filled containers that are stored should be inspected again for leaks before shipment.

2.2 STRUCTURES

Buildings and structures to house chlorine equipment or containers should conform to local building and fire codes as well as to the recommendations in this document. Any such structures should be designed and constructed to protect all elements of the chlorine system from fire hazards. Fire-resistive construction is recommended, and combustible materials should not be housed in the same building as chlorine equipment or containers. However, if flammable materials are stored or used in the same building, a fire wall should be erected to separate the chlorine from the flammables.

As of the publication date of this pamphlet, there are no federal regulations within the United States that mandate the installation of ambient chlorine monitors. However, state and local rules may require the use of monitors, and such equipment should be considered for any storage or operating area where chlorine may be released (See CI Pamphlet 73).

At least two exits should be provided from each room or building in which chlorine is stored, handled, or used. Exit doors should not be locked and should open outward. Platforms should be designed to facilitate egress, and two or more access stairways or ladders should be considered. Steel structures should be protected to prevent corrosion.

2.3 VENTILATION

It is recommended that all ventilation systems for buildings that house chlorine equipment or containers conform to applicable building code requirements, American Conference of Governmental and Industrial Hygienists (ACGIH) recommendations found in the *Industrial Ventilation Manual: A Manual of Recommended Practices* and with the guidance found in this document. The building ventilation system should provide fresh air for normal operation and should be designed to handle a situation in which a chlorine leak occurs. Natural ventilation may be adequate; otherwise, mechanical ventilation systems should be provided.

The Institute recommends that ventilation requirements be determined on a site-specific basis. Safeguards should be in place to ensure that persons without the appropriate personal protective equipment, and appropriate training in the use of such personal protective equipment, do not remain in or enter buildings where chlorine is present in the atmosphere due to a leak or equipment failure.

Chlorine scrubbing systems, as described in CI Pamphlet 89, may be appropriate depending on the individual site.

2.4 PROCESS PIPING REQUIREMENTS

The following recommendations provide general knowledge about piping systems for dry chlorine in a packaging plant. For more detailed information or to design a system see CI Pamphlet 6.

- Liquid chlorine has a high coefficient of thermal expansion. If liquid chlorine is trapped between two valves, an increase in the temperature of the trapped liquid will result in high pressures that could lead to a rupture of the line unless the piping system is protected with a pressure relief device.
- Dry chlorine systems must be protected from the intrusion of moisture because moisture from wet compressed air or from exposure to ambient air can cause severe corrosion and failure of welds, valves, hoses, and fittings.
- Dry chlorine systems must be thoroughly cleaned before use because chlorine can react violently with cutting oil, grease, and other foreign materials. New valves or other equipment received in an oily condition should be dismantled and cleaned before use.
- All dry chlorine systems should be inspected at regular intervals for signs of leakage, internal or external corrosion, insulation failure, or support problems. These inspections should be documented.

2.5 FACILITY MAINTENANCE

Good housekeeping practices lead to improved safety performance and more effective responses to emergency situations.

2.5.1 Emergency Equipment

Emergency equipment, such as The Chlorine Institute Emergency Kits A, B, and C (See Section 8.5), should be routinely inspected to assure that all components are still in the kits and are in good working order. Clear areas should be marked around the locations of the kits to assure quick and unrestricted access to them.

Self-contained breathing apparatuses (SCBAs) should be routinely checked to assure that they are ready for emergency use. The respirator portion of the SCBA should be cleaned and disinfected after each use. Air cylinders should be refilled after any use to assure maximum performance for the next use. Clear areas should be marked around the locations of the SCBAs to assure quick and unrestricted access to them.

Federal regulations require that all emergency equipment necessary to respond to a chlorine gas leak must be accessible at all times. Facilities should carefully plan and prepare for such events necessitating the use of emergency equipment at their locations. Emergency equipment, such as, but not limited to the Chlorine Emergency Kits and SCBA's, must be stored in locations that are readily accessible, but not likely to be affected by the chlorine gas in event of a leak.

Emergency escape respirators should be kept clean and free from contamination. The respirator cartridge has an expiration date that should be recorded and checked periodically. Expired cartridges should be discarded and replaced.

OSHA regulations (29 CFR) should be reviewed and followed for the use, inspection, repair and storage of all respirators.

A safety shower should be available in a location that is near, but not likely to be affected by chlorine gas in event of a leak.

2.5.2 Scales

Areas around scales should be constantly cleaned and should remain free from debris, such as container valve outlet gaskets, that may become lodged under the scale plate and cause incorrect readings, possibly leading to overfilling the chlorine container. Adequate maintenance includes a written plan for regular calibration of the scale equipment, including written documentation of the periodic testing.

2.5.3 Valving Area

The valving area should be kept clean and dry to prevent slipping and falls.

Equipment used in the valving area such as valving machines should be inspected frequently for excessive wear and calibrated periodically. Any component that shows excessive wear, especially the jaws on the valving machine, should be replaced immediately to prevent personal injury, improper valve installation, or damage to the container or valve.

2.5.4 Cylinder and Ton Container Filling Stations

The area around the filling stations should remain clean and clear.

Filled containers should be moved to the storage area as soon as is practical. Containers should not be allowed to accumulate around the filling area. The area around the station should remain clear and marked to allow for emergency egress in case of a chlorine release and to allow emergency response personnel to perform their functions.

2.5.5 Tank Car Station

The area around the tank car stations should remain clean and clear. Do not allow containers to accumulate around the tank car station. Consider marking clear areas around the station to allow for emergency egress in case of a chlorine release. This clear area will also allow emergency response personnel to perform their functions.

2.6 STORAGE OF CYLINDERS AND TON CONTAINERS

2.6.1 Location

Containers may be stored indoors or outdoors and access to storage areas by unauthorized persons must always be controlled. Local fire and building codes may dictate storage requirements, but in general the following guidance should be followed:

If stored indoors, the storage areas should comply with the provisions of Sections 2.2 and 2.3. Containers should not be stored near elevators or ventilating systems because dangerous concentrations of gas may spread rapidly if a leak occurs. Subsurface storage areas should be avoided because chlorine vapors are heavier than air and will not dissipate from low areas in the event of a leak.

All containers should be stored to minimize external corrosion and excessive temperatures. If standing water can collect around the containers, suitable platforms or supports should be in place. Containers should not be exposed to temperatures above 125°F (51.7°C). Exposure of containers to flames, intense radiant heat, or steam lines should therefore be avoided.

Containers should not be stored where heavy objects can fall on them or where vehicles could strike them. Full and empty containers should be stored separately. Even though a container is empty, the valve outlet cap(s) and the valve protective housing should be in place. Provisions should be made to permit routine inspections of all containers.

2.6.2 Accessibility for Installing Emergency Equipment

In the event of a leak, easy access to all containers is important. Accessibility for installing emergency equipment should be considered when designing a storage area for containers. Storing ton containers above the ground and away from walls is recommended.

2.6.3 Leak Detection Equipment

Chlorine gas detection equipment is recommended for the storage areas of a packaging plant if the site is not monitored 24 hours a day. The equipment should be designed and adequately maintained to warn on-site personnel of a release or to signal a remote manned location of a release. Adequate maintenance includes a written plan for regular calibration of the monitoring equipment, including written documentation of the periodic testing (See CI Pamphlet 73).

2.6.4 Compatibility with Other Stored Materials

Chlorine containers should be segregated from other compressed gas containers, flammable and oxidizing materials, and materials such as ammonia and hydrocarbons that are reactive with chlorine.

2.6.5 Cleanliness

Storage areas should be kept clean so that accumulated trash or other combustible material does not present a fire hazard.

2.6.6 Posted Information

The chlorine storage area must be properly posted with signs in accordance with local, state, federal, and provincial laws and regulations. Signs designating whether the storage area contains full or empty containers should be posted. A National Fire Protection Association (NFPA) diamond may be required both at the storage location and near the entrance of the facility.

2.6.7 Securing of Cylinders and Ton Containers

Chlorine cylinders should always be stored in an upright position. An empty 150 lb chlorine cylinder may have a tare weight between 85 and 140 lbs.

They should be secured by placing them securely in containment racks designed for cylinders, or chained to a wall or posts to prevent them from falling. Cylinders should be protected from damage by moving equipment.

The cylinder containment rack should always be secured prior to movement of the rack by a forklift truck. The forklift operator should back down ramps to lessen the chance of a cylinder falling from the containment rack.

Ton containers, which weigh between 1,300 lb (590 kg) and 1,650 lb (750 kg) when empty, are always stored in the horizontal position, above the ground or floor, on steel, concrete or other suitable supports. Individual ton containers or the ton containers at each end of a row of ton containers should be chocked to prevent rolling. Ton containers should be stored with each end accessible so an Emergency Kit B can be applied if necessary.

Moving ton containers within a plant can be accomplished by rolling on a system of rails. Because a full ton container can weigh up to 3,650 lbs (1655 kg), forklift trucks must be designed to handle the weight of a full container. The container must be stabilized on the forklift truck to prevent falling, particularly when stopping or turning. The forklift operator should back down ramps to lessen the chance of a container rolling off the forks.

3. CYLINDER AND TON CONTAINERS

Cylinders and ton containers have many similarities in the way they are handled, and many users of cylinders also use ton containers.

3.1 CYLINDER SPECIFICATIONS

3.1.1 Construction

Chlorine cylinders are constructed of seamless steel and must comply with DOT (or TC, as appropriate) specifications such as: 3A480, 3AA480, 3, 3BN480, or 3E1800.

The regulations permit only one opening in chlorine cylinders (at the top for the cylinder valve connection). However, DOT (BE)-25-type cylinders with a removable plug in the bottom were authorized for use prior to 1944 and a few of these cylinders may still be in service. It is recommended that cylinders with bottom openings be removed from chlorine service.

3.1.2 Styles

Chlorine cylinders may have convex- or concave-style base (bottom) constructions. Those with convex bases have a foot-ring to make them self-standing. Cylinders with an integrally forged bottom are commonly constructed with a concave base that provides a self-standing cylinder without some of the inherent crevice corrosion drawbacks of cylinders having a foot-ring.

Chlorine cylinders may also have a double-bottom base design. This design includes a convex base with the foot-ring supporting another false base, which serves as an indicator to discard or repair the base before corrosion affects the real bottom. Typical base construction styles are shown in Figure 1.

All cylinders must have a valve protective cap in place over the valve except when the cylinder is in use or during cylinder maintenance requiring access to the valve.



Figure 1 - Chlorine Cylinder
(Left - bump-bottom; Upper right - double-bottom; Lower right - foot-ring)

3.1.3 Threads

The opening in new chlorine cylinders is tapped with a $\frac{3}{4}$ -14NGT(CL)-1 threads. This thread is in compliance with Federal Standard H-28. Over time this thread opening will become enlarged due to the revalving of the cylinder. Therefore, chlorine cylinder valves with oversized inlet threads are provided to extend the life of used cylinders. Oversized threads on chlorine valves are (CL)-2, 4 turns oversize; (CL)-3, 8½ turns oversize; (CL)-4, 14 turns oversize; and (CL)-5, 28 turns oversize. (CL)-1 is not an oversized thread.

Oversize valve thread categories were selected over fifty years ago with the primary purpose of having enough sizes to ensure a proper fit between a new valve and a used cylinder.

3.1.4 Chlorine Institute Emergency Kit A

All 100 or 150 lb chlorine cylinders must be compatible with Chlorine Institute Emergency Kit A (See Section 8.5). Therefore, the user should be aware that changing technology may require a change in the equipment or in the instructions concerning kit use. Appropriate steps should be taken to ensure the device(s) used are compatible with the valve and cylinder.

3.1.5 Stamping

When manufactured, cylinders must be steel-die stamped in the cylinder shoulder (area near the neck-ring) with the following information:

- DOT specification number or DOT exemption number
- Material specification
- Symbol and serial number (of owner or builder)
- Inspector's official mark
- Date of test (month and year)
- Water capacity
- Tare (this is recommended by the Institute)

There may be slight differences in DOT and TC markings. Individual specifications should be checked for proper marking requirements.

Retest Stamping

Each time cylinders are retested, the new test date should be steel-die stamped into the metal near the neck-ring, near the original stamped date. It is also recommended that a new tare weight be stamped if it differs from the original tare weight by more than 5% (See DOT Interpretation, Ref. No. 02-0080 dated July 10, 2003). All retest stamping must be legible for the life of the container, per requirements of 49 CFR Parts 100-185.

3.1.6 Capacity

The DOT and TC regulations limit the maximum amount of chlorine in a cylinder to 1.25 times the weight of water that the cylinder would hold (i.e., water capacity in weight units) at 60°F (15.6°C). Chlorine cylinders are made with capacities of 1 lb (0.45 kg) to 150 lb (68 kg) of chlorine.

3.2 TON CONTAINER SPECIFICATIONS

3.2.1 Construction

Ton containers used for shipping chlorine must comply with one of the following DOT or TC specifications: 106A50X and 110A500W. Older containers must comply with ICC 106A500X, ICC 106A500, ICC 27, BE 27, or with certain DOT exemptions.

The ends of chlorine ton containers form chimes. These provide a substantial grip for safely lifting the container using a lifting beam hooked over the chimes.

3.2.2 Styles

The U.S. DOT specification ton container has a tare weight range of 1,300-1,450 lb (590-660 kg), except for some very old containers that may weigh as much as 1,650 lb (750 kg).

The standard ton container has an outside diameter of about 30 inches (76.2 cm) and is about 82 inches (208.3 cm) long. It is furnished with openings for two valves and six fusible plugs (three at each end at approximately 120 degree intervals).

The *metric ton container* has a tare weight range of 1,425-1,525 lb (648-693 kg), has an outside diameter of about 30 inches (76.2 cm), and is about 89 inches (226.1 cm) long. It is furnished with openings for two valves and eight fusible plugs at approximately 90 degree intervals.

All ton containers must have a valve protective housing in place over the two valves except when the ton container is in use or during container maintenance requiring access to the valves.

3.2.3 Openings

The openings (both for valve and fusible plugs) in new chlorine ton containers are tapped with a $\frac{3}{4}$ -14NGT(CL)-1 thread. These threads are in compliance with Federal Standard H-28. Over time these thread openings will become enlarged due to the revalving of the container. At that time chlorine cylinder valves and fusible plugs with oversized inlet threads (CL)-2 thru (CL)-5 will be used. When the openings have increased past the use of a $\frac{3}{4}$ -14NGT(CL)-5, these openings can be re-tapped to a 1-11½NGT(CL)-1 (See Section 3.11).

3.2.4 Chlorine Institute Emergency Kit B

Ton containers must be designed so that they can accommodate the various devices in the Institute's Emergency Kit B for ton containers (See Section 8.5). Therefore, the user should be aware that changing technology may require a change in the equipment or in the instructions concerning kit use. Appropriate steps should be taken to ensure the device(s) used are compatible with the valve and ton containers.

3.2.5 Stamping

When manufactured, ton containers must be steel-die stamped into the chime of the ton container on the valve end with the following information:

- DOT specification or exemption number
- Material specification
- Symbol and serial number (of owner or builder)
- Inspector's official mark
- Date of test (month and year)

- Water capacity
- Tare (this is recommended by the Institute)

There may be slight differences in DOT and TC markings. Individual specifications should be checked for proper marking requirements.

Retest Stamping

Each time ton containers are retested, the new test date must be steel-die stamped into the metal of the chime near the original stamped date.

It is also recommended that a new tare be stamped if it differs from the original. All retest stamping must be legible for the life of the container, per requirements of 49 CFR Parts 100-185.

3.2.6 Capacity

The DOT and TC regulations limit the maximum amount of chlorine in a container at 1.25 times the weight of water that the ton container would hold (i.e., water capacity in weight units) at 60°F (15.6°C).

The U.S. standard ton container is designed to hold a maximum of 2,000 lb (907 kg) of chlorine, while the metric ton container holds a maximum of 1,000 kg (2,204 lb).

3.3 TRANSPORTING CYLINDER AND TON CONTAINERS

3.3.1 Transporting Cylinders and Ton Containers

Valve outlet caps and valve protective housings must be in place when transporting cylinders and ton containers per 49 CFR Parts 100-185.

Loading cylinders or ton containers into vehicles can be done utilizing lifting beams, pallet racks, and forklifts. The containers must be secured in the truck by means of chains, straps, freight bars, and cradles. See CI Pamphlet 76 for a more detailed discussion of the transportation of cylinders and ton containers.

3.3.2 Receiving Report

When picking up chlorine cylinders and ton containers at the customer's site a receiving report should be developed to document this event. The report could serve as a receipt, with a copy left with the customer to document the type and number of cylinders or ton containers received. The report could include the following information:

- The customer's name
- The date
- Quantity and type of cylinders or ton containers

- Indication as to whether the cylinders or ton containers are full or empty
- Serial numbers of the cylinders or ton containers, if company policy
- Brief description of any visible damage or indication that there is none
- Comments about missing parts, such as valve protective housings or valve outlet caps

3.4 EVACUATION OF CYLINDERS AND TON CONTAINERS

Before conducting any internal inspection, cylinders and ton containers must be evacuated to a suitable absorption system. Close the cylinder or ton container valve(s) then remove the valve outlet cap(s) and check for leaks in accordance with Section 3.4.1.

Using an injection system, the residual chlorine in the containers is usually evacuated into a sodium hydroxide solution. The cylinder or ton container should be under a vacuum after it is evacuated so that when valves or fusible plugs are removed, no residual chlorine is released.

3.4.1 Connecting and Disconnecting Cylinders and Ton Containers for Initial Evacuation

Before attempting to connect or disconnect make sure that the cylinder or ton container is properly secured and that all personal protective equipment is in use as required by company hazard assessment. Follow these steps for connecting to or disconnecting from the cylinder or container valve:

Connecting

1. Remove the valve hood or valve protective housing.
2. Make certain the valve is closed before removing the outlet cap.
3. Make certain that the packing nut is tightened to the proper torque.
4. Remove the outlet cap (for tons with valves vertically aligned the upper valves dispense gas and the lower valves dispense liquid.)
5. Make certain that the valve face is clean and smooth.
6. Use a new appropriate ring gasket when connecting the yoke and yoke adapter to the valve (See CGA Pamphlet V-1 for washer (gasket) dimensions and CI Pamphlet 95 for the latest gasket material experience).
7. It is recommended that a new gasket be installed before tightening the yoke screw. Torque the yoke screw to make a seal without overtightening (See Section 3.13.3).
8. Slowly open the container valve briefly to introduce chlorine into the system, then close it using the $\frac{3}{8}$ inch square box end of a wrench no more than 8 inches in length or using a suitable torque wrench with a socket fitting. Never use an extension (cheater) bar.

9. A suitable leak detecting solution should be used to check for leaks at the yoke adapter connection and the packing nut area (See Section 8.2.2). If any leaks are found they must be remedied before proceeding. Repeat this step if a leak is found. If using an aqua ammonia solution, use **ONLY VAPOR** from 26° Baumé aqua ammonia or stronger for leak detection. Weaker solutions may not be concentrated enough to detect minor leaks. It is acceptable to use other concentrations based on successful experience. **CAUTION:** Never allow liquid aqua ammonia solution to come into contact with valves or piping system components as it can cause stress corrosion cracking of copper based alloys such as brass and aluminum silicon bronze that are used in the manufacture of valves.
10. Using the Institute recommended wrench, open the valve one complete turn. This is all that is required to achieve maximum flow rates.
11. Open the appropriate valves in the piping system.
12. Observe for leaks again using the aqua ammonia solution as described in item nine above.

Disconnecting

1. Close container valve and appropriate manifold valves.
2. Evacuate the hose until under vacuum.
3. Disconnect container from the evacuation system.
4. Protect the yoke adapter and evacuation hose from moisture and moist air.

3.5 TON CONTAINER AND CYLINDER GENERAL INSPECTION, CLEANING AND RECONDITIONING

3.5.1 Responsibility

All activities involving the handling of chlorine cylinders and ton containers should be performed by appropriate trained personnel. It is particularly important that venting, inspecting, cleaning and reconditioning should be assigned to trained, responsible, experienced employees.

3.5.2 Evacuating

Before conducting any internal inspection, all ton containers and cylinders must be evacuated into a suitable absorption system until a vacuum is achieved and residual chlorine is removed.

WARNING - After venting some residual chlorine may remain.

3.5.3 Frequency of Inspection

In addition to the periodic retest (See Section 6), the Institute recommends that each ton container and cylinder be externally inspected prior to each filling. This includes inspection of all appurtenances such as valves per Section 3.7.12 and fusible plugs per Section 3.7.13 as specified in this section. The frequency of internal inspection should be determined using the same criteria as found in Section 4.2.

3.6 INSPECTION EQUIPMENT

Some of the equipment referred to below requires specialized training in its use. It may not be part of the site's normal inspection procedures, but there are companies that can provide in-house service with the use of portable equipment.

3.6.1 Depth Gauge, Straightedge, Measuring Rule, etc.

Exterior corrosion, denting, bulging, gouges and/or digs are normally measured by a simple direct measurement with a rule and/or depth gauge. A rigid straightedge of sufficient length is placed across the defect and a rule is used to measure the distance (depth) from the bottom of the straightedge to the bottom of the defect (Figure 2). There are also available commercial depth gauges which are especially suitable for measuring the depth of small cuts or pits.

It is important when measuring such defects to use a straightedge which spans the entire affected area. When measuring cuts, the upset metal should be removed or compensated for so that only actual depth of metal removed from the container wall is measured.

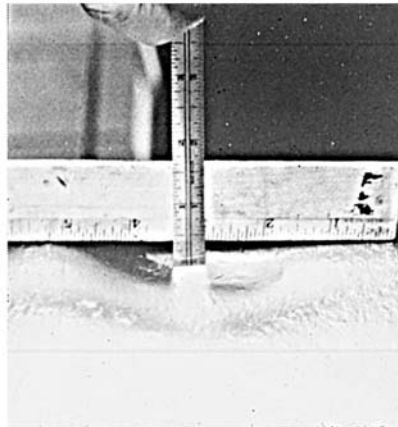


Figure 2 - Measuring the Length & Depth of a Typical Dent
(Figures 2 through 10 courtesy of Compressed Gas Association)

3.6.2 Ultrasonic Devices

There are a variety of commercial ultrasonic devices available. These can be used to detect sub-surface flaws and to measure wall thickness.

3.6.3 Magnetic Particle Inspection

Magnetic particle inspection can be used to quickly locate surface faults not readily visible to the naked eye.

3.6.4 Penetrant Inspection Materials

Dye-penetrant materials are available which show surface faults invisible/or not readily visible to the naked eye.

3.6.5 Inspection Light

Both external and internal inspections must be conducted under good lighting conditions. For internal inspections, there are a variety of illuminated boroscopes available, including fiber optics.

