AGREEMENT

GOODS AND SERVICES AGREEMENT

THIS GOODS AND SERVICES AGREEMENT is made as of the _____ day of _____ (effective date), by and between Pinellas County, a political subdivision of the State of Florida ("County"), and Brenntag Mid-South, Inc., ("Contractor"), (individually, "Party," collectively, "Parties").

W I T N E S S E T H:

WHEREAS, the County requested proposals pursuant to Contract No. 23-0385-ITB for Liquid Chlorine One Ton Cylinders; and

WHEREAS, based upon the County's assessment of Contractor's proposal, the County selected the Contractor to provide the Services as defined herein; and

WHEREAS, Contractor represents that it has the experience and expertise to provide Goods and perform the Services as set forth in this Agreement.

NOW, THEREFORE, in consideration of the above recitals, the mutual covenants, agreements, terms and conditions herein, and other good and valuable consideration, the receipt and sufficiency of which is hereby mutually acknowledged, the Parties agree as follows:

1. Definitions

A. **"Agreement"** means this Agreement, including all Exhibits, which are expressly incorporated herein by reference, and any amendments thereto.

B. **"County Confidential Information"** means any County information deemed confidential and/or exempt from Section 119.07, Florida Statutes, and Section 24(a), Article 1 of the Florida Constitution, or other applicable law, including, but not limited to data or information referenced in this Goods and Services Agreement, and any other information designated in writing by the County as County Confidential Information.

C. **"Contractor Confidential Information"** means any Contractor information that is designated as confidential and/or exempt by Florida's public records law, including information that constitutes a trade secret pursuant to Chapter 688, Florida Statutes, and is designated in this Agreement or in writing as a trade secret by Contractor (unless otherwise determined to be a public record by applicable Florida law). Notwithstanding the foregoing, Contractor Confidential Information does not include information that: (i) becomes public other than as a result of a disclosure by the County in breach of the Agreement; (ii) becomes available to the County on a non-confidential basis from a source other than Contractor, which is not prohibited from disclosing such information by obligation to Contractor; (iii) is known by the County prior to its receipt from Contractor without any obligation or confidentiality with respect thereto; or (iv) is developed by the County independently of any disclosures made by Contractor.

D. **"Contractor Personnel"** means all employees of Contractor, and all employees of subcontractors of Contractor, including, but not limited to temporary and/or leased employees, who are providing the Services at any time during the project term.

E. **"Services"** means the work, duties and obligations to be carried out and performed safely by Contractor under this Agreement, as described throughout this Agreement and as specifically described in the Statement of Work Exhibit attached hereto and incorporated herein by reference. As used in this Agreement, Services shall include any component task, subtask, service, or function inherent, necessary, or a customary part of the Services, but not specifically described in this Agreement, and shall include the provision of all standard day-to-day administrative, overhead, and internal expenses, including costs of bonds and insurance as required herein, labor, materials, equipment, safety equipment, products, office supplies, consumables, tools, postage, computer hardware/software, telephone charges, copier usage, fax charges, travel, lodging, and per diem and all other costs required to perform Services except as otherwise specifically provided in this Agreement.

2. Execution of Agreement

The execution of this Agreement is expressly limited by the Terms and Conditions hereon. County and the Contractor are not bound by additional provisions or provisions at variance herewith that may appear in the Contractor's quotation, estimate, scope of work, or any other such related documents, acknowledgement in force, or any other communication from Contractor to or from County unless such provision is expressly set forth herein.

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3. Conditions Precedent

This Agreement, and the Parties' rights and obligations herein, are contingent upon and subject to the Contractor securing and/or providing the performance security, if required, and the insurance coverage(s) required, within 10 days of the Effective Date. No Services shall be performed by the Contractor and the County shall not incur any obligations of any type until Contractor satisfies these conditions. Unless waived in writing by the County, in the event the Contractor fails to satisfy the conditions precedent within the time required herein, the Agreement shall be deemed not to have been entered into and shall be null and void.

4. Services

A. **Services** - The County retains Contractor, and Contractor agrees to provide the Services. All Services shall be performed to the satisfaction of the County and shall be subject to the provisions and terms contained herein and the Exhibits attached hereto.

B. **Services Requiring Prior Approval** - Contractor shall not commence work on any Services requiring prior written authorization in the Statement of Work without approval from the Utilities Wastewater Treatment Manager.

C. **Additional Services** - From the Effective Date and for the duration of the project, the County may elect to have Contractor perform Services that are not specifically described in the Statement of Work attached hereto but are related to the Services ("Additional Services"), in which event Contractor shall perform such Additional Services for the compensation specified in the Statement of Work attached hereto. Contractor shall commence performing the applicable Additional Services promptly upon receipt of written approval as provided herein.

D. **De-scoping of Services** - The County reserves the right, in its sole discretion, to de-scope Services upon written notification to the Contractor by the County. Upon issuance and receipt of the notification, the Contractor and the County shall enter into a written amendment reducing the appropriate Services Fee for the impacted Services by a sum equal to the amount associated with the de-scoped Services as defined in the payment schedule in this Agreement, if applicable, or as determined by mutual written consent of both Parties based upon the scope of work performed prior to issuance of notification.

E. **Independent Contractor Status and Compliance with the Immigration Reform and Control Act** - Contractor is and shall remain an independent contractor and is neither agent, employee, partner, nor joint venturer of County. Contractor acknowledges that it is responsible for complying with the provisions of the Immigration Reform and Control Act of 1986 located at 8 U.S.C. 1324, et seq, and regulations relating thereto, as either may be amended from time to time. Failure to comply with the above provisions shall be considered a material breach of the Agreement.

F. **Non-Exclusive Services** - Award of this Agreement imposes no obligation on the County to utilize the Contractor for all goods and/or services of this type, which may develop during the agreement period. This is a non-exclusive Agreement. During the term of this Agreement, and any extensions thereof, the County reserves the right to contract for another provider for similar goods and/or services as it determines necessary in its sole discretion.

G. **Project Monitoring** - During the term of the Agreement, Contractor shall cooperate with the County, either directly or through its representatives, in monitoring Contractor's progress and performance of this Agreement.

5. Term of Agreement

A. **Initial Term -** The term of this Agreement shall commence on the **Effective Date** and shall remain in full force and for twelve (12) months, or until termination of the Agreement, whichever occurs first.

B. **Term Extension**

The Parties may extend the term of this Agreement for four (4) additional twelve (12) month period(s) pursuant to the same terms, conditions, and pricing set forth in the Agreement by mutually executing an amendment to this Agreement, as provided herein.

6. Orders

Within the term of this Agreement, County may place one or more orders for goods and/or services at the prices listed on the Price Schedule Exhibit attached hereto, and which is incorporated by reference hereto.

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7. Delivery / Claims

Prices on the Schedule of Prices are F.O.B. Destination, FREIGHT INCLUDED and unloaded to location(s) within Pinellas County. Actual delivery address(es) will be identified at time of order. Contractor will be responsible for making any and all claims against carriers for missing or damaged items.

8. Inspection

In County's sole discretion, goods rejected due to inferior quality or workmanship will be returned to Contractor at Contractor's expense and are not to be replaced except upon receipt of written instructions from County.

9. Material Quality

All goods and materials purchased and delivered pursuant to this Agreement will be of first quality and not damaged and/or factory seconds. Any materials damaged or not in first quality condition upon receipt must be exchanged within 24 hours of notice to the Contractor at no charge to County.

10. Material Safety Data

In accordance with OSHA Hazardous Communications Standards, it is the Contractor seller's duty to advise if a product is a toxic substance and to provide a Material Safety Data Sheet at time of delivery.

11. Purchase Order Number

Each order will contain the Purchase Order Number applicable to this Agreement, and such Purchase Order Number must appear on all packing slips, invoices and all correspondence relating to the Order. County will not be responsible for goods delivered without a Purchase Order Number.

12. Variation in Quantity

County assumes no liability for goods or materials produced, processed or shipped in excess of the amounts ordered pursuant to the terms of this Agreement.

13. Warranty

Seller warrants that the goods are of first quality and as described in Prices Schedule. All manufacturer, producer or seller warranties offered to any other purchaser are expressly available and applicable to County.

14. Compensation and Method of Payment

A. **Goods and Services Fee** - As total compensation for the Goods and Services, the County shall pay the Contractor the sums as provided in this Section Compensation and Method Payment ("Goods and Services Fee"), pursuant to the terms and conditions as provided in this Agreement. It is acknowledged and agreed by Contractor that this compensation constitutes a limitation upon County's obligation to compensate Contractor for such Goods and Services required by this Agreement but does not constitute a limitation upon Contractor's obligation to provide Goods and perform all of the Services required by this Agreement. In no event will the Goods and Services Fee paid exceed the not-to-exceed sums set out in subsections below, unless the Parties agree to increase this sum by written amendment as authorized in the Amendment Section of this Agreement.

B. **Spending Cap and Payment Structure** - The County agrees to pay the Contractor the total annual not-to-exceed sum of **$**1,792,000.00, for Goods and Services completed and accepted herein, payable on a fixed-fee basis for the deliverables as set out in Exhibit C, upon submittal of an invoice as required herein.

C. **Price Adjustment**s-

a. **Initial Term**: Unit prices shall be held firm for the initial twelve (12) month period per the rates within Exhibit C.

b. **Term Extensions:** Upon mutual extension of the contract term, the unit prices set forth in Exhibit C may be adjusted. Price adjustments will be based on the Chemical Market Analytics for Chlor-Alkali and are effective for the twelve (12) month extension period. The increase will be the highest pricing of the three (3) manufacturers, Olin Chlor Alkali Products and Vinyls, ChemTrade, or Westlake, or an adjustment of 15% based on the current price, whichever is less. All pricing submitted must be validated by Pinellas County. The extension shall be exercised only if all terms and conditions remain the same and the County grants approval.

It is the Contractor's responsibility to request any pricing adjustment under this provision. For any adjustment to commence on the first day of any exercised extension period, the Contractor's request for adjustment and the three manufacturers' letters should be submitted to the County at time of the extension request and indicate the appropriate HIS publication ("publication") Contractor will be utilizing at the time of request. The Contractor's adjustment request should not be in excess of the relevant publication pricing. If no adjustment request is received from the Contractor, the County will assume the Contractor has agreed that the extension term may be exercised without pricing adjustment. Any adjustment request received after the commencement of a new extension period may not be considered. County has the right to request pricing decreases at any time.

D. **Travel Expenses**

The Services Fee includes all travel, lodging and per diem expenses incurred by Contractor in performing the Services.

E. **Taxes** - Contractor acknowledges that the County is not subject to any state or federal sales, use, transportation and certain excise taxes.

C. **Payments and Invoicing -** Contractor shall submit invoices for payments due as provided herein and authorized reimbursable expenses incurred with such documentation as required by County. Invoices shall be submitted to the designated person as set out in the Notices Section herein.

For time and materials Services, all Contractor Personnel shall maintain logs of time worked, and each invoice shall state the date and number of hours worked for Services authorized to be billed on a time and materials basis.

All payments shall be made in accordance with the requirements of Section 218.70 et seq., Florida Statutes, "The Local Government Prompt Payment Act." The County may dispute any payments invoiced by Contractor in accordance with the County's Invoice Payments Dispute Resolution Process established in accordance with Section 218.76, Florida Statutes, and any such disputes shall be resolved in accordance with the County's Dispute Resolution Process.

15. Acceptance of Services

For all Services deliverables that require County acceptance as provided in the Statement of Work, the County, through the Utilities Wastewater Treatment Manager or designee, will have 10 calendar days to review the deliverable(s) after receipt or completion of same by Contractor, and either accept or reject the deliverable(s) by written notice to Brenntag Mid-South, Inc. If a deliverable is rejected, the written notice from the County will specify any required changes, deficiencies, and/or additions necessary. Contractor shall then have 7 calendar days to revise the deliverable(s) to resubmit and/or complete the deliverable(s) for review and approval by the County, who will then have 7 calendar days to review and approve, or reject the deliverable(s); provided however, that Contractor shall not be responsible for any delays in the overall project schedule that result from the County's failure to timely approve or reject deliverable(s) as provided herein. Upon final acceptance of the deliverable(s), the County will accept the deliverable(s) in writing.

16. Discounts

Delay in receiving an invoice, invoicing for materials shipped ahead of specified schedule, or invoices rendered with errors or omissions will be considered just cause for County to withhold payment without losing discount privileges. Discount privilege will apply from date of scheduled delivery, the date or receipt of goods, or the date of approved invoice, whichever is later.

17. Subcontracting/Assignment.

A. **Subcontracting -** Contractor is fully responsible for completion of the Services required by this Agreement and for completion of all subcontractor work, if authorized as provided herein. Contractor shall not subcontract any work under this Agreement to any subcontractor other than the subcontractors specified in the proposal and previously approved by the County, without the prior written consent of the County, which shall be determined by the County in its sole discretion.

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B. **Assignment**

This Agreement, and all rights or obligations hereunder, shall not be assigned, transferred, or delegated in whole or in part, including by acquisition of assets, merger, consolidation, dissolution, operation of law, change in effective control of the Contractor, or any other assignment, transfer, or delegation of rights or obligations, without the prior written consent of the County. The Contractor shall provide written notice to the County within fifteen (15) calendar days of any action or occurrence assigning the Agreement or any rights or obligations hereunder as described in this section. In the event the County does not consent to the assignment, as determined in its sole discretion, the purported assignment in violation of this section shall be null and void, and the County may elect to terminate this Agreement by providing written notice of its election to terminate pursuant to this provision upon fifteen (15) days' notice to Contractor.