3.7 EXTERNAL INSPECTION

The DOT Hazardous Material Regulations, 49 CFR, Parts 100-185 as well as the regulations of Transport Canada, require that a cylinder be condemned when it leaks; when there is internal or external corrosion, denting, or bulging; and/or when evidence of rough usage exists to the extent the cylinder is likely to be weakened appreciably.

The DOT regulations reference CGA Pamphlet C-6 numerous times. This section is primarily an overview of the external inspection requirements found in Section 6 (Low pressure cylinders subject to hydrostatic testing) of this CGA pamphlet and includes discussion on dents, gouges, corrosion, cracks, fire damage, and missing, damaged or corroded cylinder foot- and neck-rings. For a complete discussion please refer to CGA Pamphlet C-6.

The following definitions apply to terms used in this section:

- Condemn – To scrap, no longer fit for service.
- Reject – To designate as not fit for service in present condition. May be requalified by either additional testing to verify adequacy of container for continued service, or by reheat treatment, repair or rebuilding to correct the defect as specified in 49 CFR Parts 100-185.

3.7.1 Initial Tare Weight Check

After venting, weigh ton container or cylinder and compare with original stamped tare weight. Be sure the cylinder is empty. Loss in weight is a danger signal.

- A cylinder must be condemned when the tare weight at the time of inspection is less than 90% of the original stamped tare weight. A cylinder should be rejected when the tare weight is less than 95% of the original tare weight. A rejected cylinder may be requalified in accordance with 49 CFR Part 180 Subpart C.
- Ton containers must be condemned if the tare weight is less than 90% of the original stamped tare weight. A ton container should be set aside for inspection and disposition when the tare weight is less than 95% of the original stamped tare weight.
- Stamp a new tare weight when the tare weight loss is 5% or greater (See US DOT interpretation letter dated July 10, 2003, Ref. No. 02-0080). Do not obliterate previous recorded tare weights.

Similarly, inspect a cylinder or ton container showing an increase in tare weight. Numerous coats of paint can add significant weight.

3.7.2 Corrosion or Pitting

Corrosion or pitting in cylinders and ton containers involves the loss of wall thickness by corrosive attack to either the outside or inside surfaces of the container.

Isolated Pitting

Isolated pits of small diameter do not effectively weaken the cylinder. Figures 3, 4 and 5 show typical examples of isolated pitting.

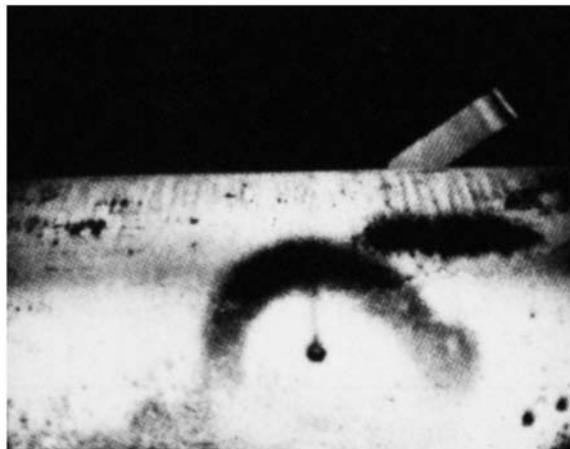


Figure 3 - Isolated Pitting

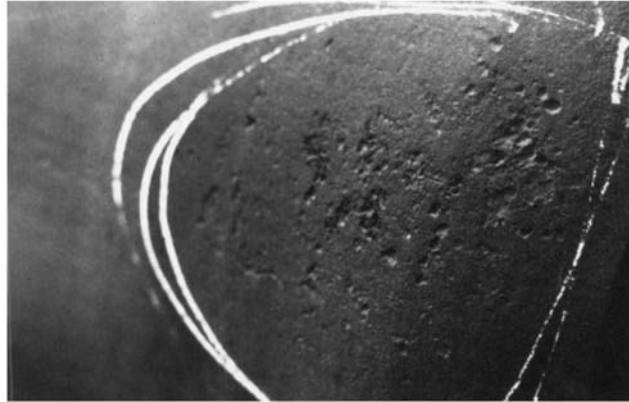


Figure 4 - Isolated Pitting - Ton Container Wall



Figure 5 - Dent with Isolated Pitting

Line Corrosion

When pits are connected or nearly connected to others in a narrow band or line, such a pattern is termed “line corrosion”. This condition is more serious than isolated pitting and generally occurs at the liquid-vapor interface inside the container when moisture is present. An example of line corrosion is shown in Figures 6 and 7.

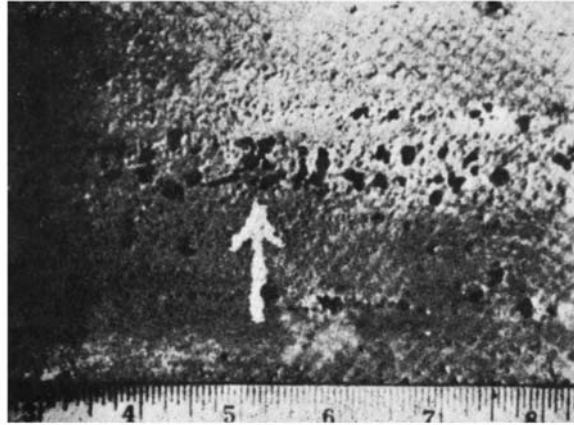


Figure 6 - Line Corrosion



Figure 7 - Line Corrosion - Cylinder Wall

Crevice Corrosion

Corrosion which occurs in the area of contact, or near contact, of the foot-ring or head-ring and the cylinder. Figure 8 is an example of crevice corrosion.

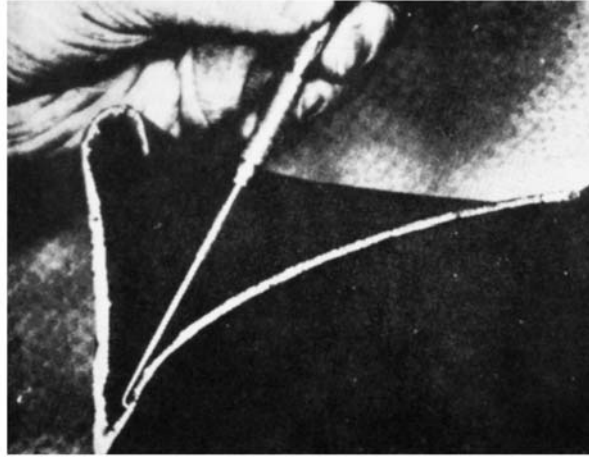


Figure 8 - Crevice Corrosion Near the Cylinder Foot-ring

General Corrosion

General corrosion is that which covers considerable surface areas of the cylinder or ton container. It reduces the structural strength. It is often difficult to measure or estimate the depth of general corrosion because direct comparison with the original wall cannot always be made. General corrosion is often accompanied by pitting. This form of corrosion is shown in Figures 9 and 10.

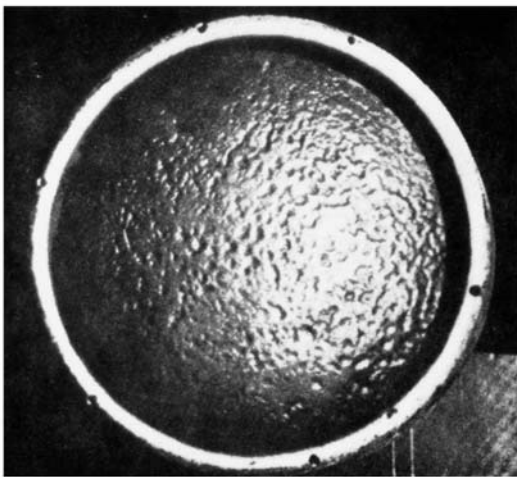


Figure 9 - General Corrosion with Pitting



Figure 10 - General Corrosion with Pitting on Cylinder Wall

3.7.3 General Corrosion Limits

Cylinders and ton containers should be checked as outlined below for corrosion, general distortion or other defect that might indicate a weakness that would render it unfit for service.

Failure to meet any of the following general rules is cause for condemning or rejecting a cylinder and/or ton container:

- A cylinder must be condemned when the current tare weight is less than 90% of the original tare weight.
- A cylinder must be condemned when the remaining wall thickness in an area of general corrosion is less than 50% of the minimum allowable design thickness (t_d) [See Table 1].
- A ton container must be condemned when the current tare weight is less than 90% of the original tare weight.
- Any corrosion that could interfere with the application of an Emergency Kit A or B is cause for rejection. Refer to Figure 11 for an example of chime corrosion.



Figure 11 - Chime Corrosion Ton Container Head

3.7.4 Industry Specific Guidelines for Inspection of Corrosion

The corrosion limits in this pamphlet are based on the minimum allowable wall (and head) thickness of a chlorine cylinder and ton container as shown in Table 1.

Table 1: Industry Guidelines for Inspection of Corrosion		
Nominal Diameter (In.)	DOT Specification²	Original Minimum Allowable Design Wall Thickness, t_d (in.)¹
10	3A480	0.150
10	3AA480	0.150
30	106A500-X ³	0.40625 (shell) 0.6875 (head)*
30	110A500-W ³	0.40625 (shell)
30	E-11808 ⁴	0.4375 (shell) 0.600 (head)
30	E-7517	0.400 (shell) 0.625 (head)
30	E-11923	0.3438 (shell, for 516GR material) 0.4063 (shell, for 285 GRC material)

*Not the specification's requirement, but the industry's recommendation for 106A500-X.

¹Some cylinders and ton containers will have thicker walls due to difference in manufacturing methods and inspection procedures. Values shown in Table 1 are absolute minimums allowed by specifications. Higher values may be used if information showing thicker walls than those listed is obtained from the container manufacturer.

² E-11808, E-7517 and E-11923 are containers with special renewable DOT permits. Other specially permitted containers may exist. It is suggested that the user contact the manufacturer for data on original minimum wall thicknesses and to verify valid exemption status.

³Shell original minimum allowable design wall thickness as per 49 CFR 179.301 (April 2004)

⁴DOT exemption - DOT-SP 11808 (January 9, 2007). Expires 12/31/10

Measuring actual wall thickness is not always feasible. The measurement of corrosion depth (See Figures 2 and 8 for examples) is typically a more practical method for inspection than the determination of remaining wall thickness.

If the original wall thickness is unknown, the remaining wall thickness can be estimated by measuring the corrosion depth and subtracting that value from the minimum allowable design wall thickness (t_d) found in Table 1.

The following should be used when considering the specific type of corrosion:

General Corrosion Accompanied by Isolated Pitting

A cylinder or ton container should be condemned when the depth of a pit is an area or general corrosion results in a remaining wall thickness less than 50% of the minimum allowable design wall thickness (t_d).

Isolated Pits Not in General Corrosion Area

A cylinder or ton container should be condemned when the remaining wall in an area having isolated pitting only is less than 66% of the minimum allowable wall thickness (t_d).

Line or Crevice Corrosion

- A cylinder should be condemned when line or crevice corrosion on the cylinder is 3 inches in length or greater and the remaining wall is less than 75% of the minimum allowable wall thickness or when line or crevice corrosion is less than 3 inches in length and remaining wall thickness (t_d) is less than 50% the minimum allowable wall thickness (t_d).
- A ton container should be condemned when line or crevice corrosion on the ton container is 3 inches in length or over and the remaining wall is less than 75% of the minimum allowable wall thickness (t_d) or when line or crevice corrosion is less than 3 inches in length and remaining wall thickness is less than 50% of the minimum allowable design wall thickness (t_d).

3.7.5 Dents

Dents in cylinders and ton containers are deformations caused by impact with a blunt object in such a way that the thickness of metal is not materially impaired. A typical dent is shown in Figure 2. Dents are of concern where the metal deformation is sharp and confined, or where it is near a weld. Where metal deformation is not sharp, dents of larger magnitude can be tolerated.

Dents at Welds

When denting occurs at the chime weld and the depth exceeds 0.25 inches the cylinder or ton container should be condemned. When denting occurs along the longitudinal weld, the provisions of "Dents Away from Welds" should apply.

Dents Away from Welds

When denting occurs so that no part of the deformation includes a weld, the cylinder or ton container should be condemned if the depth of the dent is greater than 10% of the greatest dimension of the dent but in no case should the dent exceed 0.5 inches.

3.7.6 Cuts, Gouges or Digs

Cuts, gouges or digs in cylinder and ton containers are deformations caused by contact with a sharp object in such a way as to cut into or upset the metal of the cylinder, decreasing the wall thickness and inducing stress at that point.

- A cylinder should be removed from service if the cut, gouge or dig is less than 3 inches long and its depth exceeds 0.075 inches (50% of the minimum allowable wall thickness) or if the defect is more than 3 inches and its depth exceeds 0.0375 inches (25% of the minimum allowable wall thickness).
- A ton container should be removed from service if the cut, gouge or dig is less than 3 inches long and its depth exceeds 0.2 inches (50% of the minimum allowable wall thickness) or if the defect is more than 3 inches long and its depth exceeds 0.1 inches (25% of the minimum allowable wall thickness).

3.7.7 Fire Damage

Ton containers and cylinders should be carefully inspected for evidence of exposure to fire.

Inspection for Fire Damage

Common evidences of exposure to fire are: (a) charring or burning of the paint or other protective coat; (b) burning or scorching of the metal; (c) distortion of the container; (d) melted-out fuse plugs; and (e) melted packing extruding from under valve packing nut.

Evaluation of Fire Damage

DOT Regulations state that cylinders or ton containers that have been subjected to the action of fire must not again be placed in service until it has been properly reconditioned in accordance with 49 CFR Parts 100-185.

3.7.8 Arc and Torch Burns

Cylinders and ton containers with arc or torch burns should be rejected. Evidence of these burns can be recognized by: (a) removal of metal by scarfing or cratering; (b) a scarfing or burning of the base metal; or (c) a deposit of weld metal or displacement of base metal.

3.7.9 Bulges

Obvious Bulges

Ton containers which have any definite visible outward bulges in either the shell or heads of containers should be condemned. It must be remembered that certain containers which were built to ICC-27 specifications have one convex head on the end opposite the two container valves. These containers should be removed from service because they will not accommodate Emergency Kit B.

Measurement

Bulges in cylinders and ton containers can be measured in several different ways:

1. Bulges on the cylindrical wall can be measured by comparing a series of circumferential measurements, or
2. Variations from normal contour can be measured directly by either:
 - Measuring the height of a bulge with a scale, and comparing templates of bulged areas with similar areas not bulged, or
 - With respect to ton containers, noting any change in contour of the heads from the original smooth and regular inward dish.

Ton Container Limits

Outward bulging of the heads of the ton container is rather difficult to measure and the ton container should be condemned when any abnormal bulging is observed. Ton containers should be removed from service when a variation of 1 inch or more is found in the measured circumferences.

Cylinder Limits

Cylinders should be condemned when a variation of 1% or more is found in the measured circumference of in peripheral distance measured from the valve spud to the center seam. For a 10 inch diameter cylinder the maximum circumference (equivalent to a 1% variation) would be 31.73 inches (See calculation below). This would also be equivalent to a variation in the circumference of 0.31 inches.

Normal outside diameter (d)	10"
Circumference [C=πd]	31.42"
Maximum Circumference [31.42 + 0.01 (31.42)]	31.73"
Variation in Circumference	0.31"
Equivalent Variation in Diameter	0.100"

If the bulge is uniform around the cylinder, the limiting height of the bulge would be $0.100/2 = 0.05$ inch.

3.7.10 Attachments

Cylinders

The foot-ring, neck-ring and valve protective housing of cylinders must be capable of performing their intended functions. The foot-ring should be capable of keeping the cylinder stable and upright and the neck-ring and valve protective housing should protect the valve.

If there is unreparable damage to these parts, which adversely affect their functions, the cylinder should be condemned. When the cylinder bears a permanent attachment such as a foot-ring or double bottom, which covers a portion of the cylinder surface, proper, periodic inspections of these parts should be made to ensure that they are intact and that it is in the same relation to the cylinder as at the time of its attachment. The attachment of the part to the cylinder should be checked for corrosion. Check cylinder neck-rings for tightness with a light ball peen hammer; if ring is loose, peen the top of the cylinder to make it tight. If the ring is excessively loose, it is advisable to remove the ring and inspect both it and the neck of the cylinder for excessive corrosion.

Ton Containers

Check the condition of all valve protective housing lugs and set screws for continued use. These parts should not be damaged to the degree that they can no longer perform their intended functions.

3.7.11 Markings

Check stamping for legibility and segregate containers due for periodic retest. If no defects are found, proceed with internal inspection.

3.7.12 Cylinder and Ton Container Valves

External inspection of valves should consist of examination for structural cracks due to excessive packing nut torques, corrosive attack or indications of large impact forces. Such cracks are observed sporadically, usually as tight cracks on or near one of the valve body flash lines in the packing nut region. Less frequently, these cracks have also occurred in the packing nut. Valves should also be examined for signs of leakage, excessive wear, deformations that may affect valve operation, tampering and illegible identification markings.

Valves with any of these defects must be replaced. Repairable valves may be replaced with new valves; otherwise they must be reconditioned in accordance with Sections 4.4 – 4.9 before being returned to service. Non-repairable valves; e.g., valves with cracks, deformations that may affect valve operation, exposure to fire, etc. must be condemned. Valves with linear indications, where structural cracks cannot be ruled out, should be condemned.

3.7.13 Cylinder and Ton Container Fusible Plug Pressure Relief Devices

External inspection of fusible plugs should consist of examination for signs of leakage, extrusion of fusible metal, obliteration of markings, corrosion and/or damage that might result in a leak. In accordance with CGA Pamphlet S-1.1, mandated by reference in 49 CFR Part 173, fusible plugs may not be repaired or refilled. Also by regulation, fusible plug pressure relief devices (PRDs) are the only devices permitted to replace faulty or questionable fusible plugs.

3.8 INTERNAL INSPECTION

Remove all valves from cylinders and ton containers and recondition them as described in Sections 4.6 and 4.7. One or more fusible plugs are to be removed from each end of ton containers to facilitate internal inspection. Because of the difficulty in visually examining the remaining four plugs through the two holes, it is recommended that a system be established to ensure that the same plugs are not always removed at each inspection.

3.8.1 Inspection of Fusible Plugs

Fusible plugs removed from a ton container for internal inspection of the container should be examined for corrosion, excessive extrusion of the fusible metal; i.e., over $\frac{1}{32}$ inch, and defects such as separation of the fusible metal from the fusible plug shell, which might result in a leak. Conditions such as these and other abnormal conditions such as, obliteration of markings, severely deformed hex wrench flats, or heavy wear or damage of the plug threads should be cause for replacement of the plugs. If conditions such as these are observed, consideration should be given to removal and examination of additional plugs.

3.8.2 Inspection of Ton Containers and Cylinders

Wearing appropriate personal protective equipment (See CI Pamphlet 65), inspect interiors of cylinders and ton containers from both ends with an illuminated boroscope. Due to both potential vapor release and the introduction of moist air to the container, care must be taken to minimize the exposure time to employees and to the interior of the ton container. Check the inner surface for pitting, line or general corrosion (See Section 3.7), scale, wetness, residue, foreign matter or any condition which might indicate the container to be unsafe for use, or which might contaminate the chlorine which it is intended to contain.

Inspect the eduction pipes in ton containers. Defective eduction pipes can rarely be detected by visual inspection. If defects are suspected, set the container with valves in vertical position and attach a transparent burette to the upper valve via tubing. Ensure that 1-inch of the burette extends above the shell of the container. Fill burette with water. Observe the water level; this is the height of the opening in the eduction pipe. The eduction pipe should extend within $\frac{1}{2}$ inches of the inside of the shell. Rotate the container 180 degrees and test the other eduction pipe. If the water level is lower than the eduction pipe outlet, then the eduction pipes should be replaced or the container condemned (See Section 3.11.2).

After inspection always dry the interior of cylinders and ton containers as per Section 3.9.

Valve and Fusible Plug Openings

At manufacture, cylinder openings are tapped with a $\frac{3}{4}$ -14NGT(CL)-1 thread a minimum of 13 $\frac{3}{4}$ full threads. At manufacture, ton container openings are also tapped $\frac{3}{4}$ -14NGT(CL)-1 with a minimum of 8 full threads which are limited by the $\frac{11}{16}$ inch ton container minimum head thickness.

Before valves or fusible plugs are installed, extreme caution should be exercised. The container threads should be inspected and cleaned as necessary to ensure the absence of corrosive deposits, rust, scale, dirt, paint, or other foreign matter that might damage the threads and thus endanger the effectiveness to seal. Cylinders and/or ton containers should be removed from service for repair if less than five full threads are available or if threads are broken, nicked, cut or otherwise damaged.

As ton containers become older and the openings wear larger, oversize valves and fusible plugs ($\frac{3}{4}$ -14NGT(CL)-2, -3, -4 and -5) may be used. For even larger openings, 1-11 $\frac{1}{2}$ NGT(CL)-1, -2, -3, -4 and -5 may be used for fusible plugs .

Check the location of the fusible plug openings in relation to the chime of the ton container. The location must be such that a Chlorine Institute Emergency Kit B fuse plug capping device can be effectively applied. If this device can not be applied the container must be rejected.

3.9 INTERNAL CLEANING

There are a number of suitable methods for the internal cleaning of chlorine cylinders and ton containers, some of which are described in the following sections. Regardless of the method used, care should be taken to ensure that the cylinder or container, after cleaning, remain within the dimensional specifications as required by regulation and as noted in this pamphlet. Cylinders or containers that do not conform to specifications should be condemned. **WARNING:** After venting some residual chlorine may remain. This must be removed before cleaning and reconditioning is begun.

3.9.1 Cylinders

If internal inspection shows only loose scale, invert the cylinder on a wooden block and bump out the scale. If scale is removed by bumping, proceed to drying as per paragraph below.

If the internal inspection shows the cylinder to be wet or to contain foreign material that was not removed by bumping, pour approximately one quart of 10% - 20% caustic solution into the cylinder (amount used can vary according to the internal condition of the cylinder) in accord with established safety practices. Immediately fill with water. Heat water by injecting steam into the water-filled cylinder until container is too hot to touch. Invert cylinder and empty. Flush with hot water until discharge is clean. Set upright and reinspect for internal corrosion.

If the above does not remove all of the foreign material, pour approximately 2 quarts of 18° - 20° Baumé inhibited hydrochloric acid into the cylinder, in accord with established safety procedures. Immediately fill the cylinder with water and heat solution in the cylinder by injecting steam until container is too hot to touch.

Shut off steam and allow cylinder to stand 2 to 3 minutes. Invert cylinder and empty. Flush with hot water until discharge water is clear. Set upright and inspect for internal corrosion and cleanliness. If cylinder is clean and free of corrosion defects, proceed to dry as per paragraph below.

If cylinder is dry and free of foreign material and corrosion defects, steam cylinder in inverted position until it is too hot to touch. Purge with dry air at 15 psig maximum until it is warm to the touch. Insert a new or reconditioned valve of the proper size.

3.9.2 Ton Containers

If internal inspection shows only foreign matter consisting of loose scale, place the ton container in a slanting position with an open fusible plug hole down. Blow out eduction tubes with dry air. Remove loose material from the container with an air ejector, vacuum cleaner or similar device. If scale is removed, proceed to drying as per paragraph below; otherwise, continue treatment as described below.

If internal inspection shows the ton container to be wet or to contain impurities that could not be removed by vacuuming; remove all fusible plugs and replace with solid steel or brass plugs. Apply vacuum to the container. Draw approximately two gallons of 10%-20% caustic soda solution into the container by attaching a hose to the bottom valve and putting hose into the container of caustic soda solution in accord with established safety practices. Immediately fill the ton container with water through the bottom valve, venting through the top valve.

Apply steam through a fusible plug opening equipped with an adapter leaving top valve open until water is hot. Apply water through the fusible plug opening until discharge water from the top valve runs clear. Close top valve, open bottom valve and apply air at 15 psig maximum through a fusible plug opening until ton container is empty. Remove pipe plugs and inspect ton container internally for cleanliness and corrosion. If this procedure does not remove foreign material, proceed as below. If ton container passes the inspection, proceed to drying as per paragraph below.

If the procedure does not clean the container, introduce approximately two gallons of 18° - 20° Baumé inhibited hydrochloric acid in accord with established safety procedures. Immediately fill the container with water and heat the solution by injecting steam until the container is too hot to touch. Apply air at 15 psig maximum through fusible plug opening until container is empty. Re-inspect for internal corrosion.

When an inspection shows that the container is clean then introduce steam into the container through the fusible plug opening and discharge the steam through the bottom valve opening until the container is too hot to touch. Apply dry air at 15 psig maximum through a fusible plug opening until the container is warm to the touch. Visually inspect for dryness. Install fusible plugs and valves of the proper size.

3.10 INSTALLING VALVES AND FUSIBLE PLUGS

Only install reconditioned or new valves and fusible plugs that meet the guidance provided in Section 5.1.1 and 5.1.2 as well as the Valve Performance Criteria found in Appendix A. Examine the first thread on the valve or plug to ensure it is free of nicks and deformations. Install the valve or plug about one full thread into the cylinder or container after it has been determined that the threads are clean and free of defects. Apply compatible pipe thread compound PTFE paste with a non-reactive carrier or PTFE tape to the remaining threads. If tape is utilized, then apply carefully to the threads before insertion. Engage the valve or fusible plug hand tight then wrench the valve two to three turns.

3.11 REPAIRS

3.11.1 Cylinders

Repairs to specification 3A and 3AA cylinders must be performed per the requirements in 49 CFR 180.212. The removal and replacement of a neck-ring or foot-ring on a DOT 3A, 3AA or 3B cylinder or a UN pressure receptacle that does not affect a pressure part of the cylinder can be performed without approval when the repair is performed by an authorized repair facility or a cylinder manufacturer of these types of cylinders per 49 CFR 180.212(b)(1). The repair may be made by welding or brazing in conformance with the original specification. Inspection must occur before and after replacement and any defective cylinder must be rejected. An approval issued under the provisions of 49 CFR Part 107.805 is required for any other repair.

Cylinder Valve Opening

If inspection has revealed defective threads, the threads might be repairable with a suitable tap. If the opening has become so enlarged that it does not provide proper engagement with the 3/4-NGT(CL)-5 valve, the cylinder must be removed from service. The cylinder can be drilled and tapped for a 1-11½NGT(CL) thread if the neck radius is at least ¹³/₁₆ inch, but only by the original cylinder manufacturer (CGA Pamphlet V-1, H-28/29).

49 CFR Part 180.212 states that 3A and 3AA cylinders can only be retapped by the original cylinder manufacturer.

Replacement of Neck-Rings

Replacement of neck-rings can be accomplished by removing the old neck-ring and peening a new one into the cylinder. The requirements of 49 CFR 160.212 apply to this replacement (See Section 3.11.1).

Foot-Ring Replacement

The foot-ring may be replaced by welding a new foot-ring to the existing stubs of the original foot-ring as long as the cylinder wall does not reach a temperature of 400EF (204.4EC), as verified by the use of a heat stick indicator. The requirements of 49 CFR 180.212(b)(1) apply to this replacement (See Section 3.11.1). If welding on the actual cylinder wall is involved the requirements of 49 CFR 180.212(a)(1) and 49 CFR 180.212(a)(2) are applicable.

3.11.2 Ton Containers

Ton containers that have been rejected can sometimes be repaired, including replacing education tubes, repairing corroded threads, and replacing valve protective center lugs. Such work must be done by a DOT-certified shop. After welding, the containers must be heat treated and DOT tested. It is recommended that containers requiring these repairs be returned to the manufacturer.

The following repairs can be conducted at the packaging plant. Repairs should only be performed by knowledgeable and experienced personnel.

Ton Container Valve Openings

Threads shown to be defective during inspection can sometimes be repaired with a suitable tap. If the opening has become so enlarged that it does not provide proper engagement of the $\frac{3}{4}$ -NGT(CL)-5 valve, the container may be drilled and tapped to a 1-11½NGT(CL)-1 thread. Extreme care is needed in tapping this opening to prevent thinning or damaging the education tube(s).

Ton Container Fusible Plug Openings

Threads shown to be defective during inspection can sometimes be repaired with a suitable tap. If the opening has become so enlarged that it does not provide proper engagement of the $\frac{3}{4}$ -NGT(CL)-5 fusible plug, the opening may be drilled and tapped to a 1-11½NGT(CL)-1 thread.

Ton Container Valve Protection Housing

If inspection has shown that the setscrew holding the valve protection hood has become corroded, owners may weld a setscrew lug to the valve protection bonnet (See Illustration 182 for a typical configuration). This procedure is effective only if the lugs on the ton container are in place.

3.12 DISPOSAL

Containers that cannot be repaired or re-qualified must be condemned. Condemned containers should be evacuated and purged, and then destroyed by cutting away a portion of the container that includes the chime markings.

3.13 PREPARATION FOR FILLING AND FILLING SAFETY PROCEDURES

Prior to refilling, the cylinder or ton container must be completely evacuated and placed under vacuum.

3.13.1 Final Inspection

After a cylinder or ton container is positioned at the filling station, a final inspection should be performed. This inspection will confirm that the required components have been installed on the cylinder or ton container and that all necessary repairs have been completed. Inspect all valves and fuse plugs for proper installation. This includes verification that each valve is tightly installed and that at least two full threads of each valve are exposed above the opening. Check to ensure that there are no container defects such as bulges, fire damage, or corrosion.

3.13.2 Container Tare Weight

Refer to Section 3.7.1 for information on checking actual tare weight versus stamped tare weight.

3.13.3 Connecting Container to Filling Line

Extreme caution must be exercised when filling cylinders or ton containers. Proceed with care as follows:

- Wear or equip yourself with the proper personal protection equipment, (refer to the hazard assessment that was developed for your facility or see CI Pamphlet 65). It is recommended that the flexible filling line be attached to the container valve(s) by means of a CGA 820 or 820C yoke connection. When using a yoke assembly, the following operations should be performed:
 1. The yoke should be inspected prior to use to ensure the operating parts, screw and follower operate freely;
 2. A compatible gasket (See CI Pamphlet 95) should be properly installed on the yoke adapter;
 3. With the yoke screw fully retracted, lower the yoke assembly over the valve until the valve outlet is aligned with the adapter; and
 4. Carefully tighten the yoke screw until the valve is snugly clamped between the gasket and the follower to create a seal. Do not overtighten and check to ensure the gasket is compressed uniformly. Non-uniform compression indicates misalignment of parts and raises the possibility of a leak as the yoke screw is tightened.
- Once the filling line has been connected, slowly allow a small amount of chlorine to pressurize the line. Carefully inspect for signs of leakage at the yoke connection using aqua ammonia vapor (See Section 8.2.2). If a leak is found, close the chlorine valve immediately and repair the leak.

3.13.4 Filling Observations and Leak Testing

Once a leak-tight connection has been established, the filling can proceed. Observe the scale weight before beginning so that the net weight can be determined. In some cases, the scale would be reset to zero at this point. Open the feeding valve and the container valve(s). Observe the rate of weight increase of the container. Inspect again for leaks. If necessary to maintain the filling rate, stop and evacuate excess vapor from the container. Close the valves when the correct weight has been reached.

3.13.5 Evacuating and Disconnecting Filling Lines

Extreme caution must be exercised when disconnecting cylinders or tons that are not empty. This is especially critical in systems feeding liquid chlorine. Proceed with care as follows:

- Wear or equip yourself with the proper personal protection equipment. Refer to the hazard assessment that was developed for your facility or see CI Pamphlet 65;
- Using a torque wrench, close the cylinder or ton valve to a torque of 25 to 30 foot pounds;
- Let the pressure in the system drop to 0 psig and apply a vacuum as appropriate for your system's design. When gauges indicate 0 psig or a vacuum, the appropriate piping system valve can be closed;
- Monitor the pressure gauge to ensure that the system remains at 0 psig or a vacuum. If any leaks exist, increase the torque on the valve stem to 40 foot pounds and retest for leaks. If leaks persist, evacuate the container and replace the valve with a new or reconditioned valve;
- If the pressure in the line connected to the cylinder or ton valve remains constant at or below 0 psig, the yoke can be loosened and disconnected;
- Allow sufficient time to ensure that there are no leaks from the container fixtures;
- Verify that an outlet gasket is in place and replace the valve outlet cap;
- Protect the yoke adaptor and chlorine line from moisture and moist air. Use an air-tight plastic bag, or a suitable plug to protect against moisture;
- Place a valve hood or bonnet on the cylinder or ton container as appropriate being careful to avoid damaging the valve, fuse plugs and other fixtures; and
- Place the cylinder or ton container in an appropriate location.

3.13.6 Relocating to Holding Area

All cylinders should be well secured during transport to holding areas. Chains, racks, or similar devices can be employed to secure containers while being transferred by forklift trucks (See Section 2.6.7). Filled containers should not be transported without their protective housings in place. After a minimum time of eight hours in the holding area to allow the container to reach room temperature, a final test can be made to ensure that all fittings are tight and that there are no container leaks.

3.14 PAINING AND MARKING OF CONTAINERS

Container painting and identification is usually performed before filling. Care must be taken to avoid certain hazards, as described in the following.

3.14.1 Preparation of Containers for Painting

Basic Preparation

When preparing for painting, all loose paint and other surface material should be removed from the container surface. Surface preparation can include washing, wire brushing, mechanical blasting, or other means. Care should be taken so as not to obscure or damage identification marks on the container. Grounding precautions and equipment suitable for use in the presence of flammable vapors should be utilized if the paint is flammable or contains flammable components. If flammable vapors are present, electrical equipment should be rated for the proper electrical classification.

Protecting Valves, Fusible Plugs, and Identification Marks

Painting over valves and fusible plugs may mask defects and very small leaks and hinder other inspection requirements. Special care should be taken to ensure that the last identification marking of the hydrostatic test date is clear and readable.

3.14.2 Methods and Equipment for Spray, Brush, and Roller Painting

When using spray painting systems, care should be taken to protect the operator from the hazards of airborne paint mists. A well-ventilated paint booth and the appropriate respiratory protection are recommended. It is also necessary to prevent over spray on identification marks and fixtures.

Brush and roller painting pose less of a paint mist hazard, but required respiratory protection must still be used. Brushes and rollers should be selected based on the type of paint used.

3.14.3 Installation of Warning Labels and Placards

Where necessary, warning labels and placards can be attached to the valve(s) with wire or plastic connectors. Since valves are protected during shipment by valve protective housings but must be opened during connection, valves are an ideal place for customer warnings and related information.

3.14.4 Reinstallation of Protective Equipment

Check to ensure that valve outlet caps with gaskets have been properly installed before attaching the valve protective housing. Attach covers securely before transporting the container.

3.14.5 Marking Identification Information

Markings and DOT marking labeling requirements change frequently. Packagers should check 49 CFR Parts 100-185 regularly to ensure that they are meeting current requirements. At the time of publication of this document, chlorine ton containers must be marked in 2-inch high letters on two opposing sides: "RQ Chlorine UN 1017 Inhalation Hazard." For shipments involving water transportation, refer to 49 CFR Parts 100-185 for marine pollutant requirements. Other regulations may be applicable, be sure to investigate thoroughly.

4. VALVES

The following sections apply to typical chlorine valve configurations as shown in Appendix B and as designed to satisfy the performance criteria noted in Appendix A.

4.1 TYPES

4.1.1 Cylinder Valves

Chlorine cylinders have a single valve equipped with a pressure relief device. Typical chlorine valve inlet threads comply with Federal Standard H-28 and are $\frac{3}{4}$ -14NGT(CL)-1 with four additional oversize versions: (CL)-2, 4 threads oversized; (CL)-3, 8 $\frac{1}{2}$ threads oversized; (CL)-4, 14 threads oversized; and (CL)-5, 28 threads oversized.

4.1.2 Ton Container Valves

Ton containers have two identical valves near the center of one head. A Ton container valve is identical to the cylinder valve except that it has no pressure relief device and the valve seat orifice diameter may be larger than on most cylinder valves.

The ton container valve inlet threads comply with Federal Standard H-28 and are $\frac{3}{4}$ -14NGT(CL)-1 and 1-11 $\frac{1}{2}$ NGT(CL)-1 with four additional oversize versions in both sizes: (CL)-2, 4 threads oversize; (CL)-3, 8 $\frac{1}{2}$ threads oversized, (CL)-4, 14 threads oversized; and (CL)-5, 28 threads oversized.

Valve Orientation

The Institute recommends that the ton container valves be positioned as shown below. When aligned vertically, the upper valve outlet faces 3 o'clock while the lower valve faces 9 o'clock.

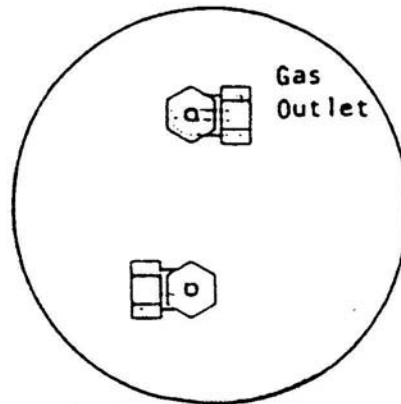


Figure 12 – Ton Container Valve Orientation

4.1.3 Outlet Threads

Outlet threads on cylinder and ton containers are special straight threads (1.030 - 14 NGO - RH - EXT) that comply with Federal Standard H-28 and CGA Connection Numbers 820 and 820C, which utilize a yoke-type connection. These threads are to accommodate the outlet cap only and are not to be used for chlorine filling or unloading line connections.

4.2 FREQUENCY OF VALVE CHANGING

It is recommended that the cylinder and ton container valves be removed, examined, reconditioned or replaced or retested at regular intervals. The frequency of these procedures should be established by each packager and based upon:

- The condition of the valve (e.g., damage, corrosion, legibility of identification markings, absence/existence of structural cracks, signs of leakage, signs of tampering). See Appendix C for additional information regarding the inspection of valves for cracks.
- The performance of the valve (e.g., ease/difficulty of operation, absence/presence of abnormal noises, excessive shut-off torques).
- The condition of the cylinder or ton container (e.g., exposure to fire, bulging, significant dent, etc.).
- Other parameters as established by the packager and other end-use requirements.

4.3 REMOVAL OF VALVES

Valve removal can be accomplished with either a manual, electric, pneumatic, or hydraulic wrench. In all cases it is important that the jaws gripping the valve fit properly over the wrenching flats on the valve without contacting the outlet or inlet threads or relief device on the valve. Poorly designed, worn, or oversized jaws can deform the wrench flats, possibly obliterating valve markings or incorrectly applying a damaging wrenching force against the fusible plug or valve outlet. The valve should be removed slowly to prevent damage to engaged threads. Before removing the valves, it is important that the container is completely empty of chlorine gas, is under a vacuum, and is secure to prevent toppling during valve removal.

4.4 VALVE RECONDITIONING FACILITIES

Valve inspection and reconditioning should be performed by trained personnel familiar with the applicable portions of this pamphlet in a dedicated area having the proper tools and equipment and adequate provisions for maintaining the cleanliness of the reconditioned valves.

4.5 DISASSEMBLY

Suitable wrenches not over 8 inches in length that fit over the packing nut and outlet cap, with a $\frac{3}{8}$ -inch square box end that fits over the valve stem are available from valve manufacturers. With the valve disassembled, its individual components should be inspected for structural cracks, gross corrosion, and other significant damage. It is common practice not to remove the fusible plug from the body on cylinder valves unless there is reason to believe it is defective. The packing rings should be inspected for wear and defects. The packing rings should be replaced when required by the facility's operating procedures.

4.6 CLEANING

There are a number of suitable methods for cleaning metal valve parts, some of which are described as follows. Regardless of the method used, care should be taken to ensure that the components, after cleaning, remain within the dimensional specifications provided by the manufacturer. Components that do not conform to specifications should be condemned.

4.6.1 Steam Cleaning

Do not steam valve bodies that contain fusible plugs.

4.6.2 Detergent

Immerse components in detergent (This process is often used in conjunction with steaming). Do not use ammonia solutions because they cause stress corrosion cracking in valve alloys.

4.6.3 Mechanical

Polish components with a power-driven brush, buffer wheel or bead blaster.

4.6.4 Chemical

Immerse components in an acid bath. Extreme care is necessary to minimize the corrosive and etching effect on the valve body and its components. Also, this method has an environmental impact due to the necessity of waste disposal.

Immerse components in a suitable chlorinated or other non-chlorine reactive solvent. Use these solvents in strict compliance with the manufacturer's safety recommendations. Obtain a material safety data sheet (MSDS) and follow all instructions. Solvent disposal can present environmental problems.

4.7 INSPECTION AND RECONDITIONING

4.7.1 Criteria

After cleaning, the valve body and its components should be inspected again for structural cracks or large material losses. See Appendix C for additional information regarding the inspection of valves for cracks. All components should meet the dimensional guidelines found in the Valve Performance Criteria, Appendix A.

4.7.2 Tools and Gauges

The external (inlet, outlet, and packing nut) threads on the valve body should be examined for structural and corrosive damage, heavy wear, and material loss. For the outlet and packing nut threads there are rethreading dies available from tool and die manufacturers that can be passed over the threads on used valves to remove material buildup. Threaded ring gauges ("Go" and "No Go") are also available from thread-gauge manufacturers to check whether threads are within specification. Inspection gauges should only be used on new or re-died threads, otherwise a false reading may result in the gauging process or the gauge could be damaged. The valve outlet sealing face should be checked for nicks and cracks. If defects are observed, reface the surface until it is smooth and flat, taking care to maintain squareness of the outlet face with the threads, reestablish the lead thread chamfer and do not reduce the full thread minimum length to less than 0.375 inch.

Inspection gauges are also available for inlet threads to check if the thread is within specification. However, these gauges should only be used on new valves. Threads on used valves are inspected visually and may be wire brushed to smooth rough finishes and remove burrs before inspection.

The internal valve body should be inspected closely under a bright light, preferably with some magnification. A device such as that used by physicians to examine eyes, ears, and throats is ideal for this purpose.

The internal bores and threads should be inspected for gross corrosion and material loss. Inspection gauges are available for the internal ACME thread. These gauges will indicate if the threads present are within specification. However, inspection will not always indicate if the threads have corroded. A visual inspection of the ACME thread is also required. The threads closest to the valve seat are the most susceptible to corrosion. Loss of these threads could lead to a loss of engagement when the valve is closed, resulting in a "spinner" (a valve with a stem unable to seal at the valve seat due to thread loss or deterioration). If a spinner condition is present, the valve body must be condemned.

The seat opening in the valve body as manufactured is sharp or nearly sharp. Over time, the sharp edge of the seat will become beveled with repeated closing, especially if excessive torque is applied. As the seat becomes more beveled, the torque required to seal the valve will increase. The seat area of the valve may be reconditioned to restore the sharp edge by refacing. Gauges are available from valve manufacturers that indicate the maximum depth the valve body may be refaced. If refacing requires the seat to be lower than the refacing gauge permits, then the valve must be condemned. Due to the difference in orifice size between the cylinder and ton container valve, there are different reconditioning gauges for use with each container. These reconditioning gauges are also used to determine the maximum distance a stem can be refaced and continue to be used in a reconditioned valve body.

4.8 REASSEMBLY AND INSTALLATION

Assemble valves using new or reconditioned parts that are clean, dry, and in good condition. Trained personnel familiar with the applicable portions of this pamphlet should perform this operation. The area in which the work is done should be clean and have the proper tools and equipment. The valve and its components should be assembled consistent with the Valve Performance Criteria, Appendix A. If non-split packing rings are used, take care that they are not damaged when installing them on the stem. Tighten the packing nut as recommended by the manufacturer, but to not more than 50 foot-pounds. To avoid thread damage, care should be taken when using air tools. Excessive force can increase wear and deformation of the valve and container threads.

4.9 TESTING

Connect the valve inlet to a source of oil-free dry air, nitrogen, or carbon dioxide regulated to 500 psig. With the valve closed and without the outlet cap in place, check for leaks at the valve seat, through the fusible plug, past its threaded connection and through the portion of the valve body below the seat by subjecting the valve to 500 psig pressure for at least one minute. Check for leaks by noting any drop in pressure or by observing bubbles when the valve is immersed in water or subjected to a leak detection solution. If there are any leaks, reject the valve, repair it if possible, and retest it. Next, install an outlet cap, open the valve, and test body integrity and packing to 500 psig as before. As an option, the valve may be pressurized through the outlet with the valve closed and check for leaks at the packing nut connection, through the valve body above the seat and again past the valve seat. If there are any leaks, reject the valve, repair it if possible, and retest it. After testing has been completed, remove the outlet cap and dry the valve thoroughly.

5. **PRESSURE RELIEF DEVICES**

5.1 TYPES

5.1.1 Cylinders

The pressure relief device on a chlorine cylinder is a fusible metal plug in the cylinder valve located below the valve seat. The fusible metal is cast into a shell of Alloy "B" or Alloy "N" (Refer to Valve Performance Criteria, Appendix A). The plug is then screwed into a tapped hole in the valve body. The fusible metal should be designed in accordance with 49 CFR Part 173.301(f).

This relief device is thermally activated to relieve pressure only when subjected to temperatures at or above the melting point of the fusible metal. The device does not provide protection from overfilling or other misuse of the cylinder. Some older valves have fusible metal poured directly into the valve body, but this process is no longer used for new valve construction.