18. Personnel

A. **E-Verify -** The contractor and their subcontractor(s) must register with and use the E-verify system in accordance with Florida Statute 448.095. A contractor and subcontractor may not enter into a contract with the County unless each party registers with and uses the E-verify system.

If a contractor enters a contract with a subcontractor, the subcontractor must provide the contractor with an affidavit stating that the Subcontractor does not employ, contract with, or subcontract with unauthorized aliens. The contractor must maintain a copy of the affidavit for the duration of the contract.

If the County, Contractor, or Subcontractor has a good faith belief that a person or entity with which it is contracting has knowingly violated Florida Statute 448.09(1) they shall immediately terminate the contract with the person or entity.

If the County has a good faith belief that a Subcontractor knowingly violated this provision, but the Contractor otherwise complied with this provision, the County will notify the Contractor and order that the Contractor immediately terminate the contract with the Subcontractor.

A contract terminated under the provisions of this section is not a breach of contract and may not be considered such. Any contract termination under the provisions of this section may be challenged to Section 448.095(2)(d), Florida Statute. Contractor acknowledges upon termination of this agreement by the County for violation of this section by Contractor, Contractor may not be awarded a public contract for at least one (1) year. Contractor acknowledges that Contractor is liable for any additional costs incurred by the County as a result of termination of any contract for a violation of this section.

Contractor or Subcontractor shall insert in any subcontracts the clauses set forth in this section, requiring the subcontracts to include these clauses in any lower tier subcontracts. Contractor shall be responsible for compliance by any Subcontractor or Lower Tier Subcontractor with the clause set for in this section.

B. **Qualified Personnel -** Contractor agrees that each person performing Services in connection with this Agreement shall have the qualifications and shall fulfill the requirements set forth in this Agreement

C. **Approval and Replacement of Personnel** - The County shall have the right to approve all Contractor Personnel assigned to provide the Services, which approval shall not be unreasonably withheld. Prior to commencing the Services, the Contractor shall provide at least ten (10) days written notice of the names and qualifications of the Contractor Personnel assigned to perform Services pursuant to the Agreement. Thereafter, during the term of this Agreement, the Contractor shall promptly and as required by the County provide written notice of the names and qualifications of any additional Contractor Personnel assigned to perform Services. The County, on a reasonable basis, shall have the right to require the removal and replacement of any of the Contractor Personnel performing Services, at any time during the term of the Agreement. The County will notify Contractor in writing in the event the County requires such action. Contractor shall accomplish any such removal within forty-eight (48) hours after receipt of notice from the County and shall promptly replace such person with another person, acceptable to the County, with sufficient knowledge and expertise to perform the Services assigned to such individual in accordance with this Agreement. In situations where individual Contractor Personnel are prohibited by applicable law from providing Services, removal and replacement of such Contractor Personnel shall be immediate and not subject to such forty-eight (48) hour replacement timeframe and the provisions of the Termination Section of this Agreement shall apply if minimum required staffing is not maintained.

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19. Name Changes

The Contractor is responsible for immediately notifying the County of any company name change, which would cause invoicing to change from the name used at the time of the original Agreement.

20. Compliance with Laws

Contractor shall comply with all applicable federal, state, county and local laws, ordinances, rules and regulations in the performance of its obligations under this Agreement, including the procurement of permits and certificates where required, and including but not limited to laws related to Workers Compensation, Americans with Disabilities Act (ADA), Section 504 of the Rehabilitation Act of 1973, Minority Business Enterprise (MBE), occupational safety and health and the environment, equal employment opportunity, privacy of medical records and information, as applicable. Failure to comply with any of the above provisions shall be considered a material breach of the Agreement.

21. Applicable Law and Venue

This Agreement and any and all purchases made hereunder shall be governed by and construed in accordance with the laws of the State of Florida (without regard to principles of conflicts of laws). The Parties agree that all actions or proceedings arising in connection with this Agreement shall be tried and litigated exclusively in the state or federal (if permitted by law and a Party elects to file an action in federal court) courts located in or for Pinellas County, Florida. This choice of venue is intended by the Parties to be mandatory and not permissive in nature, and to preclude the possibility of litigation between the Parties with respect to, or arising out of, this Agreement in any jurisdiction other than that specified in this section. Each Party waives any right it may have to assert the doctrine of forum non-conveniens or similar doctrine or to object to venue with respect to any proceeding brought in accordance with this section.

22. Public Entities Crimes

Contractor is directed to the Florida Public Entities Crime Act, Section 287.133, Florida Statutes, as well as Florida Statute 287.135 regarding Scrutinized Companies, and represents to County that Contractor is qualified to transact business with public entities in Florida, and to enter into and fully perform this Agreement subject to the provisions stated therein. Failure to comply with any of the above provisions shall be considered a material breach of the Agreement.

23. Waiver

No waiver by either Party of any breach or violation of any covenant, term, condition, or provision of this Agreement or of the provisions of any ordinance or law, shall be construed to waive any other term, covenant, condition, provisions, ordinance or law, or of any subsequent breach or violation of the same.

24. Due Authority

Each Party to this Agreement represents and warrants that: (i) it has the full right and authority and has obtained all necessary approvals to enter into this Agreement; (ii) each person executing this Agreement on behalf of the Party is authorized to do so; (iii) this Agreement constitutes a valid and legally binding obligation of the Party, enforceable in accordance with its terms.

25. Termination

A. **Contractor Default Provisions and Remedies of County**

1. **Events of Default** - Any of the following shall constitute a “Contractor Event of Default” hereunder:

i. Contractor fails to maintain the staffing necessary to perform the Services as required in the Agreement, fails to perform the Services as specified in the Agreement, or fails to complete the Services within the completion dates as specified in the Agreement;

ii. Contractor breaches Confidential Information Section of this Agreement;

iii. Contractor fails to gain acceptance of goods and/or services deliverable, for 2 consecutive iterations; or

iv. Contractor fails to perform or observe any of the other material provisions of this Agreement.

2. **Cure Provisions** - Upon the occurrence of a Contractor Event of Default as set out above, the County shall provide written notice of such Contractor Event of Default to Contractor ("Notice to Cure"), and Contractor shall have 30 calendar days after the date of a Notice to Cure to correct, cure, and/or remedy the Contractor Event of Default described in the written notice.

3. **Termination for Cause by the County** - In the event that Contractor fails to cure a Contractor Event of Default as authorized herein, or upon the occurrence of a Contractor Event of Default as specified in Termination – Contractor Default Provisions and Remedies of County – Events of Default Section of this Agreement, the County may terminate this Agreement in whole or in part, effective upon receipt by Contractor of written notice of termination pursuant to this provision, and may pursue such remedies at law or in equity as may be available to the County.

B. County Default Provisions and Remedies of Contractor

1. Events of Default - Any of the following shall constitute a "County Event of Default" hereunder:
   i. the County fails to make timely undisputed payments as described in this Agreement;
   ii. the County breaches Confidential Information Section of this Agreement; or the County fails to perform any of the other material provisions of this Agreement.

2. **Cure Provisions** - Upon the occurrence of a County Event of Default as set out above, Contractor shall provide written notice of such County Event of Default to the County ("Notice to Cure"), and the County shall have thirty (30) calendar days after the date of a Notice to Cure to correct, cure, and/or remedy the County Event of Default described in the written notice.

3. **Termination for Cause by the Contractor** - In the event the County fails to cure a County Event of Default as authorized herein, Contractor may terminate this Agreement in whole or in part effective on receipt by the County of written notice of termination pursuant to this provision, and may pursue such remedies at law or in equity as may be available to the Contractor.

C. Termination for Convenience

1. Notwithstanding any other provision herein, the County may terminate this Agreement, without cause, by giving 30 days advance written notice to the Contractor of its election to terminate this Agreement pursuant to this provision.

26. Time is of the Essence

Time is of the essence with respect to all provisions of this Agreement that specify a time for performance, including the Services as described in the Exhibits attached hereto; provided, however, that the foregoing shall not be construed to limit a Party's cure period allowed in the Agreement.

27. Confidential Information and Public Records

A. **County Confidential Information** - Contractor shall not disclose to any third-party County Confidential Information that Contractor, through its Contractor Personnel, has access to or has received from the County pursuant to its performance of Services pursuant to the Agreement, unless approved in writing by the County Contract Manager. All such County Confidential Information will be held in trust and confidence from the date of disclosure by the County, and discussions involving such County Confidential Information shall be limited to Contractor Personnel as is necessary to complete the Services.

B. **Contractor Confidential Information** - All Contractor Confidential Information received by the County from Contractor will be held in trust and confidence from the date of disclosure by Contractor and discussions involving such Contractor Confidential Information shall be limited to the members of the County's staff and the County's subcontractors who require such information in the performance of this Agreement. The County acknowledges and agrees to respect the copyrights, registrations, trade secrets and other proprietary rights of Contractor in the Contractor Confidential Information during and after the term of the Agreement and shall at all times maintain the confidentiality of the Contractor Confidential Information provided to the County, subject to federal law and the laws of the State of Florida related to public records disclosure. Contractor shall be solely responsible for taking any and all action it deems necessary to protect its Contractor Confidential Information except as provided herein. Contractor acknowledges that the County is subject to public records legislation, including but not limited to Chapter 119, Florida Statutes, and the Florida Rules of Judicial Administration, and that any of the County's obligations under this Section may be superseded by its obligations under any requirements of said laws.

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C. **Public Records** - Contractor acknowledges that information and data it manages as part of the services may be public records in accordance with Chapter 119, Florida Statutes and Pinellas County public records policies. Contractor agrees that prior to providing services it will implement policies and procedures to maintain, produce, secure, and retain public records in accordance with applicable laws, regulations, and County policies, including but not limited to the Section 119.0701, Florida Statutes. Notwithstanding any other provision of this Agreement relating to compensation, the Contractor agrees to charge the County, and/or any third parties requesting public records only such fees allowed by Section 119.07, Florida Statutes, and County policy for locating and producing public records during the term of this Agreement.

If the contractor has questions regarding the application of Chapter 119, Florida Statutes, to the contractor's duty to provide public records relating to this agreement, the contractor shall contact:

Pinellas County Board of County Commissioners
Purchasing and Risk Management Division
400 S. Ft. Harrison Ave, 6th Floor,
Clearwater, FL 33756
Public Records Liaison
Phone: 727-464-3237
Email: mcchartier@pinellas.gov

28. Audit

Contractor shall retain all records relating to this Agreement for a period of at least 5 years after final payment is made. All records shall be kept in such a way as will permit their inspection pursuant to Chapter 119, Florida Statutes. In addition, County reserves the right to examine and/or audit such records.

29. Digital Accessibility

Contractor acknowledges and warrants that all digital content and services provided under this contract conforms and shall continue to conform during the Term of this Agreement to the W3C Web Content Accessibility Guidelines, version 2.0 ("WCAG 2.0") at conformance Level A and AA. If all digital content and services does not fully conform to WCAG 2.0 A and AA, Contractor shall advise Pinellas County in writing of the nonconformance prior to execution of this Agreement and shall provide Pinellas County a plan to achieve conformance to WCAG 2.0 A and AA, including but not limited to, an intended timeline for conformance. Failure to achieve conformance, as determined in Pinellas County's sole discretion, on its intended timeline shall be considered a material breach of this Agreement and grounds for termination by Pinellas County.

If during the Term of this Agreement, Contractor fails to maintain compliance with WCAG 2.0 A and AA or Pinellas County otherwise identifies an issue related to accessibility of the product (the "Accessibility Issue") that renders the product inaccessible, then Pinellas County shall notify Contractor of non-compliance. Within 30 days of Contractor's receipt of a non-compliance notice ("Notice"), Contractor and Pinellas County shall meet and mutually agree upon an appropriate timeline for resolution of the Accessibility Issue(s) ("Initial Meeting").

Should Contractor:

i. fail to acknowledge receipt of the notice within 30 days of receipt of the Notice;

ii. unreasonably and solely withhold agreement regarding a timeline for resolution for more than 30 days following the Initial Meeting: or

iii. fail to materially resolve the Accessibility Issue(s) within the agreed-upon timeline,

Failure to comply with the requirements of this section shall constitute a material breach of this Agreement and shall be grounds for termination of this Agreement by Pinellas County and subject Contractor to the Liability and Insurance – Indemnification Section of this Agreement, "Indemnification."

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30. Liability and Insurance

A. **Insurance** - Contractor shall comply with the insurance requirements set out in the Insurance Exhibit B, attached hereto and incorporated herein by reference.

B. **Indemnification** - Contractor agrees to indemnify, pay the cost of defense, including attorney's fees, and hold harmless the County, its officers, employees and agents from all damages, suits, actions or claims, including reasonable attorney's fees incurred by the County, of any character brought on account of any injuries or damages received or sustained by any person, persons, or property, or in any way relating to or arising from the Agreement; or on account of any act or omission, neglect or misconduct of Contractor; or by, or on account of, any claim or amounts recovered under the Workers' Compensation Law; or of any other laws, regulations, ordinance, order or decree; or arising from or by reason of any actual or claimed trademark, patent or copyright infringement or litigation based thereon; or for any violation of requirements of the Americans with Disabilities Act of 1990, as may be amended, and all rules and regulations issued pursuant thereto (collectively the "ADA") except when such injury, damage, or violation was caused by the sole negligence of the County.