5.1.2 Ton Containers

Ton container valves do not have fusible plugs, but the container itself is equipped with six threaded fusible plugs (See Illustration 111 for a typical configuration): three in each head, spaced approximately 120 degrees apart (See Illustration 197 for a typical configuration). The metric ton container is equipped with four fusible plugs in each head spaced approximately 90 degrees apart. The fusible metal is cast into a shell made typically of Alloy "B" or Alloy "N". The plug is then screwed into a tapped hole in the ton container (See Illustration 197 for a typical configuration). The fusible metal should be designed in accordance with 49 CFR Part 173.301(f). This relief device is thermally activated to relieve pressure only when subjected to temperatures at or above the melting point of the fusible metal. The device does not provide protection from overfilling or other misuse of the container.

5.2 INSPECTION AND RECONDITIONING OF FUSIBLE PLUGS

See Sections 3.7.13 and 3.8.1 for fusible plug inspections. Reconditioning of fusible plugs should be limited to inspection and cleaning, which includes removal of corrosion and minor repairs to damaged threads such as removal of burrs. Do not attempt to refill or repair fusible plugs. Replace fusible plugs if they are faulty or their condition is questionable. If in doubt, replace the fusible plug.

5.3 THREAD SIZES

Cylinder valve fusible plug threads are 1/8-27NGT-MOD (See Illustration 111 for a typical configuration).

Ton container fusible plugs are manufactured 3/4-14NGT(CL)-1 and 1-11 1/2 NGT(CL)-1 threads, which comply with Federal Standard H-28, with four additional versions in both sizes: (CL)-2, 4 threads (or turns) oversize; (CL)-3, 8 1/2 threads oversize; (CL)-4, 14 threads oversize; and (CL)-5, 28 threads oversize.

6. PERIODIC TESTING OF CONTAINERS

DOT and TC regulations require hydrostatic testing at the time of manufacture for chlorine cylinders and ton containers. Fitness for continued service is established by periodic retests required at regular intervals over the life of the cylinder or ton container. Hydrostatic/ultrasonic retesting facilities performing these retests must be DOT or TC approved. Upon expiration of the test period no cylinder or ton container must be filled or transported with product inside without completion of a new test and stamping of retest date.

6.1 FREQUENCY

6.1.1 Cylinders

All chlorine cylinders (except DOT 3E 1800) must be hydrostatically tested every five years from the date of the previous hydro test (49 CFR Parts 100-185). A cylinder may not be filled after it reaches the month and year five years past its last test date.

Retesting is also required after any reheat treatment or if the cylinder shows any signs of weakness, such as a loss in weight of 5% or more (See Section 3.7.1). Additionally, each time a cylinder is retested it must also be visually inspected, internally and externally, in accordance with CGA Pamphlet C-6.

6.1.2 Ton Containers

All ton containers must be hydrostatically tested every five years from the date of the previous hydro test (49 CFR Parts 100-185). A ton container may be filled until the end of the calendar year during which its five-year test is due. Retesting is also required after any reheat treatment or if the ton container shows any signs of weakness, such as a loss in weight of 5% or more (See Section 3.7.1). Retesting is also required when the pressure-bearing portion of a ton container is repaired. Additionally, stress relieving is also required after such repairs have been completed.

6.2 PREPARATION OF CONTAINERS FOR TESTING

6.2.1 Cylinders

Prior to testing, the chlorine cylinder should be cleaned, weighed, and inspected internally and externally in accordance with CGA Pamphlet C-6. The inspection should also include a visual check of the cylinder inlet threads. Cylinders not meeting the requirements of CGA Pamphlet C-6 should be rejected or condemned.

The cylinder must also be free of chlorine residue. To ensure safe removal of any chlorine, the cylinder should be vented to a suitable absorption system or its contents neutralized with a caustic soda solution. See Section 3.9 for details on internal cleaning procedures.

6.2.2 Ton Containers

Prior to testing, the ton container should be cleaned, weighed, and inspected internally and externally. The inspection should also include a visual check of the valve and fusible plug inlet threads.

The ton container must also be free of chlorine residue. To ensure safe removal of any chlorine, the ton container should be vented to a suitable absorption system or its contents neutralized with a caustic soda solution. See Section 3.9 for details on internal cleaning procedures.

6.3 METHODS

6.3.1 Hydrostatic Testing

The two common methods for testing chlorine containers are the water jacket volumetric method and the direct expansion method (See CGA Pamphlet C-1).

Water Jacket Volumetric Expansion Method

When volumetric expansions are required, the water jacket volumetric expansion method is the recommended method for testing compressed gas cylinders. It consists of enclosing the test container filled with water in a jacket vessel, which is also filled with water.

The jacket has the necessary attachments for measuring the volume of water forced from the jacket on application of pressure to the container, as well as the volume remaining on release of the pressure. These volumes represent the total and permanent expansions of the container, respectively. The difference between the total and permanent expansions equals the elastic expansion of the cylinder during the test. In general, an increase in elastic expansion indicates a reduction of average wall thickness.

Direct Expansion Method

Using the direct expansion method, the total expansion is determined by measuring the amount of water forced into a container to pressurize it to a predetermined test pressure, and the permanent expansion is determined by measuring the amount of water expelled from the container when the pressure is released. In general, an increase in elastic expansion indicates a reduction of average wall thickness.

6.3.2 Ultrasonic Testing for Cylinders

DOT has issued several special permits that allow the hydrostatic test to be replaced with ultrasonic testing for steel cylinders only. This special permit does not apply to ton containers, but only to chlorine and certain other steel containers. CI does not maintain a listing of exemption holders.

Hydrostatic testing provides good information about the quality of heat treatment and gross condition of wall thickness, which is useful for quality control during cylinder manufacture. However, the hydrostatic testing does not really provide any information about fatigue cracks or localized thinning due to corrosion or misuse. Such information is more reliably found by ultrasonic methods for thickness gauging and flaw detection. At present, DOT and TC regulations do not permit the use of ultrasonic test methods as an alternative to the hydrostatic test to requalify. However, cylinder users could employ these methods for their internal cylinder evaluation programs. The experience from these programs could be used to petition the regulatory authorities to accept these methods as alternatives to hydrostatic testing for cylinder retesting.

6.4 RETURNING CONTAINERS TO SERVICE

After hydrostatic testing is satisfactorily completed, the water is removed from the container, which is then dried by a dry hot air blast or other suitable means. The container is then inspected internally and externally before returning it to service in accordance with CGA Pamphlet C-6. A pressure test at 100 psig is required after the unit is dried as described in 49 CFR, Part 180.519.

6.5 RECORD KEEPING

A retesting facility must maintain the following records at the facility's location. Review 49 CFR Parts 100-185 for complete up-to-date record-keeping requirements, including:

- Records of authority to inspect and mark containers, and
- Records of visual inspection and hydrostatic retest, which must be maintained until either the expiration of the retest period or until the container is again reinspected or retested, whichever occurs first.

The container manufacturer is required to retain the test report for 15 years from the original test date of the container.

7. **TANK CAR HANDLING**

7.1 RECEIVING TANK CARS

7.1.1 Rail Siding

DOT regulations require that chlorine tank cars must be loaded or unloaded on a private track or siding. Derails and a blue flag must be provided for the open end or ends of the siding. A suitable platform should be provided for safe and easy access to the tank car manway area. Special attention should be given to lighting in the area. Even if night operations are not contemplated, effective lighting should be installed as an aid in dealing with possible night emergencies. Emergency lighting should be available in case of power failure.

7.1.2 Securement and Protection of the Car

Setting Car Brakes

When the tank car has been placed at the desired location on the siding, and before connections to the tank car are made, the hand brake must be set, and the wheels properly chocked. Brake shoes should be in contact with the wheels. A check should be made to ensure the brake is holding.

Placing Derails

During the loading or unloading of a car, measures must be taken to prevent the tank car from being hit or moved by another car or locomotive. This is accomplished by using derails or stops 50 feet or more from both ends of the car. Derails should not be removed for any reason until all cars are disconnected from the loading/unloading rack. If a portable derail is used, it should be properly secured.

Caution Signs/Lights

A tank car positioned for loading or unloading must have caution signs (and/or lights) placed at or near each derail or stop to warn persons approaching the car. Caution signs must remain in place until the operation is completed, all connections removed, and angle valve outlets properly closed with pipe plugs.

Transfer Area Securement

It is recommended that warning signs be posted at the transfer area, and that it be cordoned off as necessary from casual passers by.

7.2 TANK CAR UNLOADING

Chlorine tank cars are unloaded by increasing the pressure in the vapor space above the liquid to a level sufficient to force the liquid chlorine up the eduction pipes and out the liquid angle valves. If the pressure in the tank car is not sufficient to unload the car when received or throughout unloading, the tank may be padded (See Section 7.3).

When unloading a chlorine tank car the safety aspects of the operation should be uppermost in the minds of unloading personnel. The unloader must verify that proper spotting and unloading procedures have been completed before beginning transfer operations. Proper personal protective equipment should be worn during the transfer operation (See CI Pamphlet 65). Safety showers and eyewash facilities should be available. In addition all suppliers' recommendations should be followed during product transfer.

7.2.1 Tank Car Inspection Checklist

An inspection checklist should be used for all aspects of the unloading operation. It should include all recommendations contained in this pamphlet plus any company procedures or special requirements specific to each facility. The checklist documents that proper unloading and securement procedures have been completed. The checklist should be retained for records retention as per company policy. See CI Pamphlet 66 for an example of a typical checklist.

The checklist for procedures to be followed after spotting the tank car should at a minimum include the following items:

- Verify the receiving and spotting procedures have been followed.
- Verify the tank car is loaded with chlorine by careful inspection of the bill of lading or other shipping documents, the reporting marks, the car number, commodity marking, placards and the reported shipping cable seal is intact.
- Open the housing cover and inspecting the manway fittings for evidence of a leak.
- If unloading to a storage tank, verify there is sufficient capacity to receive the chlorine to be transferred.
- Verify the angle valve is fully closed before removing the angle valve plug.

7.2.2 Emergency Shut-Off

Excess flow valves cannot be relied upon as a means of mitigating a hose or piping failure during chlorine transfer. CI Pamphlet 57, Emergency Shut-Off Systems for Bulk Transfer of Chlorine, outlines recommended practices for emergency protection against releases during transfers involving chlorine tank handling systems. The pamphlet illustrates emergency shut-off systems that will quickly bring a release situation under control.

Use of an emergency shut-off system that meets the standards in CI Pamphlet 57 is recommended during the unloading of a chlorine tank car. Use of a proper hose suitable for the transfer of chlorine as recommended in CI Pamphlet 6 should be part of the transfer system.

7.2.3 Connections

Valve Connections

Chlorine tank car angle valves are equipped with a 1 inch pipe plug closure secured to the valve body. This plug should be tightly in place when the car is received and spotted for unloading at the facility. Before any connection is made to a chlorine tank car, all piping should be clean, dry, free of oil, and in-test (See CI Pamphlet 6).

Liquid Valve Connections

To prepare a car for unloading, a threaded nipple made from 1 inch schedule 80 carbon steel (experience has shown that a 15 inch long nipple has been found to be adequate in most circumstances), should be tightly screwed into the tank valve outlet. The threads on the nipple should be standard NPT, sharp and clean and prepared with an appropriate sealant. Teflon® tape (T-tape) can be an effective lubricant/sealant of threaded pipe and plug connections to tank car angle valves if it is applied correctly. If the tape is incorrectly applied to these connections, it can be sucked into the internal components of the car's angle valves if the car is pulled under a vacuum during its preparation for loading, thereby preventing these valves from being able to be completely closed.

To properly apply Teflon® tape to a pipe nipple or a pipe plug to be installed in an angle valve, use a thick grade of tape, i.e., one that meets Military Specification MIL-T-27730A or General Services Administration Commercial Item Description (CID) A-A-58092, and do not wrap the tape past the first thread at the end of the pipe nipple or valve plug. A thread gauge can be used to ensure the acceptability of the threads. The threads should be of a proper length to prevent damage to the valve seat or stem area. Care should be taken when tightening the nipple to prevent undue strain on the valve.

A flexible transfer hose, per recommendations contained in Appendix A of CI Pamphlet 6 or a flexible copper loop, per Illustration 118 (Appendix B), should be provided between the nipple and the process piping to compensate for the rise of the car during unloading. Valve arrangements, incorporating fail safe features as described in CI Pamphlet 57, mounted at the tank car and on the process piping feeding the chlorine to the process or to storage are recommended.

Inspection and Tests

After all connections are made, it is advisable to allow a small amount of chlorine into the system. Each connection, valve packing and flange should then be checked for leaks with ammonia vapors. If a leak is found, it must be corrected before allowing more chlorine into the line.

Vapor from a squeeze bottle containing a 26° Baumé aqua ammonia solution or stronger can be used to detect a minor chlorine release or leak. Weaker solutions may not be concentrated enough to detect minor leaks. It is acceptable to use other concentrations based on successful experience. A white cloud will form if a leak is present.

To avoid corrosion, the aqua ammonia solution should not be directly sprayed onto connections.

Any efforts to detect the source of a leak should be carried out with full consideration for potential hazards. Appropriate personal protective equipment must be used.

7.2.4 Opening Liquid Angle Valves

Each education pipe on the chlorine tank car is equipped with an excess flow valve. The tank car liquid angle valve must be opened slowly until completely open, and left fully open. If opened rapidly, the excess flow valve may close and flow will not occur.

7.2.5 Line Pressurization

A differential pressure must be maintained between the chlorine tank car and the system receiving the chlorine. While slowly opening the tank car liquid angle valve, the pressure gauge located at the beginning of the permanent piping should be observed. A rise in pressure indicates there is liquid flow. The line valve should be in a closed position at this point. As soon as the gauge indicates a steady pressure, the tank liquid angle valve should be opened fully. The line valve should then be opened slowly until the liquid chlorine completely fills the line to the process. The line valve should be opened until the desired flow rate is obtained taking care to ensure the flow does not cause the excess flow valve in the tank car to check.

CAUTION: If liquid chlorine is trapped between two valves, extremely high pressure can develop upon increase in the temperature of the chlorine. Refer to CI Pamphlet 6.

7.2.6 Excess Flow Valve Unseating

With the exception of those cars equipped with pneumatically operated angle/internal check valve combinations, all chlorine bulk transports are equipped with excess flow valves under the liquid angle valves. There may be times, due to opening the angle valve too rapidly or due to unusually high flow rates, the excess flow valve will close. If this occurs, the angle valve on the car should be closed and left closed until the metal ball or plug in the excess flow valve drops back into place. A noticeable click will be heard when it drops. If the ball or plug does not drop, a connection can be made to the other liquid valve on the car. The supplier should be consulted if neither of these two methods is successful.

7.2.7 Monitoring the Unloading

Regulations prior to the issue of HM-223 required that throughout the entire period of unloading, and while the car is connected to the unloading device, the car must be attended by the unloader. CI strongly recommends that, although not required in most cases by current DOT regulation, it is best practice to provide continuous monitoring of unloading operations. If it is necessary to discontinue unloading a tank car for any reason, all valves must be tightly closed and unloading connections disconnected and plugs installed in the tank car valves. Past correspondence from the DOT indicates that "attending" the unloading includes having an employee physically present at the unloading site, electronic monitoring with remote shut-off equipment, television camera monitoring or by any means by which the tank car is monitored and the flow of chlorine can be stopped if unloading difficulties develop. Shippers/receivers have had successful experience utilizing all of these methods.

A number of regulatory exemptions have been issued by the DOT (SP 12443) to permit tank cars containing chlorine to remain standing with unloading connections attached when product is not being transferred. Special provisions must be followed to meet the terms of the DOT special permit including the designation of an employee responsible for on-site monitoring of the transfer facility.

It is anticipated DOT will soon provide additional clarification on the issue of monitoring the unloading of a tank car. It is the responsibility of each unloading site to ensure all applicable regulations are followed.

7.2.8 Leaks During Unloading

Appropriate PPE per CI Pamphlet 65 should always be used and emergency capping equipment must be readily accessible.

Leaks in Connections and Piping

Chlorine piping systems should be pressure tested at regular intervals according to Institute recommendations (See CI Pamphlet 6). Chlorine piping systems should also be inspected at regular intervals for signs of leakage, internal or external corrosion, insulation failure, or

support problems. If a chlorine leak should occur in equipment or piping, the chlorine transfer should be stopped immediately by closing the tank car angle valves, and the unloading line pressure relieved so the necessary repairs can be made. When the leak has been located and the faulty equipment repaired, unloading may be resumed.

Leaks at Tank Car Fittings

Leaks around the tank car angle valve stems can usually be stopped by tightening the packing gland nuts. If this does not stop the leak, the angle valve should be closed. Only if a tank car valve leak cannot be stopped by corrective measures should the capping devices in the Emergency Kit C be used. If the pressure relief device must be capped, regular monitoring of the tank car's internal pressure must be established. The shipper should be advised of the problem as soon as possible.

7.2.9 Determining Amount of Chlorine Unloaded

Where chlorine tank cars cannot be unloaded on track scales, and reliable direct gauging devices are not readily available, the most common practice for estimating the quantity of chlorine remaining in the car is from the consumption records of the quantity removed. The contents should be unloaded to the maximum extent practicable.

7.2.10 Disconnecting

As soon as it is determined that the tank car is as empty as possible, the liquid chlorine manifold header valves should be closed followed by the tank car liquid angle valves, and the transfer hoses emptied, before any other valves in the discharge system are closed.

The unloading lines should then be purged, evacuated and disconnected. This should be done with care to ensure the line has been cleared and chlorine will not be released upon disconnection. Appropriate respiratory personal protective equipment should be worn when disconnecting lines that have contained chlorine.

Liquid chlorine should never be trapped in the discharge line between valves, since extremely high pressure can develop from an increase in the temperature of the chlorine. This pressure may lead to hydrostatic rupture of the line. If the car has been padded, the pad gas supply line should be shut-off, evacuated and disconnected.

7.2.11 Prerelease Check

- Inspect angle valves to ensure they are closed.
- Using aqua ammonia (refer to Section 7.2.3), check for leaks from angle valves with the valves closed and the plugs removed, and from the manway plate and the pressure relief device. All leaks must be eliminated prior to the release of the tank car.
- Using an appropriate wrench thread sealant, tighten the outlet plugs of all angle valves.

- Indicate any unusual condition by applying a tag to any of the valves, describing the condition found.
- Close and secure the protective housing cover. A cable seal of not less than $3/16$ inch thickness should be applied to the protective housing cover locking pin in such a manner that the pin cannot be removed without breaking the seal.
- Check for proper marking and placarding of tank car. Placards must be installed in placard holders in four locations on the car.
- Complete shipping papers.
- Remove derail and make other preparations for tank car removal.
- Notify the railroad agent that the car is empty.
- Refer to 49 CFR 173.31(d) for additional pre-release examination items.

7.3 PRESSURE PADDING

Chlorine tank cars are often unloaded by increasing the pressure in the vapor space above the liquid to a level sufficient to force the liquid chlorine up the eduction pipe and out the liquid angle valves. The process of increasing the pressure in the vapor space is called pressure padding. The reader should refer to CI Pamphlet 66 for a detailed discussion.

7.3.1 Need for Padding

The vapor pressure of chlorine varies with temperature. If more pressure is needed to unload the car, padding of the tank may be necessary. While dry air is commonly used, other suitable, dry, inert gases, such as nitrogen, can be used. To minimize the need for padding, considerations should be given to the following:

- Reducing the pressure at the point of consumption;
- Reducing the pressure drop in the piping system;
- Minimizing the effect of the difference in elevation by using a vaporizer so gas is elevated rather than liquid. Liquid chlorine has a specific gravity of about 1.47, so each foot of liquid chlorine is equivalent to about 0.64 psig. Each foot of gas is equivalent to about 0.005 psig; and/or
- Housing the car in a warm shed to minimize the effect of extremely cold weather.

7.3.2 Air Supply and Drying Requirements

Air Quality

Even small amounts of moisture can cause excessive corrosion to tank car equipment and to piping and handling systems. It is essential the air used for padding be free from oil and

foreign matter and be dried to a dew point of -40°F (-40°C) or below measured at the operating pressure. Chlorine and oil can react to produce heat and under certain conditions, the reaction may create a fire.

Moisture Content

To ensure no moisture is entering the chlorine system, the moisture content of padding air should be continuously monitored when the tank car is connected for padding. This is easily done with a commercially available in-line dew point analyzer with alarm. The dew point of the dry air must always be sampled at the operating pressure, not at atmospheric pressure.

Separate System

Padding air should not be taken from the plant air system, but should come from an independent air compressor used solely for this purpose. In a common system, a heavy demand for air elsewhere can lower the overall system pressure below the tank car pressure; chlorine would then feed back into the air system with probable damage to equipment and danger to personnel. Adequate backflow protection should be utilized to prevent contamination of the padding system.

Air Padding

A suitable air compressor and an ASME Code receiver equipped with the appropriate instrumentation such as pressure gauges and switches, temperature gauges and switches, safety valves, automatic electronic drain valves and automatic pressure controls should be used.

The operating conditions and characteristics of the compressor should be considered when designing the system. For example, operating a typical compressor at 60-70% of maximum design rpms will reduce air outlet temperatures, compressor wear and long term oil carryover.

Greater compressor capacity will be required when padding a tank car manually rather than automatically. This larger capacity requirement should be taken into consideration when purchasing an air compressor system.

Depending on the type of dryer system installed with the compressor, dryer system outlet flow rates may be reduced to 85-90% of the compressor output capacity. This reduction must be considered in the final design. Multiple compressors should be considered for continuous duty.

Special consideration should be given to compressor location. Compressor rooms should be well ventilated. Air inlet filters should be considered to ensure clean air. Silencers should be used to reduce the sound level to acceptable standards. The inlet air supply to the compressor should be drawn from an area that is unlikely to be contaminated with chlorine or other chemical fumes that would quickly corrode and damage the compressor internal components.

Air Dryers

Commercial regenerative-type dryers using activated alumina or silica gel as the desiccant are recommended. They can be obtained with any degree of refinement from manual to fully automatic control. If continuous operation is desired, dual units are necessary. See CI Pamphlet 66 for assistance in calculating the required capacity.

7.3.3 Padding Pressure Considerations

To minimize the increased hazards accompanying air padding, pressures should be kept as low as possible. In any case, the total pressure (the vapor pressure of the chlorine plus the pressure of the air pad) should not exceed 125 psig in tank cars equipped with a 225 psig safety relief device and 200 psig in tank cars equipped with a 375 psig safety relief device.

As the tank car is padded the warm air entering the car will raise the temperature of the liquid chlorine and increase its vapor pressure. The heat will also cause the liquid to expand, thus reducing the vapor space with a resulting increase in the vapor space pressure. The combined effects of expansion of the liquid and increase in its vapor pressure may increase the total pressure enough to open the safety valve. For example, if a full car at 33°F (0.56°C) is padded from the vapor pressure of 40 psig to a total pressure of 125 psig and then allowed to warm up to 88°F (31.1°C), the combined effects of the expansion of the liquid chlorine and increase in its vapor pressure will raise the total pressure above 225 psig and a safety relief device set at that pressure will open. For similar reasons as in the example, most chlorine tank cars in North America are equipped with 375 psig safety relief devices.