C. **Liability** - Neither the County nor Contractor shall make any express or implied agreements, guaranties or representations, or incur any debt, in the name of or on behalf of the other Party. Neither the County nor Contractor shall be obligated by or have any liability under any agreements or representations made by the other that are not expressly authorized hereunder. The County shall have no liability or obligation for any damages to any person or property directly or indirectly arising out of the operation by Contractor of its business, whether caused by Contractor's negligence or willful action or failure to act.

D. **Contractor's Taxes** - The County will have no liability for any sales, service, value added, use, excise, gross receipts, property, workers' compensation, unemployment compensation, withholding or other taxes, whether levied upon Contractor or Contractor's assets, or upon the County in connection with Services performed or business conducted by Contractor. Payment of all such taxes and liabilities shall be the responsibility of Contractor.

31. County's Funding

The Agreement is not a general obligation of the County. It is understood that neither this Agreement nor any representation by any County employee or officer creates any obligation to appropriate or make monies available for the purpose of the Agreement beyond the fiscal year in which this Agreement is executed. No liability shall be incurred by the County, or any department, beyond the monies budgeted and available for this purpose. If funds are not appropriated by the County for any or all of this Agreement, the County shall not be obligated to pay any sums provided pursuant to this Agreement beyond the portion for which funds are appropriated. The County agrees to promptly notify Contractor in writing of such failure of appropriation, and upon receipt of such notice, this Agreement, and all rights and obligations contained herein, shall terminate without liability or penalty to the County.

32. Survival

The provisions of this Agreement shall survive the expiration or termination of this Agreement.

33. Notices

All notices, authorizations, and requests in connection with this Agreement shall be deemed given on the day they are: (1) deposited in the U.S. mail, postage prepaid, certified or registered, return receipt requested; or (2) sent by air express courier (e.g., Federal Express, Airborne, etc.), charges prepaid, return receipt requested; or (3) sent via email and addressed as set forth below, which designated person(s) may be amended by either Party by giving written notice to the other Party:

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For County:

Attn: Dontrell Smith
Utilities Wastewater Treatment Manager
Pinellas County Utilities
7401 54th Street North
Saint Petersburg, FL 33709

dsmith@pinellas.gov

with a copy to:

Attn: Merry Celeste
Purchasing and Risk Management Division Director
Pinellas County Purchasing Department
400 South Fort Harrison Avenue
Clearwater, FL 33756

mceleste@pinellas.gov

For Contractor:

Attn: Ray Sibbitt
Director of Mini Bulk/ Municipal Development
1405 Highway 136 West
Henderson, KY 42419

rsibbitt@brenntag.com

34. Conflict of Interest

A. The Contractor represents that it presently has no interest and shall acquire no interest, either direct or indirect, which would conflict in any manner with the performance of the Services required hereunder, and that no person having any such interest shall be employed by Contractor during the agreement term and any extensions.

B. The Contractor shall promptly notify the County in writing of any business association, interest, or other circumstance which constitutes a conflict of interest as provided herein. If the Contractor is in doubt as to whether a prospective business association, interest, or other circumstance constitutes a conflict of interest, the Contract may identify the prospective business association, interest or circumstance, the nature of work that the Contractor may undertake and request an opinion as to whether the business association, interest or circumstance constitutes a conflict of interest if entered into by the Contractor. The County agrees to notify the Contractor of its opinion within (10) calendar days of receipt of notification by the Contractor, which shall be binding on the Contractor.

35. Right to Ownership

All work created, originated and/or prepared by Contractor in performing Services pursuant to the Agreement, to the extent that such work, products, documentation, materials or information are described in or required by the Services (collectively, the “Work Product”) shall be County’s property when completed and accepted, if acceptance is required in this Agreement, and the County has made payment of the sums due therefore. The ideas, concepts, know-how or techniques developed during the course of this Agreement by the Contractor or jointly by Contractor and the County may be used by the County without obligation of notice or accounting to the Contractor. Any data, information or other materials furnished by the County for use by Contractor under this Agreement shall remain the sole property of the County.

AGREEMENT

36. Amendment

This Agreement may be amended by mutual written agreement of the Parties hereto.

37. Severability

The terms and conditions of this Agreement shall be deemed to be severable. Consequently, if any clause, term, or condition hereof shall be held to be illegal or void, such determination shall not affect the validity or legality of the remaining terms and conditions, and notwithstanding any such determination, this Agreement shall continue in full force and effect unless the particular clause, term, or condition held to be illegal or void renders the balance of the Agreement impossible to perform.

38. No Third-Party Beneficiary

The Parties hereto acknowledge and agree that there are no third-party beneficiaries to this Agreement. Persons or entities not a party to this Agreement may not claim any benefit from this Agreement or as third-party beneficiaries hereto.

39. Force Majeure

"Force Majeure Event" means any act or event that (i) prevents a Party (the "Nonperforming Party") from performing its obligations or satisfying a condition to the other Party's (the "Performing Party") obligations under this Agreement, (ii) is beyond the reasonable control of and not the fault of the Nonperforming Party, and (iii) the Nonperforming Party has not, through commercially reasonable efforts, been able to avoid or overcome. Force Majeure Event(s) do not include economic hardship, changes in market conditions or insufficiency of funds. If a Force Majeure Event occurs, the Nonperforming Party is excused from the performance and thereby prevented from satisfying any conditions precedent to the Performing Party's performance that cannot be satisfied, in each case to the extent limited or prevented by the Force Majeure Event. The Nonperforming Party must promptly notify the Performing Party upon the occurrence of a Force Majeure Event. When the Nonperforming Party is able to resume its performance or satisfy the conditions precedent to the Performing Party's obligations, the Nonperforming Party will resume performance under this Agreement without undue delay. Each Party will use commercially reasonable efforts to mitigate the effect of a Force Majeure Event.

40. Order of Precedence

All Exhibits attached and listed below are incorporated in their entirety into, and form part of this Agreement and will have priority in the order listed

A. Pinellas County Agreement
B. Exhibit A - Statement of Work
C. Exhibit B - Insurance Requirements
D. Exhibit C - Payment Schedule
E. Exhibit D - Payment/Invoices
F. Exhibit E - Dispute Resolution for Pinellas County Board of County Commissioners in Matters of Invoice Payments

In the event of an inconsistency in this Agreement and any of the attached Exhibits, the terms set forth in this Agreement will prevail.

41. Entirety

This Agreement constitutes the entire Agreement between the Parties and supersedes all prior negotiations, representations or agreements either oral or written.