It is especially important to prevent buildup of excessive pressure over periods when chlorine is not being withdrawn, such as nights, weekends, and plant vacation periods or shutdowns. Under these circumstances, cars should be inspected routinely for leaks and excessive pressure. If necessary, excessive pressure should be vented to a recovery system.

8. CHLORINE EMERGENCIES

8.1 GENERAL

A chlorine emergency may occur during any phase of a packaging plant's operation. Trained employees along with a comprehensive, written emergency response plan (See Section 10 and CI Pamphlet 64) are necessary to mitigate the consequences of an emergency.

Federal, state, and provincial regulations, as well as various local fire and building codes, regulate chemical emergency preparedness. All persons handling or responsible for the handling of chlorine must be familiar with the contents of those various requirements.

Regulatory requirements deal generally with the preparation for and response to chemical and other emergencies. This section is intended to provide additional information for use in chlorine emergencies. Help is also available from CHLOREP, through CHEMTREC in the United States and through CANUTEC in Canada.

8.2 RELEASES

8.2.1 General

Chlorine facilities should be designed and operated so that risk of a chlorine release into the environment is minimized. However, accidental releases and leaks of chlorine may occur, and so the overall effects of such incidents must be considered.

8.2.2 Detection of Minor Releases and Leaks

A plastic squeeze bottle containing 26° Baumé aqua ammonia can be used to detect a minor release or leak. Weaker solutions may not be concentrated enough to detect minor leaks. It is acceptable to use other concentrations based on successful experience. **WARNING:** Only the ammonia vapor is directed at a leak, never liquid. A white cloud will form indicating the source of the leak. If a laboratory wash bottle is used, the dip tube inside the bottle should be cut off so that squeezing the bottle directs vapor, not liquid, out of the nozzle. Never allow the aqua ammonia solution to come into contact with valves or piping system components. Portable electronic chlorine monitors can also be used to detect leaks.

If a leak occurs in equipment or piping, the chlorine supply should be shut off, the pressure relieved, chlorine evacuated, and necessary repairs made.

The chlorine supplier should be notified of a leak in a tank car.

8.2.3 Types of Releases

Chlorine releases can be classified as either instantaneous (puffs) or continuous. (See CI Pamphlet 74 for details).

Instantaneous Release

An instantaneous release is characterized by the escape of chlorine to the atmosphere in a relatively short period of time (a few minutes), resulting in a cloud that moves across the downwind range while growing in size and decreasing in concentration. Thus, the concentration of chlorine monitored at any given point downwind will vary over time depending on the position of the chlorine cloud.

Continuous Release

A continuous release is characterized by the escape of chlorine to the atmosphere over a long period of time (usually more than 15 minutes), resulting in a continuous plume that reaches an equilibrium size and concentration gradient. Thus, the concentration of chlorine monitored at any given point downwind from the source will be constant over time for the duration of the release. The failure of a valve or fitting on a large container is an example of a continuous release situation.

8.2.4 Physical Form of the Release

Chlorine exists as a gas or liquid depending on the pressure and temperature. Typically, chlorine is stored and transported as a liquid under pressure. Whether the release source is a liquid or gas significantly affects the downwind dispersion because liquid chlorine expands in volume by nearly 460 times when it vaporizes.

During a release, chlorine can escape as a gas, a liquid, or both. When pressurized liquid or gas is released from a container, the temperature and pressure inside the container will decrease, thus reducing the release rate.

Escaping liquid may collect in a pool and may actually form a running stream. Chlorine will immediately cool to its boiling point (-29°F [-34°C]) as it enters the atmosphere. On contact with any heat source (the air, ground, or water) the heat will cause the chlorine to boil readily. Typically, the boil-off rate will be relatively high initially and then decline as the heat source surrounding the chlorine is cooled by the chlorine.

Water in bulk provides a vast heat source for evaporating liquid chlorine. It should be assumed that any liquid chlorine falling into water will vaporize quickly. For this reason, emergency response personnel should try to prevent water from contacting a liquid chlorine pool as well as chlorine flowing into water drains.

8.2.5 Area Affected

The area affected by a chlorine release and the duration of the exposure depends on the total quantity released, the rate of release, the height of the release point, and the weather conditions, as well as the physical form of the chlorine being released. Chlorine downwind can vary from barely detectable to high concentrations. CI Pamphlet 74 provides information on the area affected by specific chlorine-release scenarios.

8.3 RESPONSE TO A CHLORINE RELEASE

8.3.1 Personnel Considerations

As soon as there is any indication of a chlorine release, immediate steps must be taken to correct the condition. Chlorine leaks always get worse if they are not promptly corrected. When a leak occurs, authorized, trained personnel equipped with respiratory and other personal protective equipment (PPE) should investigate and take proper action. Personnel should not enter into atmospheres containing concentrations of chlorine in excess of the immediately dangerous to life and health (IDLH) concentration (10 ppm) without appropriate PPE and back-up personnel. See Section 11 for basic PPE information. CI Pamphlet 65 provides detailed PPE recommendations for responders to a chlorine release.

Keep unnecessary personnel away and isolate the hazard area. Persons potentially affected by a chlorine release should be evacuated or sheltered in-place as circumstances warrant. Area chlorine monitors and wind direction indicators can supply timely information

(e.g., escape routes) to help determine whether personnel are to be evacuated or sheltered in-place. If evacuation is chosen, potentially exposed persons should move to a point upwind of the leak. Because chlorine is heavier than air, higher elevations are preferable. To escape in the shortest time, persons already in a contaminated area should move crosswind.

When inside a building and sheltering in-place is selected, shelter by closing all windows, doors, and other openings (when possible, this includes the taping of cracks, etc), and turning off heating, ventilation and air conditioning systems. Personnel should move to the side of the building farthest from the release.

Because new leaks may occur or the existing leak may get larger, care must also be taken not to position personnel without an escape route.

8.3.2 Corrective Actions

These specific actions may be taken to contain or reduce leaks:

- If chlorine is escaping as a liquid from a container, an attempt should be made to align the container so that only gas will be leaking. In this position, the chlorine release will be greatly minimized.
- If leaks occur around container valve stems or past the packing nut threads, close the valve, then tighten the packing nut.
- If practical, reduce pressure in the container by removing the chlorine gas (not as liquid) to process or a disposal system. **CAUTION:** Do not tighten connections or leaking fittings or attempt other repairs while the system is under pressure (See CGA Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*).
- If simple corrective measures are not sufficient, the appropriate Chlorine Institute Emergency Kit (See Section 8.5) should be applied. If the container is a cylinder it may also be placed in a DOT approved recovery vessel designed to contain the leak.
- If conditions permit, and while employing proper safety techniques and PPE, move the container to an isolated spot where the consequences will be lessened.
- A leaking container must not be immersed or thrown into a body of water; the leak will be aggravated and the container may float when still partially full of liquid chlorine, allowing gas evolution at the surface.

If notification of local authorities is required, the following information should be provided:

- Company name, address, telephone number, and the name of the person(s) to contact for further information;
- Description of the emergency;

- Travel directions to the site;
- Type and size of the container involved;
- Corrective measure(s) being applied; and
- Other pertinent information, such as weather conditions, injuries, etc.

8.4 RESPONSE TO A FIRE

If fire is present or imminent, chlorine containers and equipment should be moved away from fire, if possible. If a non-leaking container or equipment cannot be moved, it should be kept cool by applying water on it.

Water should not be used directly on a chlorine leak. Chlorine and water react to form acids, and the leak will quickly get worse. However, where several containers are involved and some are leaking, it may be prudent to use a water spray to help prevent over pressurization on the non-leaking containers. Whenever containers have been exposed to flames, cooling water should be applied until well after the fire is out and the containers are completely cooled.

8.5 EMERGENCY KITS AND RECOVERY VESSELS

Chlorine Institute Emergency Kits and cylinder recovery vessels are designed to temporarily contain most of the leaks that may be encountered in chlorine shipping containers until the chlorine can be safely transferred to another container. The following are available:

- Kit A for 100- and 150-lb cylinders;
- Kit B for ton containers;
- Kit C for tank cars and tank trucks; and
- Recovery vessels (DOT approved) for cylinders

The kits operate on the principle of containing valve leaks by applying hoods and gaskets. For cylinders and ton containers, patches are provided for sealing off a small hole in the side wall. Capping devices are provided for fusible plugs in ton containers.

Chlorine recovery vessels are commercially available DOT approved equipment designed to hold an entire cylinder. CI Pamphlet IB/RV provides detailed information on recovery vessels for 100- and 150-lb cylinders. A leaking cylinder can be placed in a vessel that is then closed, thus containing the leak. The chlorine can then be recaptured from the recovery vessel.

The U.S. DOT allows chlorine cylinders and ton containers with appropriate Emergency Kit A or B devices installed to be shipped on the highways for transport to a destination for final disposal. See 49 CFR Parts 173.3 for details before shipping.

8.6 REPORTING

Most government agencies have reporting requirements for chlorine releases. Packaging plants must be aware of the reportable quantity (RQ) and of all relevant requirements.

In the United States, any chlorine release of 10 lbs or more, within a 24-hour period not specifically allowed by an operating permit must be reported immediately (within 15 minutes) to the National Response Center (NRC) at 1-800-424-8802 or 202-426-2675, (40 CFR Part 302.6(a) and 49 CFR Part 171.15).

A written follow-up report is required by the U.S. EPA for all RQ releases. The report is usually submitted to the State Emergency Response Committee in a time frame specified by the SERC. Packagers should contact their state emergency services or environmental agency to obtain these requirements.

The Department of Transportation requires all releases of chlorine during transport, loading, unloading or storage to be reported in writing on DOT Form 5800. The DOT specifies no release quantity to trigger written reporting. These reports must be submitted in duplicate within 30 days from the date of the incident (49 CFR Part 171.16).

9. **MEDICAL ASPECTS AND FIRST AID**

9.1 HAZARDS TO HEALTH

9.1.1 General

Chlorine gas is primarily a respiratory irritant. It is so intensely irritating that low concentrations in the air (well below 1 ppm) are detectable by most people. At low concentrations, chlorine gas has an odor similar to household bleach. As the concentrations increase from the level of detection by smell, so does the symptomatology in the exposed individual. At chlorine concentrations above 5 ppm the gas is very irritating, and it is unlikely that any person would remain in such an exposure for more than a very brief time unless the person was trapped or unconscious. The effects of exposure to chlorine may become more severe for up to 36 hours after the incident. Close observation of exposed individuals should be a part of the medical program.

Table 2 lists a compilation of chlorine exposure thresholds and reported responses in humans. It should be noted that there can be a considerable variation in effect among subjects.

Table 2: Chlorine Exposure Thresholds and Effects¹	
Exposure Level (ppm)	Effect
0.2 - 0.4	Odor threshold (decrease in odor perception occurs over time)
Less than 0.5	No known acute or chronic effect.
0.5	TLV-TWA, REL-Ceiling
1	PEL-Ceiling, TLV-STEL, ERPG-1
1 – 3	Mild, mucous membrane irritation, tolerated up to 1 hour
5 - 15	Moderate irritation of the respiratory tract
3	ERPG-2
10	IDLH
20	ERPG-3
30	Immediate chest pain, vomiting, dyspnea, cough
40 - 60	Toxic pneumonitis and pulmonary edema
430	Lethal over 30 minutes
1000	Fatal within a few minutes

¹CI Pamphlet 63

CI Pamphlet 63 provides detailed information concerning:

- The health hazards of chlorine;
- First aid including the administration of oxygen;
- Medical Management of Chlorine Exposures subsequent to first aid;

- Recommended medical surveillance program for persons potentially exposed to chlorine; and
- Recommended occupational hygiene and exposure assessment monitoring for individuals working with or around chlorine.

In addition, the Institute has developed a video, *Health Effects from Short-Term Chlorine Exposure* (H-DVD).

9.2 FIRST AID

First aid is the immediate temporary treatment given to an exposed individual. Prompt action is essential. Reassurance to the individual will help to alleviate anxiety. When indicated, medical assistance must be obtained as soon as possible. **WARNING:** Effects of chlorine exposure may be delayed. Caution is advised. Chlorine is corrosive and will be converted to hydrochloric acid in the lungs.

Responders should take the necessary precautions to protect themselves from any exposure to chlorine while administering first aid and should move the victim from any contaminated area as quickly as possible.

9.2.1 Inhalation Exposure

See CI Pamphlet 63 and the chlorine gas label for inhalation first aid instructions. At a minimum, move the victim to fresh air. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health care facility.

9.2.2 Dermal/Eye Exposure

See CI Pamphlet 63 and the chlorine gas label for detailed dermal/eye first aid instructions. At a minimum, remove victims from exposure. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support. Remove contaminated clothing as soon as possible. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 - 20 minutes. Wash exposed skin areas for at least 15 - 20 minutes with soap and water. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures. Transport to a health care facility.

9.2.3 Ingestion

See CI Pamphlet 63 and the chlorine gas label for detailed ingestion first aid instructions.

10. EMERGENCY PLANNING AND EMPLOYEE SAFETY TRAINING

10.1 PLANNING

10.1.1 Hazard Communication

A packaging plant must have a hazard communication plan in place in order to satisfy OSHA's Hazard Communication Regulation 29 CFR Part 1910.1200. The plan must be developed, implemented, and maintained as a written hazard communication program. Every member of the management team should be familiar with the location of this document so that he or she can readily access it in the event of an emergency or an audit.

The plan should include the following elements:

- Provisions for providing employees with effective information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new physical or health hazard the employees have not been previously trained about, is introduced to the work area.
- Explanations of labeling requirements. Each container must be properly labeled with the appropriate hazard warning. The warning should include the name of the material and the hazards involved, and safety precautions in reference to the MSDS for more detailed information.
- Management of MSDS. The material safety data sheets for each material are to be provided by the manufacturer of that material, and they must be available to the employee in the workplace.
- Provide a list of hazardous chemicals known to be present using an identity reference on the appropriate MSDS.
- Methods for informing employees of the hazards of non-routine task and the hazards associated with chemicals contained in unlabeled pipes in the work area.

A written hazardous communication program must be made available to all employees, or their designated authorized representative, upon request.

10.1.2 Emergency Response Plan

A packaging plant must have an emergency response plan, which may be part of the contingency plan for the facility. The written plan should include details regarding the following:

- Pre-emergency planning and coordination with outsiders;
- Personal roles, lines of authorities, and communication; and
- Evacuation procedures, site control, and places of refuge.

For more detailed information, see CI Pamphlet 64.

10.2 TRAINING

10.2.1 General

Training is needed for packaging plant employees for two distinct reasons: to ensure the safety of the employees and to comply with the laws requiring such training. This section describes some of the chlorine specific training necessary for employees.

Job Specific Elements

Each employee involved in operating chlorine process equipment is to be trained in the overview of that process. The training should emphasize specific safety and health hazards, emergency operations, and safe work practices applicable to the employee's job tasks. Training topics include, but are certainly not limited to:

- Chlorine physical properties and hazards;
- Health hazards;
- Container construction and inspection;
- Container transportation;
- Connecting and disconnecting containers and tank cars;
- Chlorine leaks;
- Personal protective equipment and first aid;
- Emergency procedures; and
- Coordination with outside emergency responders.

Refresher Training

Refresher training is to be provided every three years, and more often if necessary, for each employee involved in the chlorine process operations.

10.2.2 Personal Protective Equipment

A personal protective equipment (PPE) program is required by 29 CFR Part 1910.132. Employers are required to conduct a hazard assessment of the workplace and define applicable PPE to be worn by the employees. A written program must be developed to certify that this hazard assessment has been completed. Employees, in the absence of a suitable, economical engineering control to mitigate the hazard, are to be trained regarding the following:

- When the use of PPE is necessary;
- What PPE are necessary;

- How to properly put on, take off, adjust and wear PPE; and
- The proper care, maintenance, useful life, and disposal of the PPE.

Retraining of employees must be conducted in the following situations:

- When changes in the workplace render the previous training obsolete;
- When changes in the types of PPE to be used render the previous training obsolete; or
- When it becomes obvious that an employee has not retained the required understanding or skills necessary to use the prescribed PPE.

All training is to be documented. The training record must include:

- Name of the employee;
- Date of training;
- Identification of training subject matter; and
- Written certification that the employee received and understood the training.

See Section 11 for additional information about PPE.

10.2.3 Emergency Responder Training

The type of training needed for an emergency responder varies as to the level of responsibility of that responder, per 29 CFR Part 1910.120(q). There are seven types of responders requiring different types or amount of training:

1. First Responder, Awareness Level: a person who may discover the problem and who will only notify the proper authorities; requires understanding of the materials, including their risks, and of how to secure the site and of whom to notify.
2. First Responder, Operations Level: a person involved in the initial response to a release or potential release of hazardous substance for the purpose of protecting nearby persons, the environment, or property from the effects of the release. This person responds defensively to contain the release from a safe distance, keeps it from spreading, and prevents exposures without trying to actually stop the release. This level requires eight hours of training, including awareness-level topics.
3. Hazardous Materials Technician: a person who aggressively responds to leaks to try to stop the release by plugging or patching; requires 24 hours of training, including operations-level topics.

4. Hazardous Materials Specialist: a person having specific knowledge about the products involved in the emergency, who supports the technician, and who may also act as the site liaison with federal, state, local, and other government authorities regarding site activities. This level requires 24 hours of training equal to technician-level competency.
5. On-Site Commander: a person who directs and coordinates all aspects of the emergency response; requires 24 hours of training equal to operational-level competency, plus competency in implementing and directing emergency responses.
6. Skilled Support Personnel: persons who are skilled in operating specialized equipment; requires pre-entry briefing.
7. Specialized Employees: persons who work regularly with the products involved in the emergency and who may be called on to provide technical advice or assistance; requires annual training and competency in the area of specialization.

Employees must be provided with annual refresher training of sufficient duration to maintain the skill levels that are necessary. This training must be documented.

Recordkeeping

All emergency responder training must be documented. Written documentation must include:

- Employee's Name;
- Course Title;
- Course Date;
- Statement that the employee has successfully completed the course;
- Name and address of person or organization providing the training;
- An individual identification number for the document or certificate; and
- A list of the levels or personal protective equipment used by the employee to complete the course.

All emergency responder training documentation is to be maintained for a minimum of five years.

10.2.4 HAZMAT Transportation Training

According to 49 CFR Subpart H, Parts 172.700-704, employees affecting the transportation of hazardous material (HAZMAT) must be trained in four areas:

1. *General awareness and familiarization.* Employees must receive training designed to provide familiarity with the requirements of the Hazardous Material Regulation (HMR) and to enable the employee to recognize and identify hazardous materials consistent with the DOT's hazard communication standard.
2. *Function-specific training.* Each employee must receive function-specific training concerning regulatory requirements that are applicable to his or her job functions.
3. *Safety training.* Each employee must receive safety training concerning his or her job, (i.e. hazardous communication, personal protective equipment, emergency action, etc.).
4. *Security Training.* Each employee must receive training that provides an awareness of security risks associated with hazardous material transportation and methods designed to enhance transportation security. The training must also include how to recognize and respond to possible security threats, as well as company organization security structure, specific security objectives and procedures, actions to be taken in the event of a security breach, and employee responsibilities.

Employees requiring training include, but are not limited to, supervisors, tank car unloaders, ton and cylinders loaders, hydrostatic testers, visual inspections, plant personnel loading and unloading the transport vehicles, drivers and dispatchers.

All training is to be documented. The training record must include:

- Employee's name;
- Training date;
- Description, copy or location of training materials used;
- Name and address of person providing the training; and
- Certification that the employee has been trained and tested.

Refresher Training

All hazmat employees must receive refresher training at least once every three years.

11. PERSONAL PROTECTIVE EQUIPMENT

11.1 AVAILABILITY AND USE

Exposure to chlorine can occur whenever chlorine is handled. Personal protective equipment (PPE) must be provided for employee use for specific job tasks. PPE for emergency use must be available for employee use away from areas of likely contamination during an emergency event. If chlorine is handled in widely separated locations, PPE for emergency use should be available near each area.

CI Pamphlet 65 provides recommendations on PPE for specific tasks including loading and unloading, initial line entry, material sampling, and emergency response.

11.2 RESPIRATORY EQUIPMENT

All personnel entering areas where chlorine is stored or handled should carry or have immediately available an emergency escape respirator.

Respiratory equipment should be selected based on evaluation of hazards and degree of potential exposure. For selection considerations as well as other requirements, please refer to the hazard assessment that was developed for your facility or see CI Pamphlet 65.

11.3 OTHER PPE

The facility should also specify other PPE requirements that are site specific and protect against other hazards that may be encountered on the job. For selection considerations as well as other requirements, please refer to the hazard assessment that was developed for your facility or see CI Pamphlet 65.

11.4 OTHER SAFETY EQUIPMENT

There should be emergency eyewash and deluge shower stations located throughout the facility. Each station should be close to any potential exposure zones, but not so close to the potential source as to be unusable in an emergency do to contamination. Please see OSHA 29 CFR and ANSI Z358.1 for detailed requirements.

12. KEY REGULATIONS AND CODES

Regulations change and current editions of the various *Code of Federal Regulations* (CFR) documents should be reviewed periodically. Both the text and section numbers tend to change.

The following are known federal regulations that impact chlorine packaging facilities, but should not be considered a complete listing. This document does not deal with the more general regulations with which any type of business must be concerned.

12.1 U.S. OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION: 29 CFR

Part 1904, Record Keeping Requirements

Part 1910.20, Access to Exposure and Medical Records

Part 1910.38, Emergency Action Plans

Part 1910.95, Occupation Noise Exposure

Part 1910.119, Process Safety Management of Highly Hazardous Chemicals

Part 1910.120, Hazardous Waste Operations and Emergency Response

Parts 1910.132 to 1910.139, Personal Protective Equipment

Part 1910.146, Confined Space

Part 1910.147, Control of Hazardous Energy (Lockout/Tag-out)

Part 1910.151, First Aid/Medical Service

Part 1910.154, Fire Extinguishers

Part 1910.178, Fork Trucks

Part 1910.1000, Air Contaminants

Part 1910.1200, Hazard Communication

12.2 U.S. ENVIRONMENTAL PROTECTION AGENCY: 40 CFR

Part 68, Clean Air Act/Accidental Releases

Part 150-159, Pesticide Registration and Classification Procedures

Parts 302 and 355, Release of Hazardous Substances, Emergency Planning, and Notification

Parts 307 and 372, Hazardous Chemicals Reporting: Community Right to Know

Parts 700 to 799, Toxic Substance Control Act (Record keeping and reporting for various chemical substances)

12.3 U.S. DEPARTMENT OF TRANSPORTATION: 49 CFR

Part 171, General Information, Regulations and Definitions

Part 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, Training and Security Requirements (Shipping papers, marking, labeling, and placarding, as well as the training of hazmat employees and security program development)

Part 173, Shippers (General requirements for shipping and packaging; definitions of hazardous materials for transportation purposes; requirements for container inspections, testing, and retesting)

Part 174, Carriage by Rail (Transport, loading and unloading of railcars)

Part 177, Carriage by Public Highway (Handling, transportation, loading and unloading, and segregation of hazardous materials)

Part 178, Specifications for Packaging (Specifications for cylinders, portable tanks, and cargo tanks)

Part 180, Continuing Qualifications and Maintenance of Packaging (Qualifying existing cargo tanks for hazardous materials)

12.4 U.S. DEPARTMENT OF HOMELAND SECURITY: 6 CFR

Part 27, Chemical Facility Anti-Terrorism Standards

12.5 LOCAL REGULATIONS: FIRE CODES AND BUILDING CODES

Numerous fire and building codes affect chlorine production, storage, packaging, distribution, and use. Code requirements may include, but are not limited to, minimum separation distance between classes of chemicals, design of piping systems, secondary containment, need for treatment systems or gas detectors, emergency response requirements, and the need for sprinklers.