(Signature Page Follows)

AGREEMENT

IN WITNESS WHEREOF, the Parties hereto have executed this Agreement the day and year first written.

PINELLAS COUNTY, FLORIDA
By and through its
Board of County Commissioners

By

Brenntag Mid-South, Inc.
Name of Firm

By: Ray Sibbitt
Signature
Ray Sibbitt
Print Name
Director of Mini Bulk / Municipal Development
Title

APPROVED AS TO FORM
By: *Keiah Townsend*
Office of the County Attorney

AGREEMENT

EXHIBIT A - STATEMENT OF WORK

1. SITE LOCATIONS

LOCATION
W. E. DUNN WATER RECLAMATION FACILITY 4111 DUNN DRIVE PALM HARBOR, FL 34683
SOUTH CROSS BAYOU ADVANCED WASTEWATER RECLAMATION FACILITY 7401 54TH AVENUE NORTH ST. PETERSBURG, FL 33709

2. REQUIREMENTS

A. Product Requirements – The product shall be Liquid Chlorine Cylinders owned by the Contractor, delivered destination/freight included (FOB) in accordance with all applicable American Water Works Association (AWWA) / American National Standards Institute (ANSI) / National Sanitation Foundation (NSF) standards, latest revisions, including ANSI/AWWA Standard Number B301-04 and NSF Standard 60.
B. Liquid chlorine must meet all guidelines as established by the AWWA Standards Manual under B300 Disinfection, Sections 2 (materials) and 3 (sampling, inspection, packaging, and marking).
C. Liquid chlorine shall be chemically pure, anhydrous, and free from floating taffy and other debris which tend to plug connections and passageways in feeding equipment.

3. PRODUCT SPECIFICATION

A. Chlorine shall be ninety-nine-point-five (99.5%) percent pure by volume, free of iron, meeting the specifications of AWWA B301-92 or the latest revision of the standard.
B. Chlorine shall be supplied and shipped in one (1) ton cylinders.
C. Liquid Chlorine supplied under this specification shall contain no soluble mineral or organic water that has been treated with the Liquid Chlorine.
D. The Liquid Chlorine supplied shall be dry chlorine. Moisture content shall not exceed one-hundred fifty (150 mg/l) milligrams/liter, (0.015 percent) by weight.
E. The sum of all heavy metals present in the Liquid Chlorine shall not exceed thirty (30 mg/l) milligrams/liter, (0.003 percent) expressed as Lead.
F. Mercury shall not exceed one (1 mg/l) milligram/liter, (0.0001 percent) reported as Mercury.
G. Arsenic shall not exceed three (3 mg/l) milligram/liter, (0.0003 percent) reported as Metallic Arsenic.
H. The total non-volatile residue shall not exceed fifty (50 mg/l) milligram/liter, (0.005 percent) by weight in Liquid Chlorine as loaded by the manufacturer into tank cars or chlorine tank trucks and shall not exceed one-hundred fifty (150 mg/l) milligram/liter, (0.015 percent) by weight, in Liquid Chlorine as loaded into one (1) ton cylinders.
I. Carbon Tetrachloride shall not exceed one hundred (100 mg/l) milligram/liter, (0.010 percent) in the Liquid Chlorine supplied.
J. Trihalomethanes (THM) shall not exceed three hundred (300 mg/l) milligram/liter, (0.030 percent).
K. Liquid Chlorine supplied under this specification shall be ninety-nine-point-five (99.5%) percent pure by volume, as a minimum, as determined by analyzing the chlorine using AWWA, ASTM International (ASTM), Food Chemical Codex or other approved methods.
L. Container shipments shall include a complete chemical analysis of the product, including moisture content, lead, mercury, arsenic, non-volatile residue, carbon tetrachloride, Trihalomethanes (THM), and all inorganic and organic contaminants with percent by weight.
M. Cylinders for shipment and storage of Liquid Chlorine shall be as described in Section 3.1, Container Descriptions – Chlorine Basics, 8th Edition, The Chlorine Institute, Inc.

4. PACKAGING AND VALVE RECONDITIONING

A. Contractor shall furnish one (1) ton cylinders for use in packaging, delivery, and furnishing of chlorine.

B. All cylinders shall be tested and serviceable in accordance with standards, recommended practices, and procedures of The Chlorine Institute's Chlorine Basics, provided in the solicitation as **Attachment A - The Chlorine Institute Chlorine Basics**.

C. All cylinder testing and certifications shall be labeled on the cylinders and test reports shall be provided with cylinder delivery.

D. Contractor shall perform the following activities to assure safety, serviceability, and filling of the chlorine cylinders:

i. All cylinder valves shall be serviced in accordance with The Chlorine Institute guidelines and procedural requirements before filling cylinders.
ii. All cylinder interiors must be visually inspected and cleaned in accordance with The Chlorine Institute guidelines and procedural requirements. The loose scale shall be removed accordingly before the filling process.
iii. All cylinder exteriors must be cleaned, painted, and free of excess paint scale build-up.
iv. All cylinder valves must be removed prior to refilling, and a new or rebuilt valve must be inserted and must be able to be opened with reasonable ease using a standard chlorine valve wrench (3/8" square box wrench with an overall length no greater than 8")
v. All cylinders must be shipped with the valve protection covers secured.
vi. All chlorine must be filtered with a removal rating of eighteen (18) to twenty (20) microns absolute; five (5) microns nominal during packaging so as to prevent end-user system components issues.
vii. Contractor must observe all cylinders for a twenty-four (24) hour storage period after filling and before releasing for delivery.
viii. Contractor must provide two (2) lead washers per cylinder. Lead washers must not be fixed to cylinders using wire as the wire cuts into the washer. Contractor must carry extra washers and have these available upon request.
ix. Each cylinder and container shall be stamped or marked with current Tare Weight prior to filling.

5. QUALITY ASSURANCE, SAFETY TRAINING AND CERTIFICATION

A. Certified Analysis: Contractor shall supply an affidavit upon cylinder delivery and signed by a corporate official certifying that the Liquid Chlorine furnished by the Contractor at the time of container loading complies with all applicable requirements of these specifications and AWWA Standard B301, latest revision.

B. National Sanitation Foundation (NSF) Certification Requirement: within forty-eight (48) hours of a request from the County, the Contractor shall provide NSF certification that the Liquid Chlorine to be provided is approved for potable water treatment and meets the NSF Standard 60.