To properly address these codes, the local government (e.g., city or county) should be contacted. Determine what specific fire and building codes, including the code year, were passed by the governing jurisdiction.

Some local or state authorities develop their own codes. However, many jurisdictions adopt a model code or reference National Fire Protection Association (NFPA) Standards. Either of these may serve as the local code(s).

The model codes are modified annually and yearly supplements are issued. Completely new editions of the codes are published every third year. Therefore, the code year is important in determining which code is applicable. The specific requirements are contained in the applicable code.

The National Fire Protection Associations (NFPA) and the International Code Council (ICC) can provide all of the major model building and fire codes:

National Fire Protection Association
1 Battery March Park
P.O. Box 9101
Quincy, MA 02169-7471
Phone: (800) 344-3555
<http://www.nfpa.org/>

International Code Council
Phone: (888) 422-7233
<http://www.iccsafe.org/>

12.6 KEY CANADIAN REGULATIONS

Transport Canada, The Transportation of Dangerous Goods Act and Regulations (published by and obtainable from the Department of Supply and Services, Canadian Government Publication Center, Ottawa, Ontario, Canada. <http://www.tc.gc.ca/>

WHMIS, Hazardous Products Act, Controlled Products Regulations (published by and obtainable from the Department of Supply and Services, Canadian Government Publication Center, Ottawa, Ontario, Canada)

13. REFERENCES

The following sections provide detailed bibliographic information on the Chlorine Institute publications and other documents.

13.1 CHLORINE INSTITUTE REFERENCES

The following publications are specifically referenced in CI Pamphlet 17. The latest editions of CI publications may be obtained at <http://www.chlorineinstitute.org>.

<u>Pamphlet & DVD #</u>	<u>Title</u>
6	<i>Piping Systems for Dry Chlorine</i> , ed. 15; Pamphlet 6; The Chlorine Institute: Arlington, VA, 2005 .
57	<i>Emergency Shut-Off Systems for Bulk Transfer of Chlorine</i> , ed. 5-R1; Pamphlet 57; The Chlorine Institute: Arlington, VA, 2009 .
63	<i>First Aid, Medical Management / Surveillance and Occupational Hygiene Monitoring Practices for Chlorine</i> , ed. 7; Pamphlet 63; The Chlorine Institute: Arlington, VA, 2003 .
64	<i>Emergency Response Plans for Chlor-Alkali, Sodium Hypochlorite, and Hydrogen Chloride Facilities</i> , ed. 6-R1; Pamphlet 64; The Chlorine Institute: Arlington, VA, 2008 .
65	<i>Personal Protective Equipment for Chlor-Alkali Chemicals</i> , ed. 5; Pamphlet 65; The Chlorine Institute: Arlington, VA, 2008 .
66	<i>Recommended Practices for Handling Chlorine Tank Cars</i> , ed. 4-R1; Pamphlet 66; The Chlorine Institute: Arlington, VA, 2009 .
73	<i>Atmospheric Monitoring Equipment for Chlorine</i> , ed. 7; Pamphlet 73; The Chlorine Institute: Arlington, VA, 2003 .
74	<i>Guidance on Complying with EPA Requirements Under the Clean Air Act by Estimating the Area Affected by a Chlorine Release</i> , ed. 4-R1; Pamphlet 74; The Chlorine Institute: Arlington, VA, 2006 .
76	<i>Guidelines for the Safe Motor Vehicular Transportation of Chlorine Cylinders and Ton Containers</i> , ed. 4; Pamphlet 76; The Chlorine Institute: Arlington, VA, 2007 .
89	<i>Chlorine Scrubbing Systems</i> , ed. 3-R1; Pamphlet 89; The Chlorine Institute: Arlington, VA, 2008 .
95	<i>Gaskets for Chlorine Service</i> , ed. 4; Pamphlet 95; The Chlorine Institute: Arlington, VA, 2008 .

<u>Pamphlet & DVD #</u>	<u>Title</u>
100	<i>Dry Chlorine: Definitions and Analytical Issues</i> , ed. 3; Pamphlet 100; The Chlorine Institute: Arlington, VA, 2002 .
H-DVD	<i>Health Effects from Short-Term Chlorine Exposure</i> ; H-DVD; The Chlorine Institute: Arlington, VA, 2006 .
Security	<i>Security Management Plan for the Transportation and On-Site Storage and Use of Chlorine Cylinders, Ton Containers and Cargo Tanks</i> ; The Chlorine Institute: Arlington, VA, 2003 .

13.2 OTHER REFERENCES

The following documents are specifically referenced in Pamphlet 17.

Industrial Ventilation: A Manual of Recommended Practice
American Conference of Governmental Industrial Hygienists
1330 Kemper Meadow Drive
Cincinnati OH 45240
<http://www.acgih.org/>

CGA Pamphlet C-1, Methods for Hydrostatic Testing of Compressed Gas Cylinders
Compressed Gas Association, Inc.
4221 Walney Road, 5th Floor
Chantilly, VA 20151
<http://www.cganet.com/>

CGA Pamphlet C-6, Standards for Visual Inspection of Steel Compressed Gas Cylinders
Compressed Gas Association, Inc.
4221 Walney Road, 5th Floor
Chantilly, VA 20151
<http://www.cganet.com/>

CGA Pamphlet P-1, Safe Handling of Compressed Gases in Containers
Compressed Gas Association, Inc.
4221 Walney Road, 5th Floor
Chantilly, VA 20151
<http://www.cganet.com/>

CGA Pamphlet S-1.1, Pressure Relief Device Standards - Part 1 - Cylinders for Compressed Gases
(Different editions of this pamphlet are referenced by DOT and OSHA regulations)
Compressed Gas Association, Inc.
4221 Walney Road, 5th Floor
Chantilly, VA 20151
<http://www.cganet.com/>

CGA Pamphlet V-1, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

(This pamphlet is also designated as ANSI B57.1 and CSA B96.)

Compressed Gas Association, Inc.

4221 Walney Road, 5th Floor

Chantilly, VA 20151

<http://www.cganet.com/>

CGA Pamphlet V-9, Standard for Compressed Gas Cylinder Valves

Compressed Gas Association, Inc.

4221 Walney Road, 5th Floor

Chantilly, VA 20151

<http://www.cganet.com/>

13.3 OTHER RECOMMENDED READING AND VIEWING

The following Chlorine Institute pamphlets and other documents, though not specifically referenced in Pamphlet 17, may be of additional help to the reader. These CI documents as well as the complete CI catalog may be obtained at <http://www.chlorineinstitute.org/>.

<u>Pamphlet & DVD #</u>	<u>Title</u>
1	<i>Chlorine Basics</i> (Formerly <i>The Chlorine Manual</i>), ed. 7; Pamphlet 1; The Chlorine Institute: Arlington, VA, 2008 .
5	<i>Bulk Storage of Liquid Chlorine</i> , ed. 7; Pamphlet 5; The Chlorine Institute: Arlington, VA, 2005 .
9	<i>Chlorine Vaporizing Systems</i> , ed. 6; Pamphlet 9; The Chlorine Institute: Arlington, VA, 2002 .
49	<i>Recommended Practices for Handling Chlorine Bulk Highway Transports</i> , ed. 9; Pamphlet 49; The Chlorine Institute: Arlington, VA, 2009 .
82	<i>Recommendations for Using 100 and 150 Pound Chlorine Cylinders at Swimming Pools</i> , ed. 2; Pamphlet 82; The Chlorine Institute: Arlington, VA, 2008 .
85	<i>Recommendations for Prevention of Personnel Injuries for Chlorine Producer and User Facilities</i> , ed. 4; Pamphlet 85; The Chlorine Institute: Arlington, VA, 2005 .
87	<i>Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Tank Cars</i> , ed. 3; Pamphlet 87; The Chlorine Institute: Arlington, VA, 2005 .

<u>Pamphlet & DVD #</u>	<u>Title</u>
88	<i>Recommended Practices for Handling Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic) Cargo Tanks</i> , ed. 2; Pamphlet 88; The Chlorine Institute: Arlington, VA, 2001 .
91	<i>Checklist for Chlorine Packaging Plants, Chlorine Distributors, and Tank Car Users of Chlorine</i> , ed. 3; Pamphlet 91; The Chlorine Institute: Arlington, VA, 2006 .
94	<i>Sodium Hydroxide Solution and Potassium Hydroxide Solution (Caustic): Storage Equipment and Piping Systems</i> , ed. 3; Pamphlet 94; The Chlorine Institute: Arlington, VA, 2007 .
96	<i>Sodium Hypochlorite Manual</i> , ed. 3-R1; Pamphlet 96; The Chlorine Institute: Arlington, VA, 2008 .
98	<i>Recommended Practices for Handling Hydrochloric Acid in Tank Cars</i> , ed. 3-R2; Pamphlet 98; The Chlorine Institute: Arlington, VA, 2007 .
152	<i>Safe Handling of Chlorine Containing Nitrogen Trichloride</i> , ed. 2; Pamphlet 152; The Chlorine Institute: Arlington, VA, 2005 .
155	<i>Water and Wastewater Operators Chlorine Handbook</i> , ed. 2; Pamphlet 155; The Chlorine Institute: Arlington, VA, 2008 .
162	<i>Generic Risk Management Plan for Chlorine Pkg Plants & Sodium Hypochlorite Production Facilities</i> , ed. 2-R1; Pamphlet 162; The Chlorine Institute: Arlington, VA, 2004 .
163	<i>Hydrochloric Acid Storage and Piping Systems</i> , ed. 2; Pamphlet 163; The Chlorine Institute: Arlington, VA, 2006 .
164	<i>Reactivity and Compatibility of Chlorine and Sodium Hydroxide with Various Materials</i> , ed. 2; Pamphlet 164; The Chlorine Institute: Arlington, VA, 2007 .
167	<i>Learning From Experience</i> , ed. 1; Pamphlet 167; The Chlorine Institute: Arlington, VA, 2002 .
IB/A	<i>Instruction Booklet: Chlorine Institute Emergency Kit A for 100-lb and 150-lb Chlorine Cylinders</i> , IB/A; The Chlorine Institute: Arlington, VA, 2009 .
IB/B	<i>Instruction Booklet: Chlorine Institute Emergency Kit B for Chlorine Ton Containers</i> , IB/B; The Chlorine Institute: Arlington, VA, 2009 .
IB/C	<i>Instruction Booklet: Chlorine Institute Emergency Kit C for Chlorine Tank Cars and Tank Trucks</i> , IB/C; The Chlorine Institute: Arlington, VA, 2009 .

<u>Pamphlet & DVD #</u>	<u>Title</u>
IB/RV	<i>Instruction Booklet: Chlorine Institute Recovery Vessel for 100-lb and 150-lb Chlorine Cylinders</i> , IB/RV; The Chlorine Institute: Arlington, VA, 2009 .
P-DVD	<i>Packager Training Program</i> , P-DVD; The Chlorine Institute: Arlington, VA, 2001 .
WC-1	<i>Wall Chart: Handling Chlorine Cylinders and Ton Containers</i> , WC-1; The Chlorine Institute: Arlington, VA, 2001 .
W-DVD	<i>Chlorine Safety for Water and Wastewater Operators</i> , W-DVD; The Chlorine Institute: Arlington, VA, 2009 .

APPENDIX A

**PERFORMANCE CRITERIA FOR
NEW CHLORINE CYLINDER AND TON CONTAINER VALVES
May 22, 2008**

Performance Criteria	Supplemental Information and Notes
A. PERFORMANCE	
1. Flow - Minimum C_v	
Cylinder 0.7 Ton Container 0.85 (at 360° open) 1.2 (at full open)	Cylinder charging and discharge rates and evacuation times are affected by the flow capacity of the cylinder valve. Determine C _v of valve by flow test and formula per CGA Pamphlet V-1. See CGA Pamphlet V-9 for qualifying test and qualifying test sample.
2. Operating Temperature	
No visual evidence of leakage, deformation or damage after two opening/closing cycles	See CGA Pamphlet V-9 for low/high temperature operation test.
3. Storage Temperature	
No visual evidence of leakage, deformation or damage after two opening/closing cycles.	See CGA Pamphlet V-9 for low/high temperature storage test.
4. Leakage	
Leak integrity should be demonstrated by using procedures and meeting the standards as specified in CGA Pamphlet V-9.	
5. Proof Pressure	
Proof pressure should be demonstrated by using procedures and meeting the standards as specified in CGA V-9.	

¹ CGA V-9: Compressed Gas Association Standard for Compressed Gas Cylinder Valves

Performance Criteria	Supplemental Information and Notes								
6. Burst Pressure									
Burst pressure should be demonstrated by using procedures and meeting the standards as specified in CGA V-9.									
7. Endurance									
Endurance should be demonstrated by using procedures and meeting the standards as specified in CGA V-9.									
8. Maximum Opening/Closing Torque									
<table border="1"> <thead> <tr> <th data-bbox="103 842 164 869"><u>Test</u></th> <th data-bbox="488 842 591 869"><u>Inch-lbs</u></th> </tr> </thead> <tbody> <tr> <td data-bbox="103 877 451 905">Maximum Opening Torque</td> <td data-bbox="488 877 537 905">150</td> </tr> <tr> <td data-bbox="103 913 451 940">Maximum Closing Torque</td> <td data-bbox="488 913 537 940">150</td> </tr> <tr> <td data-bbox="103 949 269 976">Over Torque</td> <td data-bbox="488 949 537 976">300</td> </tr> </tbody> </table>	<u>Test</u>	<u>Inch-lbs</u>	Maximum Opening Torque	150	Maximum Closing Torque	150	Over Torque	300	Maximum opening and closing torque should be demonstrated by using procedures and meeting the standards as specified in CGA Pamphlet V-9.
<u>Test</u>	<u>Inch-lbs</u>								
Maximum Opening Torque	150								
Maximum Closing Torque	150								
Over Torque	300								
B. DESIGN									
1. Valve Inlet Connection									
<p>Cylinder valve inlet connection should be in conformance with one of the ¾-14NGT(CL) thread series in Federal Standard H28 and CGA Pamphlet V-1.</p> <p>Ton container valve inlet connection should be in conformance with one of the ¾-14NGT(CL) thread series in Federal Standard H28 and CGA Pamphlet V-1 or with one of the 1-11½NGT(CL) thread series in the following table:</p>	<p>To accommodate cylinder or ton container thread wear, oversize threads can be used (e.g. ¾-14NGT(CL)-2 through ¾-14NGT(CL)-5 threads).</p> <p>See CI Pamphlet 17, Sections 3 and 4, for more information related to valve inlet connections and thread sizes.</p>								

Performance Criteria	Supplemental Information and Notes
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INLET THREAD DIMENSIONS, VALVE BODY	1-11 ½NGT(CL)-X (X=1,2,3,4, OR 5)				
	SIZE 1	SIZE 2	SIZE 3	SIZE 4	SIZE 5
SMALL END - MAJOR DIA.	1.2832	1.3049	1.3294	1.3592	1.4352
SMALL END - PITCH DIA.	1.2136	1.2353	1.2598	1.2896	1.3656
SMALL END 45° CHAMFER (MIN. DIA.)	1.1250	1.1467	1.1712	1.2010	1.2770
FULL EFFECTIVE THREADS PITCH DIA.	1.2712	1.2929	1.3174	1.3472	1.4232
LARGE END - MAJOR DIA. APPROX.	1.3457	1.3674	1.3919	1.4217	1.4977
HAND TIGHT ENGAGEMENT (NOMINAL)	0.4000				
FULL EFFECTIVE THD. LENGTH (ALL SIZES)	0.9217 (10.6 THREADS)				
OVERALL THREAD LENGTH (ALL SIZES)	1.0000				

2. Valve Outlet Connection

Valve outlet connection should be in conformance with CGA 820 or CGA 820C.	See CGA Pamphlet V-1 and CI Illustrations 131 and 189.
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3. Operation

a. Minimum Torque to Failure

The valve and stem must withstand a minimum closing torque of 900 in-lbs without structural failure.	See CGA Pamphlet V-9 torque testing guidelines.
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b. Valve Stem Wrench Connection

The valve stem must have a 3/8 inch wrench square.	This will allow the use of current wrenches for opening and closing the valve. Handles to be avoided so as not to interfere with attached hardware and safety closure operations.
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c. Open Position of Valve Stem

Stem travel height should be limited to 1/8 inch for the 360° rotation.	
---	--

Performance Criteria	Supplemental Information and Notes
d. Maximum Dimension of Outlet to Valve Stem End	
<p>1. Maximum dimension from "centerline of valve outlet" to "end of valve stem" when at minimum C_v to be 2.835".</p> <p>2. Maximum width of valve at centerline of outlet to be 1.125".</p>	<p>Additional distance from centerline to stem end will interfere with some dispensing equipment and prevent access with valve wrench.</p> <p>Additional width will interfere with discharge hardware and controls.</p>
4. Maintenance/Replacement of Parts	
<p>Design to provide for ease of maintenance and replacement of parts.</p>	<p>Recommend that maintenance be done in accordance with CGA Pamphlet V-9.</p> <p>This refers to the component parts that form the pressure boundary between the wetted and non-wetted parts of the valve.</p> <p>Included are such components as bonnets, packing nuts, packing, washers, diaphragms, o-rings, packing rings and packing followers.</p> <p>The design of the valve closure systems should provide for easy maintenance and replacement of parts.</p>
5. Pressure Relief Devices - Fusible Plug	
<p>Melt temperature: Reference 49 CFR Part 173.301(f)</p>	

Performance Criteria	Supplemental Information and Notes
6. Materials	
<p>Valve must be chemically compatible with dry chlorine gas and liquid. Valve must be able to meet all engineering requirements.</p>	<p>The following materials have been used successfully in the chlorine industry; however, it is not inclusive of all materials that may be qualified for this application.</p> <ul style="list-style-type: none"> • Aluminum Silicon Bronze, C64210 • Naval Brass, C48500, C46400, C48200 • Brass, C36000 - in non-wetted areas only • Monel, UNS N04400 • Teflon®, Virgin PTFE • Garlock 6130 <p>Sample testing should be done to determine susceptibility to stress corrosion cracking. Examples of appropriate test standards for copper alloy parts are:</p> <ul style="list-style-type: none"> • ASTM B858 Standard Test Method for Ammonia Vapor Test for Determining Susceptibility to Stress Corrosion Cracking in Copper Alloys • ASTM B154 Standard Test Method for Mercurous Nitrate Test for Copper Alloys • ISO 6957 Copper Alloys - Ammonia Test for Stress Corrosion Resistance <p>For definition of dry chlorine reference CI Pamphlet 100 - <i>Dry Chlorine: Definitions and Analytical Issues</i>.</p> <p>Reference CGA Pamphlet V-9.</p> <p>Reference CI Pamphlet 164 – <i>Reactivity and Compatibility of Chlorine and Sodium Hydroxide with Various Metals</i> – This pamphlet should be used only for an initial review. Designers should reference other sources for final design criteria.</p>
7. Markings	
a. General	
<p>Mark as per CGA Pamphlet V-9.</p>	

Performance Criteria	Supplemental Information and Notes
b. Inlet Thread Size	
<p>To indicate (CL)- size.</p> <p>Markings for oversize inlet threads should be as follows:</p> <ol style="list-style-type: none"> 1. Standard size threads shall be marked (CL)-1. 2. Oversize Inlets that are 4 threads oversized should be marked (CL)-2. 3. Oversize Inlets that are 8-½ threads oversized should be marked (CL)-3. 4. Oversize Inlets that are 14 threads oversized should be marked (CL)-4. 5. Oversize Inlets that are 28 threads oversized should be marked (CL)-5. <p>Other oversize inlets should be marked accordingly.</p>	<p>See Federal Standard H-28/9 or CGA Pamphlet V-1 for marking specifications.</p>
c. Other Markings	
<p>At manufacturer's discretion.</p>	<p>At the manufacturer's or user's discretion, additional markings may be used where in their judgment such markings have beneficial value.</p> <p>Marking to identify oversize threads is required.</p>
8. Leak Testing of Valves	
<p>Demonstration of no leaks with valve pressurized open (outlet capped) or closed at 500 psig for one minute.</p>	<p>See CGA Pamphlet V-9.</p> <p>Each lot of production valves should be tested for leak integrity.</p> <p>See table in CGA Pamphlet V-9 on minimum test pressures for valves with relief device on the valve.</p>