C. Occupational Health and Safety: in compliance with Chapter 442, Florida Statutes, any items delivered from a Contractor must be accompanied by a Material Safety Data Sheet (SDS), which County will maintain. SDS sheets must include the following information:

i. The chemical name and the common name of the toxic substance
ii. The hazards or other risks in the use of the toxic substance, including:

- The potential for fire, explosion, corrosivity, and reactivity.
- The known acute and chronic health effects of risks from exposure, including the medical conditions which are generally recognized as being aggravated by exposure to the toxic substance; and
- The primary routes of entry and symptoms of overexposure

iii. The proper precautions, handling practices, necessary personnel, protective equipment, and other safety precautions in the use of, or exposure to, toxic substances, including appropriate emergency treatment in the case of overexposure.
iv. Emergency procedure for spills, fire, disposal, and first aid
v. A description, in lay terms, of the known specific potential health risks posed by the toxic substance intended to alert any person reading this information.
vi. The year and month, if available, that the information was compiled and the name, address, and emergency telephone number of the manufacturer responsible for preparing the information.
vii. Any questions regarding this requirement should be directed to:

AGREEMENT

Department of Labor and
Employment Security Bureau of
Industrial Safety and Health
Toxic Waste Information
Center 2551 Executive
Center Circle West
Tallahassee, Florida
32301-5014
Phone: (800) 367-4378

6. SAFETY

A. Contractor shall comply with all local, state, and federal Laws, Standards, and Regulations protecting workers from known hazards, as described in the OSHA Act of 1970, which includes providing them hazard awareness training.
B. Contractor shall be responsible for ensuring their workers are trained in the transportation, handling, and storage of toxic and hazardous materials and in compliance with OSHA 29 CFR 1910.1000 (Subpart Z "Toxic and Hazardous Substances").
C. Contractor shall provide a safety plan for the transportation and handling of the toxic and hazardous material they will bring onto government property, which shall include a hazard analysis particular to the location that it will be delivered to, what controls will be utilized to protect workers (contractor and government) from injury, and prevent damage to government property, including facilities, equipment, and landscaping. All reasonable precautions for the safety of, and shall provide, all reasonable protection to prevent damage, injury, or loss too.
D. Safety Training/Seminars: Upon request, Contractor shall provide a minimum of two (2) onsite training presentations per year per facility covered under this contract. Presentations shall cover known hazards associated with the toxic and hazardous material covered under this contract, the information provided by the manufacturer, as listed on the safety data sheet (SDS), regulatory Standards, and the contractor's safety plan.
E. Contractor shall ensure that all motor vehicles and equipment used to deliver and move hazardous materials is maintained in a safe condition.
F. Contractor's employees shall be properly trained and certified to transport and handle the Class of toxic and hazardous materials being delivered and handled under the terms of this contract.
G. Contractor is responsible for ensuring their workers are provided with necessary personal protective equipment (including respirators, self-contained breathing apparatus (SCBA), face and eye protection, and other protective equipment as described in the chemical manufacturer's safety data sheet (SDS).
H. Contractor shall provide all tools and equipment necessary to repair and handle chemical storage tanks and cylinders.
I. Contractor shall be responsible for developing an emergency response plan in the event of an accident, mishap, or emergency condition that may arise during the performance of this statement of work (SOW).
J. Contractor shall immediately inform a County representative when a problem exists, which is less than an emergency, and what remediation actions will be performed to control or eliminate hazards related to the reported issue. Contractor is responsible for providing Contractor-trained personnel within twenty-four (24) hours after receipt of a maintenance problem.

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7. EMERGENCY PLAN

A. At the Pre-commencement meeting (prior to first delivery):

i. Contractor shall provide, in writing, an emergency contingency plan with appropriate telephone contacts for County to follow in case of an emergency supply of Liquid Chlorine is needed.
ii. Contractor shall include an emergency spill response plan with the appropriate emergency response personnel names and twenty-four (24) hour telephone contact numbers.

B. Contractor must provide emergency response for any delivery site within ninety (90) minutes of being contacted, twenty-four (24) hours per day, seven (7) days per week.

**For damaged or leaking cylinders, the Contractor shall provide an emergency response with pick-up and removal from sites within two (2) hours of being contacted.

C. Proper spill response notification procedure must be followed, and any forms required by all local, state, or federal regulatory agencies shall be the responsibility of the Contractor.

i. In the event of a spill or leak, the Contractor shall supply the necessary personnel to respond to such an event to work with the local Hazardous Materials Response Team and to manage and oversee "After Event" cleanup efforts.
ii. Should a spill or leak occur caused by the Contractor's personnel, equipment, or method of delivery Contractor shall immediately comply with all applicable terms and conditions of the current version of Title III, Superfund Amendments and Reauthorization Act of 1986. 42 U.S.C.S.11001 et seq. (SARA) and the Florida Hazardous Materials Emergency Response and Community Right-to-Know Act of 1988 Part II Florida Statutes.
iii. The responsibility for compliance with Federal and State Rules and Regulations regarding Contractor caused spills or releases shall be the sole responsibility of the Contractor. Contractor shall hold County harmless for any failure to properly report and/or comply with this provision.

D. Safe Handling Training: Contractor shall coordinate, schedule, and provide one (1) training class at no additional cost to County, onsite at each delivery location, no less than once every twelve (12) months. Training to include chlorine handling procedures, SDS training, donning of respiratory equipment, and the use of A and B kits.

8. SHIPMENT/DELIVERY

A. Shipping: Liquid chlorine shall be shipped in accordance with standards and recommendations as described in Section 3.4 Container Shipping – Chlorine Basics, 8th Edition, The Chlorine Institute, Inc. or in such manner which, in the opinion of the County, is equal to or superior to such standards.
B. Empty tanks and cylinders are to be picked up and returned by the Contractor's trucks at no charge to the County. No deposits are to be charged for cylinders or drums.
C. Not less than every three (3) weeks, at minimum, the Contractor will advise the County, in writing, whether or not the County has chlorine containers in their possession that have been outstanding for ninety (90) days or more. Any listing of outstanding chlorine containers shall include: the type of container, container serial number, delivery point, and any other pertinent information.

9. DELIVERY AND STORAGE

A. Delivery of Liquid Chlorine shall be in one (1) ton cylinders owned by the Contractor, and delivery shall be made to various County locations. **Minimum delivery shall be one (1) cylinder.**
B. One (1) ton cylinders shall be delivered by flatbed truck to be off-loaded by the County overhead crane.
C. Packaging and shipment of Liquid Chlorine shall conform to all current regulations of the State of Florida, the United States Department of Transportation (USDOT), or other applicable regulatory agencies.