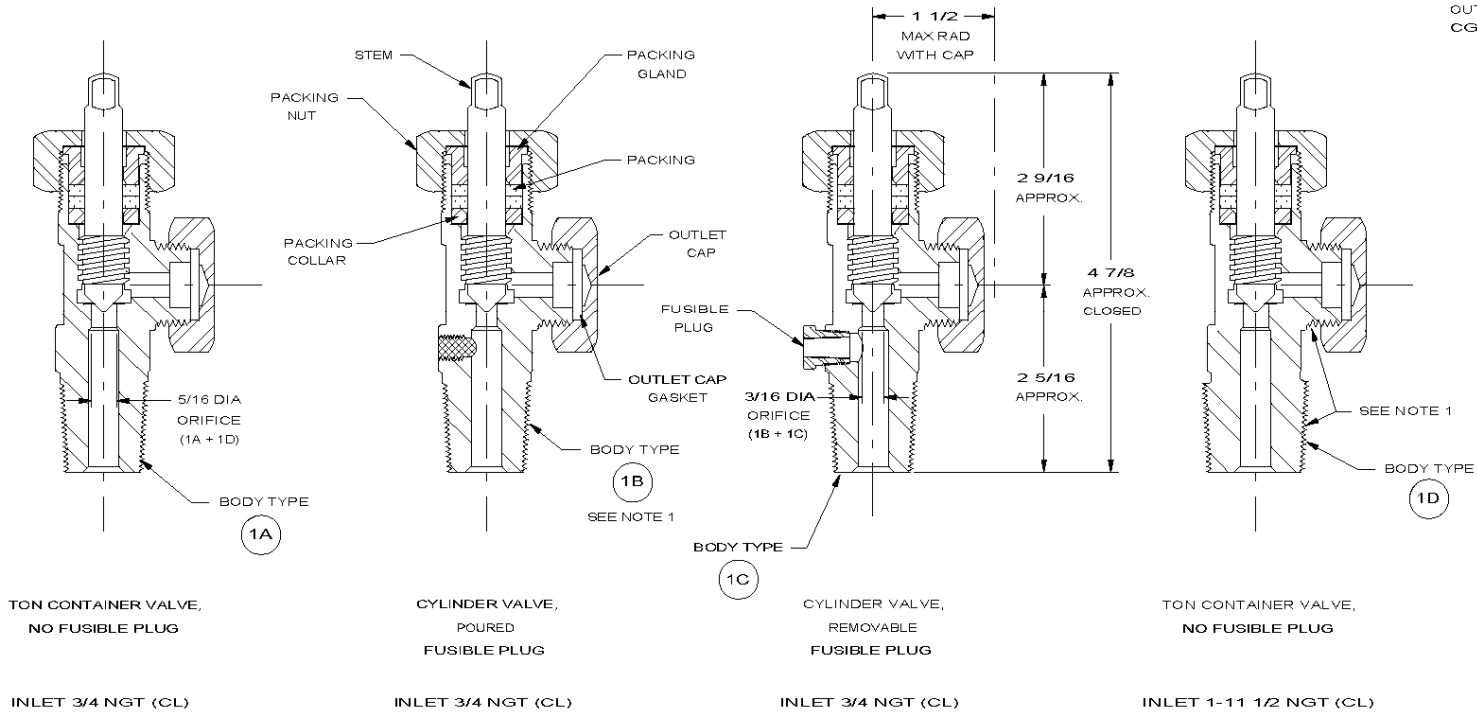
Performance Criteria	Supplemental Information and Notes
C. ADDITIONAL CRITERIA FOR CHLORINE CYLINDER AND TON CONTAINER VALVES	
<ol style="list-style-type: none">1. Valves must be compatible with Chlorine Institute open and closed yokes with adaptors (See CI Illustrations 130, 131, and 189).2. The valve outlet cap must provide a pressure seal.3. Cylinder valves must fit under current cylinder protective hoods.4. Cylinder valves must be compatible with Chlorine Institute Emergency Kit A hood devices.5. Ton container valves must be compatible with Chlorine Institute Emergency Kit B hood devices.6. Valves must have interchangeable parts within a specific manufacturer's valve designs.	<p>See CGA Pamphlet V-9.</p> <p>Valve designs found to be not compatible with the current Emergency Kit A or B should be brought to the attention of the Institute.</p>

APPENDIX B
ILLUSTRATIONS

All dimensions are for example purposes only

NOTES:

1. INLET AND OUTLET DIMENSIONS CONFORM TO ANSI/CSA/CGA V-1. OUTLETS CONFORM TO CONNECTION CGA 820, 1.030-14 NGO-RH-EXT.



- 1A TON CONTAINER VALVE (NO TAP)
- 1B CYLINDER VALVE (POURED PLUG, TAP 5/16-18 NC-1)
- 1C CYLINDER VALVE (REMOVABLE PLUG, TAP 1/8-27 NGT)
- 1D TON CONTAINER (NO TAP)

EXAMPLE OF:
VALVES FOR CHLORINE
CYLINDERS AND TON
CONTAINERS ASSEMBLIES

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

ILLUSTRATION

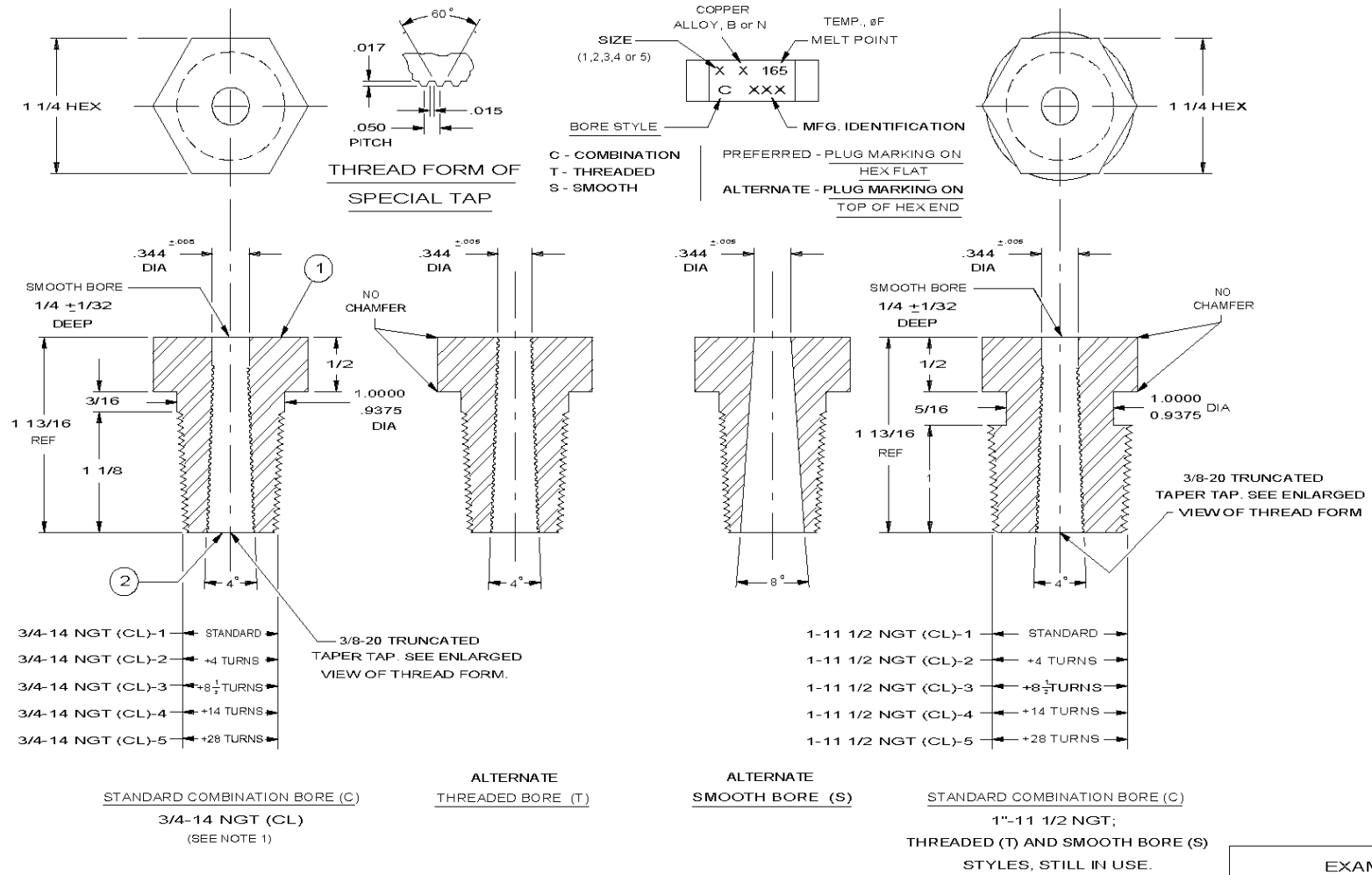
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ISSUE

5

All dimensions are for example purposes only.

ITEM	NAME OF PART
1	FUSIBLE PLUG BODY
2	FUSIBLE ALLOY



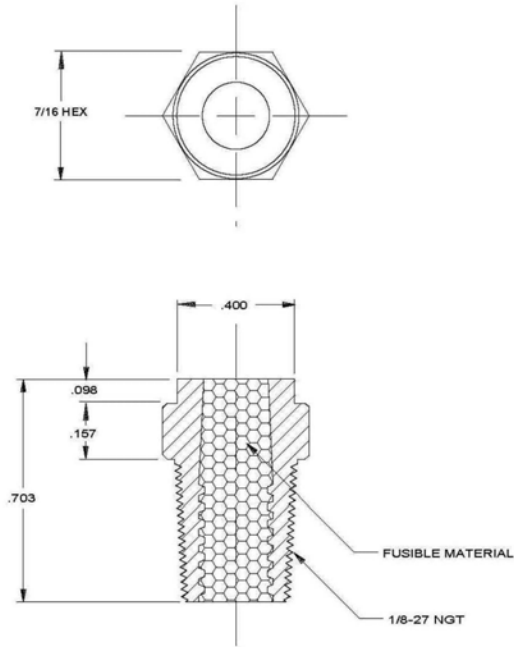
EXAMPLE OF:
 3/4 AND 1 INCH FUSIBLE PLUGS
 FOR CHLORINE TON
 CONTAINERS

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

All dimensions are for example purposes only.

NOTES:

1. This new style fusible plug may be visually identified by the presence of the 0.098" high cylindrical section which extends above the hex nut portion of the plug. Old style fusible plugs with a different melt range do not have the extended section.
2. New style fusible plugs also possess markings that identify the plug maximum melt temperature. This and other markings may be found on the side or the top of the cylindrical section which extends above the hex portion of the plug.



158° FUSE PLUG FOR CHLORINE CYLINDER VALVE

1/8-27 NGT-MOD

EXAMPLE OF:
1/8" FUSIBLE PLUG
FOR CHLORINE CYLINDER VALVE

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

ILLUSTRATION

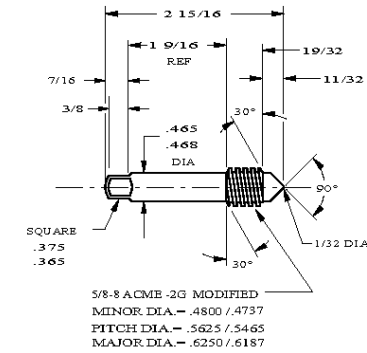
112

ISSUE

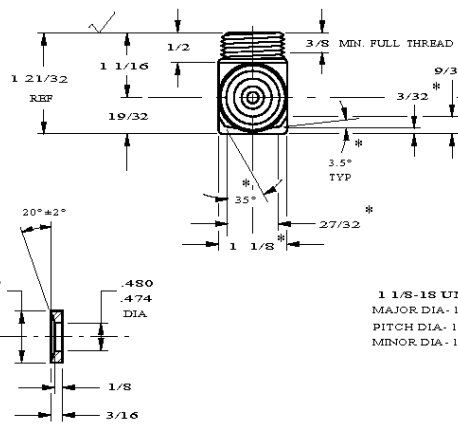
1

All dimensions are for example purposes only.

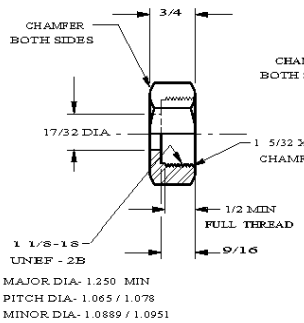
* AS FORGED DIMENSIONS, TOLERANCES TO BE IN ACCORD WITH GOOD COMMERCIAL PRACTICES.



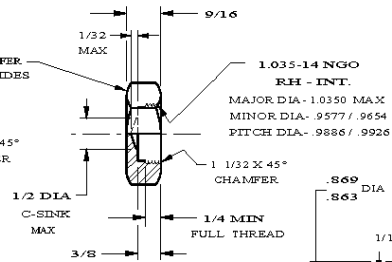
2 STEM



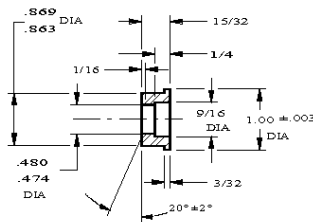
5 PACKING COLLAR



3 PACKING NUT

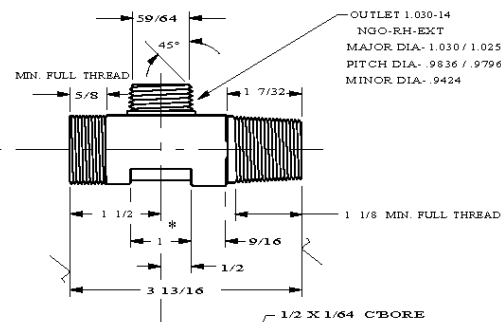


6 OUTLET CAP

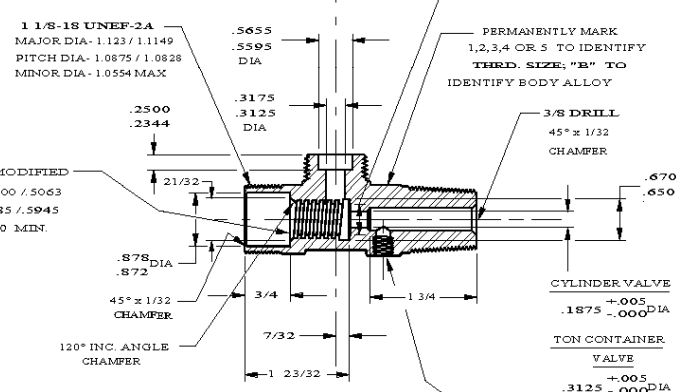


4 PACKING GLAND

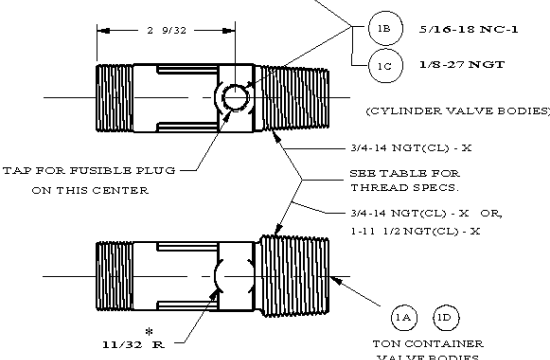
NOTE:
VALVE BODY DETAILS APPLY TO BOTH TON CONTAINER AND CYLINDER VALVES UNLESS OTHERWISE SPECIFIED.



1 VALVE BODY



ITEM	NAME OF PART
1A	TON CONTAINER VALVE BODY 3/4-14 NGT
1B	CYLINDER VALVE BODY (POURED PLUG)
1C	CYLINDER VALVE BODY (REMOVABLE PLUG)
1D	TON CONTAINER VALVE BODY 1-11 1/2 NGT
2	STEM
3	PACKING NUT (1-1/4 HEC)
4	PACKING GLAND
5	PACKING COLLAR
PACKING	
6	OUTLET CAP (1-1/4 HEC)
	OUTLET CAP GASKET ALT. 1 ALT. 2
	FUSIBLE PLUG ASSY. (STANDARD)
	FUSIBLE PLUG ASSY. (ALTERNATE)



EXAMPLE OF:
VALVE DETAILS FOR
CHLORINE CYLINDERS AND
TON CONTAINERS

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

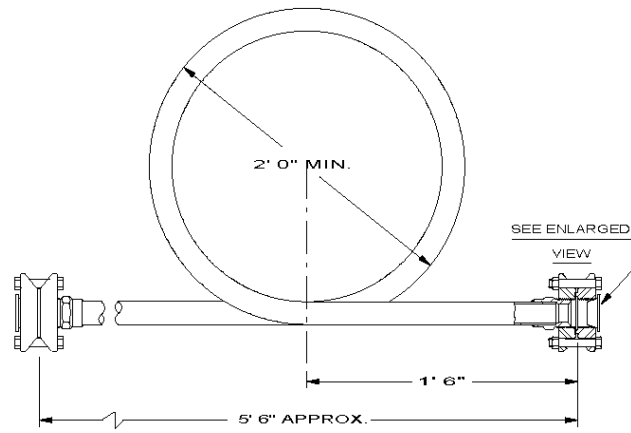
ILLUSTRATION

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ISSUE

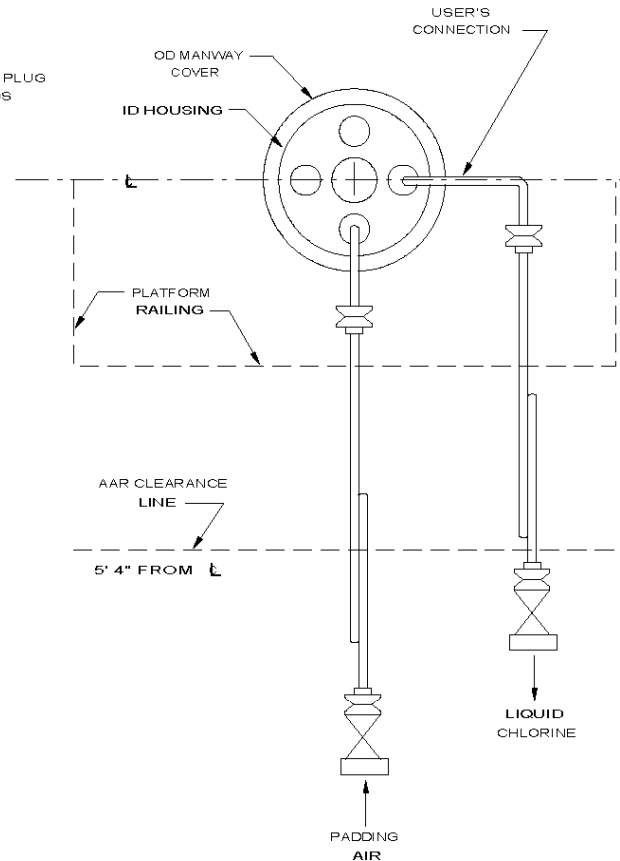
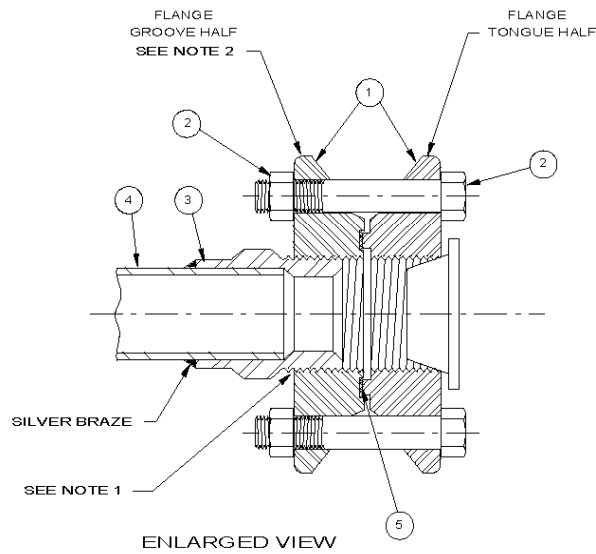
9

All dimensions are for example purposes only.



TESTING

HYDROSTATIC TEST AT 600 PSIG AND DRY THOROUGHLY.



ITEM	NAME OF PART
1	TWO BOLT OVAL FLANGED UNION TYPE 1500# 1" NPT FEM THD (NOTE 4)
2	BOLTS & NUTS, HVY HEX, BOLTS PER ANSI B18.2.1 NUTS PER ANSI B18.2.2 THREADS PER ANSI B1.1 CLASS 2A & 2B FIT, BOLT DIA. & LENGTH TO SUIT FLANGES.
3	ADAPTER, SOLDER JOINT, PER ANSI B16.22; 1 1/8 OD TUBE TO 1" NPT MALE
4	TUBING, TYPE K, ANNEALED SIZE PER ANSI H 23.1 (1 1/8 OD x .065 WALL)
5	GASKET, ASBESTOS COMPOSITION OR 2% TO 4% ANTIMONY LEAD, DIMENSIONS TO SUIT FLANGES

NOTES:

1. USE LITHARGE AND GLYCERINE OR WHITE LEAD PASTE ON PIPE THREADS.
2. ASSEMBLE THE GROOVE HALF OF THE FLANGE TO THE ADAPTER-BOTH ENDS.

**EXAMPLE OF:
CHLORINE TANK CAR
UNLOADING
CONNECTION**

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

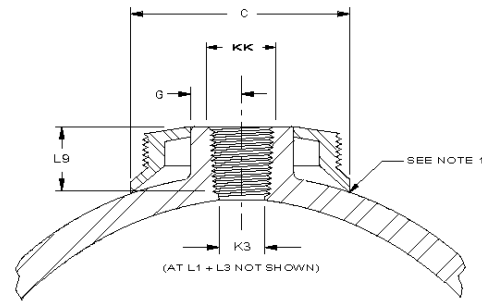
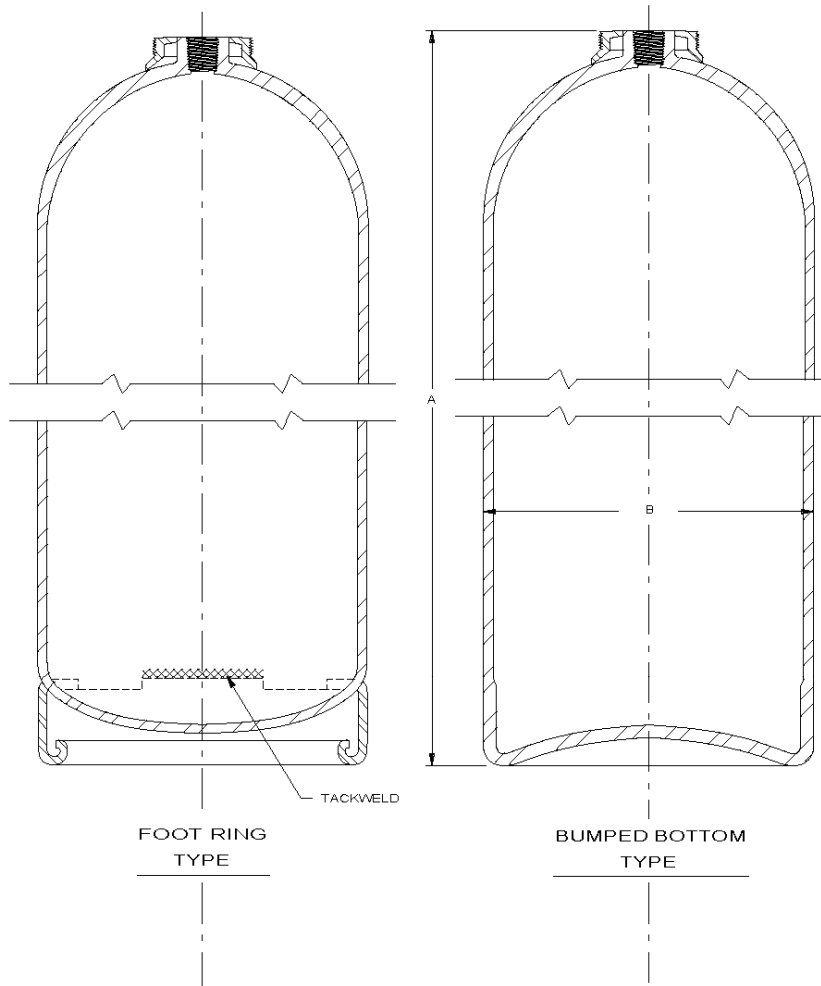
ILLUSTRATION

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ISSUE

5

All dimensions are for example purposes only.



ENLARGED VIEW
OF NECK RING

NOTES:

1. NECK RINGS MUST BE SECURED BY PEENING OR WELDING.
2. THE 3/4"-NGT (CL)-1 THREAD SHALL CONFORM WITH ANSI B57.1 (CGA PAMPHLET V-1). LIMITS ON SIZE OF INTERNAL THREADS SHALL BE PLUS OR MINUS ONE TURN ALTHOUGH PREFERRED WORKING LIMITS ARE PLUS OR MINUS 1/2 TURN.
3. LIMITS ON TAPER OF 3/4"-NGT(CL)-1 THREAD SHALL BE PLUS ONE TURN MINUS ZERO TURNS.

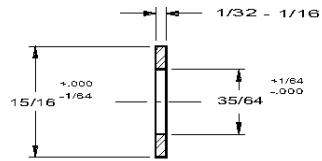
	DIMENSIONS	MIN.	NOMINAL	MAX.
A	HEIGHT- 100# LONG	47	-	49 1/2
	100# SHORT	33	-	36
	150#	47	-	49 1/2
B	O.D.- 100# LONG	8 1/4	-	8 1/2
	100# SHORT	10 1/4	-	10 1/2
	150#	10 1/4	-	10 1/2
C	O.D.- NECK RING	3 1/2	-	4 3/8
KK	COUNTERSINK DIA.	-	-	1 1/16
E1	PITCH DIA. AT FACE	-	0.9889	-
G	NECK RADIUS	11/16	-	-
K3	BORE AT FULL THD.	-	-	0.8972
L9	FULL ROOT LENGTH	0.9461	-	-
	INTERNAL THREAD	-	3/4"-NGT (CL)-1	-
	EXTERNAL THREAD	-	3 1/8"-7NS-1A	-

EXAMPLE OF:
LIMITING DIMENSIONS
FOR
CHLORINE CYLINDERS

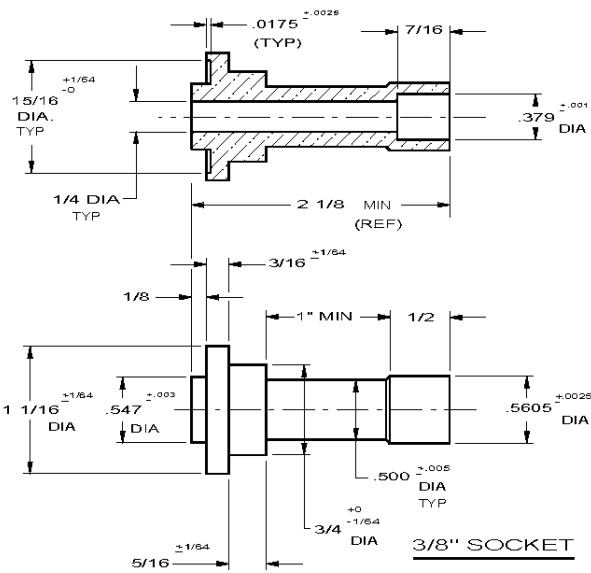
ILLUSTRATION **121** ISSUE **5**

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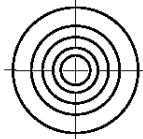
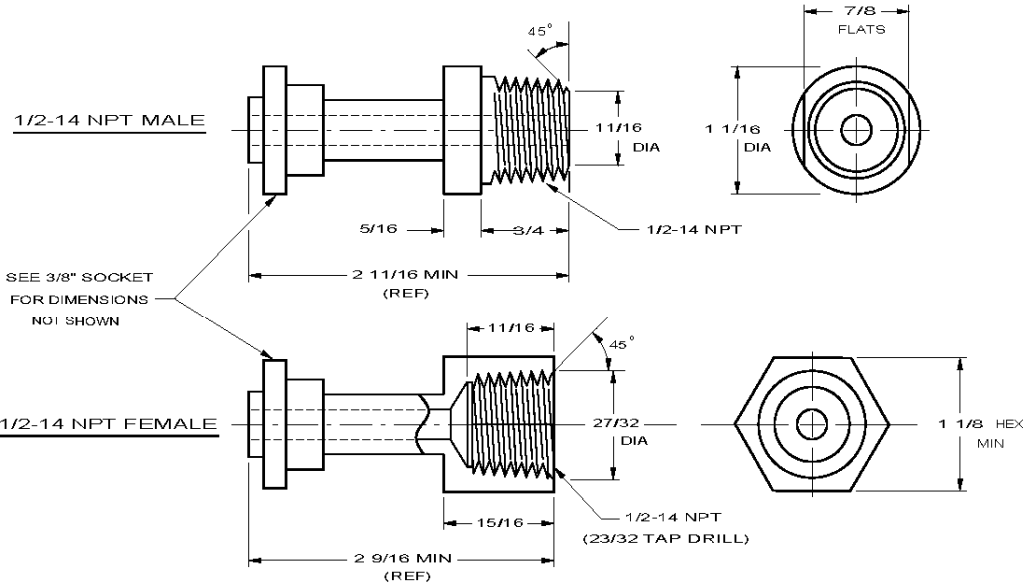
All dimensions are for example purposes only.



WASHER



3/8" SOCKET

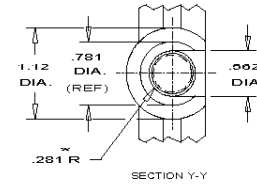
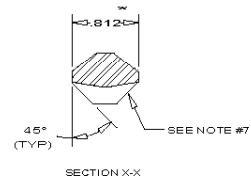
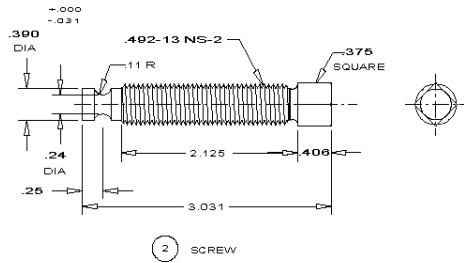
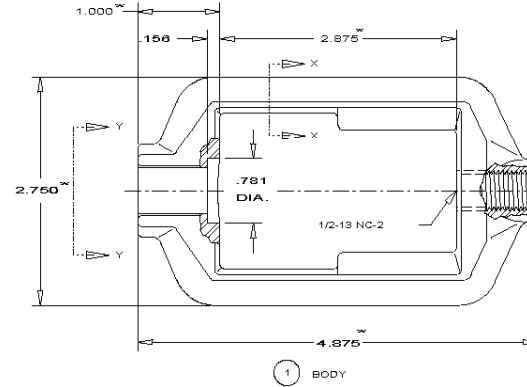
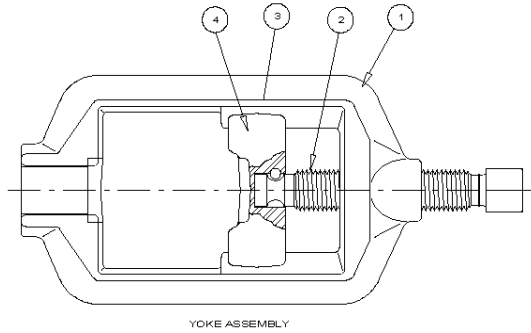


EXAMPLE OF: CHLORINE CYLINDER AND TON CONTAINER VALVE YOKE ADAPTERS		
ILLUSTRATION	130	ISSUE
		6

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

All dimensions are for example purposes only.

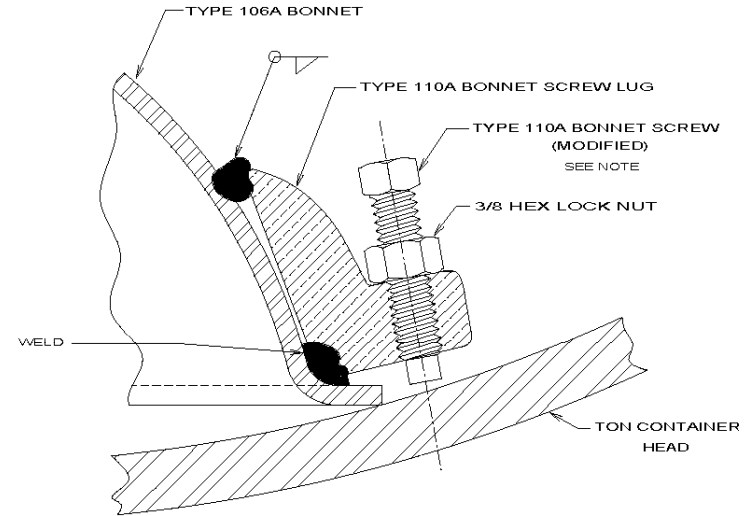
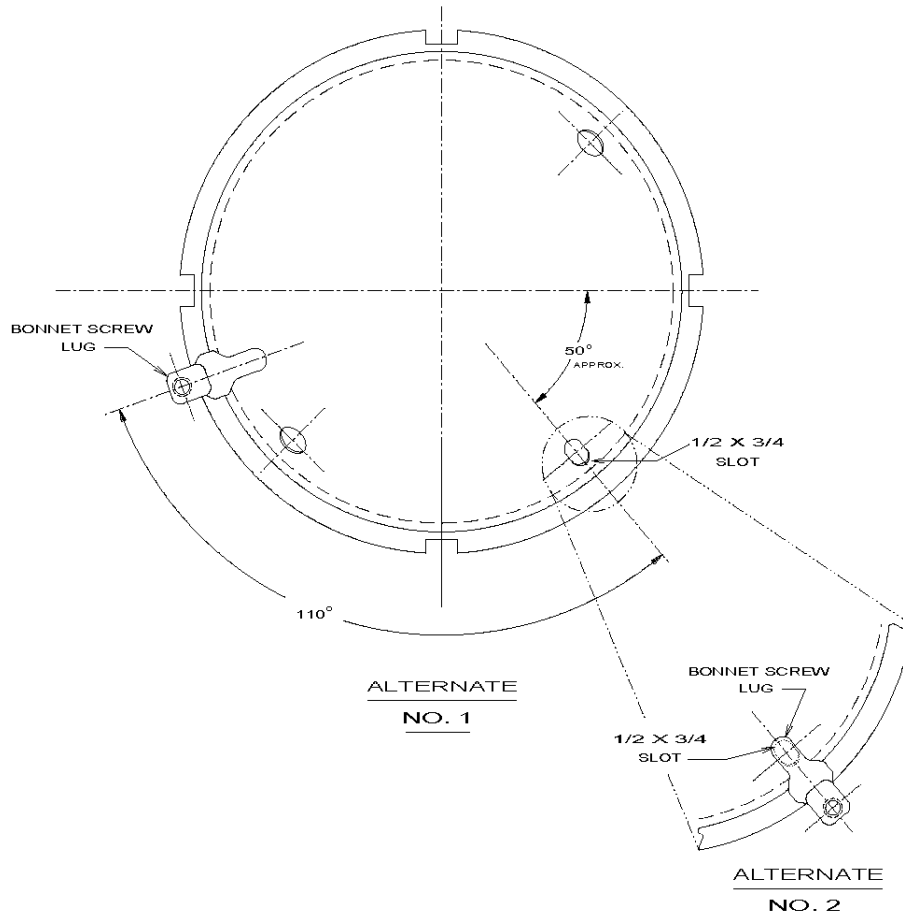
ITEM	NAME OF PART
1	BODY
2	SCREW
3	YOKE FOLLOWER
4	FOLLOWER PIN



EXAMPLE OF: CHLORINE CYLINDER VALVE YOKE	
ILLUSTRATION	ISSUE
131	5

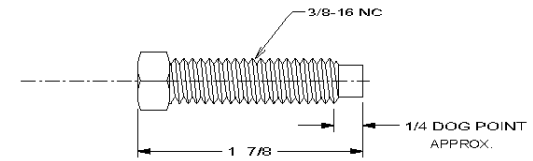
The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

All dimensions are for example purposes only.



MODIFICATION NOTE:

- SHORTEN STANDARD 110A BONNET SCREW TO 1 7/8 OAL AS SHOWN BELOW.

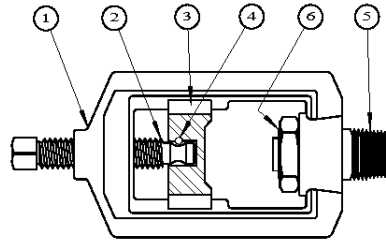


EXAMPLE OF: A LOCKING LUG ARRANGEMENT FOR VALVE PROTECTIVE HOUSING ON TON CONTAINERS	
ILLUSTRATION	182
ISSUE	4

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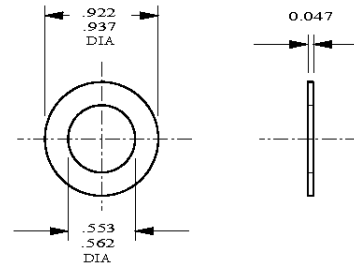
All dimensions are for example purposes only.

ITEM	NAME OF PART
1	BODY
2	SCREW
3	YOKE FOLLOWER
4	FOLLOWER PIN
5	NIPPLE
6	GASKET

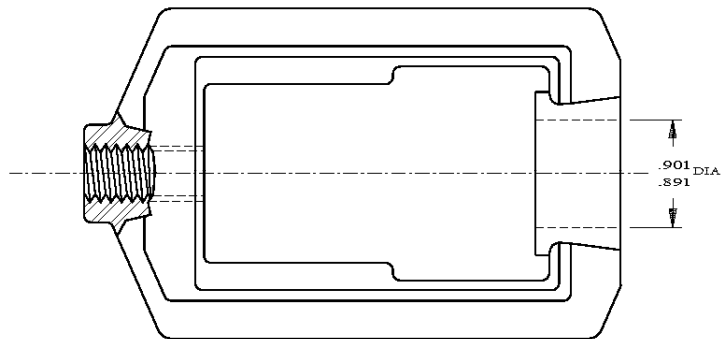


YOKE ASSEMBLY WITH NIPPLE

(1/2 SCALE)

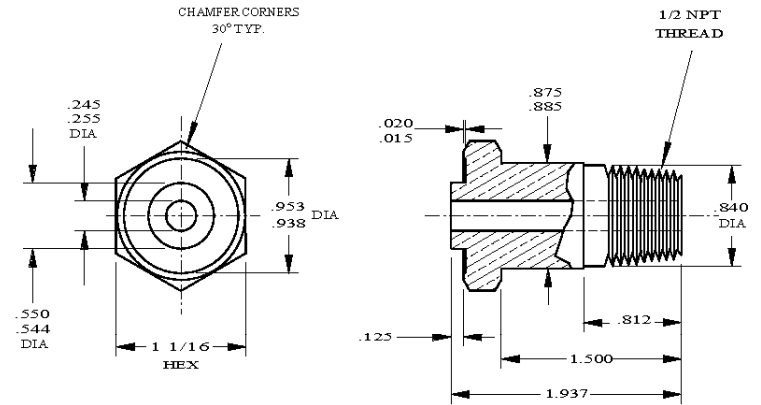


6 GASKET



SEE ILLUSTRATION 131 FOR ADDITIONAL INFORMATION

1 BODY

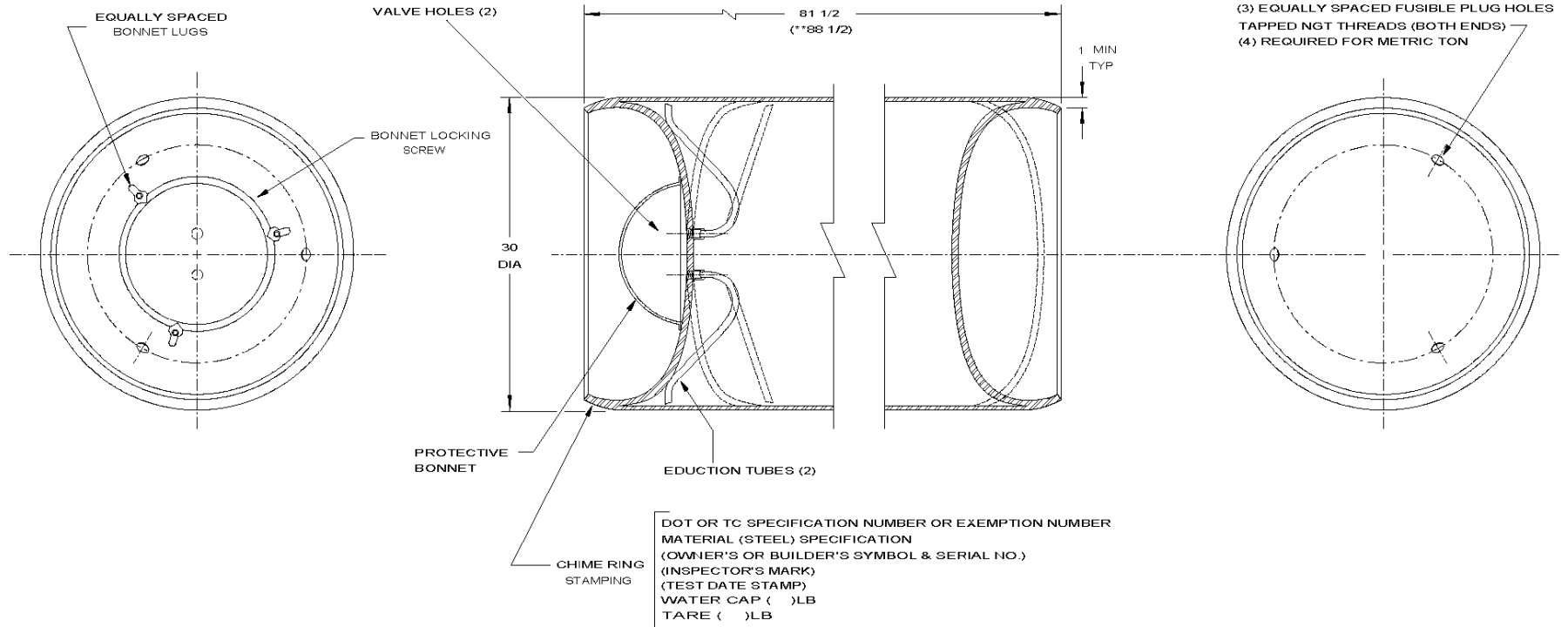


5 NIPPLE

EXAMPLE OF: CLOSED YOKE CHLORINE CONTAINER VALVE	
ILLUSTRATION	189
ISSUE	3

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

All dimensions are for example purposes only.



———— WATER CAPACITY AND WEIGHT ————

- ▶ WATER CAPACITY = 1600 LB. (**1764 LB) MINIMUM
- ▶ AVERAGE WEIGHT = 1375-1400 LB. (**1475 LB) INCLUDING WEIGHT OF VALVES & FUSIBLE PLUGS.

———— COMMODITY CAPACITY ————

- ▶ LIQUID CHLORINE CAPACITY = 2000 LB = 1 TON (**2204 LB) AT U.S. STANDARD FILLING DENSITY OF 125 PERCENT.
- ▶ FOR CAPACITY AND FILLING DENSITY OF OTHER U.S. AUTHORIZED LIQUIDS AND GASES SEE U.S. DEPARTMENT OF TRANSPORTATION HAZARDOUS MATERIALS REGULATIONS.

NOTE:

1. TARE WEIGHT INCLUDES WEIGHT OF EMPTY CONTAINER VALVES AND FUSIBLE PLUGS. DOES NOT INCLUDE WEIGHT OF VALVE PROTECTIVE BONNET.
2. CHLORINE TON CONTAINERS ARE BUILT TO U.S. DEPARTMENT OF TRANSPORTATION SPECIFICATIONS, DOT EXEMPTION OR THE EQUIVALENT TRANSPORT CANADA REGULATIONS.
3. **APPLIES TO METRIC TON CONTAINERS.
4. DOTTED LINE DENOTES ALTERNATE DESIGN.

**EXAMPLE OF:
CHLORINE
TON CONTAINER**

The purpose of this illustration is to show key features only. It is not intended to serve as a standard design nor should it be used for fabrication in any way.

ILLUSTRATION

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ISSUE

2

APPENDIX C

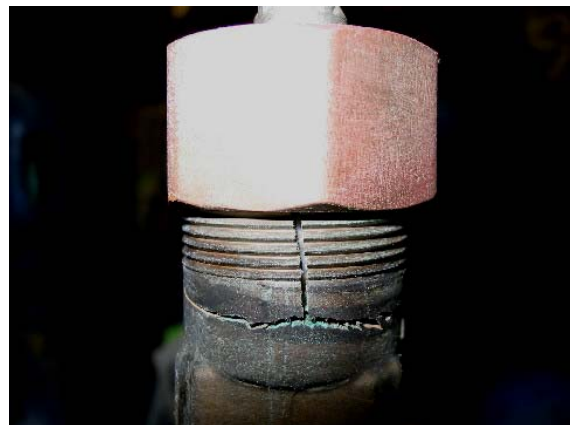
RECOMMENDED INSPECTION PROCEDURES CHLORINE CYLINDER AND TON CONTAINER VALVES

This document was prepared to add an extra level of safety for the users of chlorine cylinders and ton containers.

Although not common, there have been reports of cracks in both cylinder and ton container valves, most often in the area of the packing nut threads. Leaks, if any, will stop once the valve is closed. Normally, when the valve is open, leaks through the cracks are unlikely because they are sealed by the packing. On rare occasions, cracks have also been found elsewhere in the valve body and the packing nuts. Crack inspection should therefore cover the entire valve body.

Valves should be inspected each time before they are opened or reopened.

1. The cracks (See photos below) have been found running longitudinally through the threads by the packing nut (this is the nut that the valve stem passes through) as well as the valve body threads below and under the packing nut. The crack may vary from fractions of a millimeter up to 30 millimeters in length. In some instances, a second crack appears perpendicular to this crack about 10 to 30 millimeters below the bottom packing thread. One such crack covered a distance of about 120 degrees around the valve body. Longitudinal and transverse cracks may range from barely visible in length and depth to easily visible cracks over an inch long. If any cracks are found, separate and tag the cylinder or ton container. **Do not open the valve!**
2. If no cracks are found, you can connect to the container valve and by following CI recommended procedures, open the valve. A careful check using only the vapors from a 26° Baumé ammonia water (ammonium hydroxide solution) will produce a visible white gas if there is a leak. If a leak is found, close the valve and contact your chlorine supplier immediately.
3. If using ton container valves on manifolds or in chlorine headers, inspect the valve every time chlorine containers are changed. If a crack is found, close the valve and contact your equipment supplier immediately for instructions.





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