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D. Delivery shall be within forty-eight (48) hours of authorization. Delivery time of day shall be as arranged upon placement of the order and shall be between the hours of 7:00 A.M. and 2:30 P.M. EST. Requests to deviate from schedule must be confirmed by the Contractor with the ordering facility at least forty-eight (48) hours prior to scheduled delivery and must conform to delivery conditions set forth in this specification.
E. The ordering facility reserves the right to change quantities and delivery dates at their discretion within twenty-four (24) hour notice.
F. **County reserves the right to order one (1) ton cylinder at a time as needed.**

G. County will not pay deposit charges for cylinders within their possession.

H. Contact Person: Contractor shall provide the following information regarding the customer care representative to County within twenty-four (24) hours of notification of the award. County will not authorize the delivery of orders until the following information has been provided so that County can accurately monitor chemical orders:

Dontrell Smith
(727)582-7043
Dsmith@pinellas.gov
Pinellas County Utilities
7401 54th Street North
St. Petersburg, FL 33709

Additionally, the Contractor shall have a service representative familiar with chlorine applications in water and wastewater treatment plants available within forty-eight (48) hours of award notification to assist in product application, if necessary.

I. Within two (2) business hours of order placement, Contractor's contact person will confirm receipt of the order to the County's plant representative via e-mail.

10. DELIVERY INSPECTION AND TESTING

A. The Manufacturer-certified test report and accompanying certification pertaining to the quality of the material shall be supplied with every shipment, or the shipment will be refused at no cost to County.
B. Upon delivery, each valve container cap will be loosened, and the valve re-tested for leaks.
C. The container must also be inspected for physical damage, including any corrosion that is noticeable around the valve or fittings.

D. If the condition of the container and valves do not meet inspection, the container will be refused for delivery, and the Contractor shall remove the container from the facility at no cost to County.
E. A cylinder will be denied for delivery if the container displays the following:

i. Container shows signs of chemical leaking, physical damage, or excessive container rust or corrosion.
ii. Container valve leak under the valve cap, and the leak cannot be stopped by tightening the valve or packing gland.
iii. Should a container have a leak that cannot be secured for return, the container will be secured at the loading dock using the facilities "B-Kit," and the Contractor will be required to remediate the defective container removal within twenty-four (24) hours.

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11. SECURITY

There is an increased level of security at all County facilities; therefore, the following precautions must be followed by the Contractor:

A. At the pre-commencement meeting, the Contractor will provide County with a photo with each name of the drivers to be making the deliveries.
B. The facility scheduled to receive a delivery from the Contractor is to be notified before the tanker or truck leaves the terminal with the name of the driver, which will allow the facility to match up the driver and photo with his identification when he arrives.
C. Contractor's delivery tankers or trucks must be sealed with a security tag, and the serial number faxed or emailed to County after the vehicle has been loaded and is ready for shipping so County can match the numbers to ensure it is the same tanker or truck that left the terminal.
D. Manifests shall contain all of the same information along with the serial numbers and tanker or truck numbers.
E. Contractor's drivers must prominently display Contractor's company name on their person at all times.
F. Contractor's driver must notify County facility staff upon arriving and when leaving the facility.

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EXHIBIT B - INSURANCE REQUIREMENTS

1. INSURANCE:

The Contractor shall obtain and maintain and require any subcontractor to obtain and maintain, at all times during its performance of the Agreement, insurance of the types and in the amounts set forth. For projects with a Completed Operations exposure, Contractor shall maintain coverage and provide evidence of insurance for two (2) years beyond final acceptance. All insurance policies shall be from responsible companies duly authorized to do business in the State of Florida and have an AM Best rating of A- VIII or better.

A. If Contractor does not currently meet insurance requirements, Contractor shall also include verification from their broker or agent that any required insurance not provided at that time of submittal will be in place prior to the award of contract.

Contractor shall email certificate that is compliant with the insurance requirements. If the certificate received is compliant, no further action may be necessary. The Certificate(s) of Insurance shall be signed by authorized representatives of the insurance companies shown on the Certificate(s). **The Certificate holder section shall indicate Pinellas County, a Subdivision of the State of Florida, 400 S Fort Harrison Ave, Clearwater, FL 33756. Pinellas County shall be named as an Additional Insured for General Liability. A Waiver of Subrogation for Workers Compensation shall be provided if Workers Compensation coverage is a requirement.**

B. Approval by the County of any Certificate(s) of Insurance does not constitute verification by the County that the insurance requirements have been satisfied or that the insurance policy shown on the Certificate(s) of Insurance is in compliance with the requirements of the Agreement. County reserves the right to require a certified copy of the entire insurance policy, including endorsement(s), at any time during contract period.

C. If any insurance provided pursuant to the Agreement expires or cancels prior to the completion of the Work, you will be notified by CTrax, the authorized Contractor of Pinellas County. Upon notification, renewal Certificate(s) of Insurance and endorsement(s) shall be furnished to Pinellas County Risk Management at InsuranceCerts@pinellas.gov and to CTrax c/o JDi Data at PinellasSupport@ididata.com by the Contractor or their agent prior to the expiration date.

1) Contractor shall also notify County within twenty-four (24) hours after receipt, of any notices of expiration, cancellation, nonrenewal or adverse material change in coverage received by said Contractor from its insurer Notice shall be given by email to Pinellas County Risk Management at InsuranceCerts@pinellas.gov. Nothing contained herein shall absolve Contractor of this requirement to provide notice.

2) Should the Contractor, at any time, not maintain the insurance coverages required herein, the County may terminate the Agreement,

D. If subcontracting is allowed under this Agreement, the Primary Contractor shall obtain and maintain, at all times during its performance of the Agreement, insurance of the types and in the amounts set forth; and require any subcontractors to obtain and maintain, at all times during its performance of the Agreement, insurance limits as it may apply to the portion of the Work performed by the subcontractor; but in no event will the insurance limits be less than $500,000 for Workers' Compensation/Employers' Liability, and $1,000,000 for General Liability and Auto Liability if required below.

All subcontracts between the Contractor and its Subcontractors shall be in writing and are subject to the County's prior written approval. Further, all subcontracts shall

1. Require each Subcontractor to be bound to the Contractor to the same extent the Contractor is bound to the County by the terms of the Contract Documents, as those terms may apply to the portion of the Work to be performed by the Subcontractor.
2. Provide for the assignment of the subcontracts from the Contractor to the County at the election of Owner upon termination of the Contract.
3. Provide that County will be an additional indemnified party of the subcontract.

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4. Provide that the County will be an additional insured on all insurance policies required to be provided by the Subcontractor except workers compensation and professional liability.
5. Provide a waiver of subrogation in favor of the County and other insurance terms and/or conditions
6. Assign all warranties directly to the County; and
7. Identify the County as an intended third-party beneficiary of the subcontract. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract, copies of the Contract Documents to which the Subcontractor will be bound by this Section C and identify to the Subcontractor any terms and conditions of the proposed subcontract which may be at variance with the Contract Documents.

E. Each insurance policy and/or certificate shall include the following terms and/or conditions:

1) The Named Insured on the Certificate of Insurance and insurance policy must match the entity's name that responded to the solicitation and/or is signing the agreement with the County.
2) Companies issuing the insurance policy, or policies, shall have no recourse against County for payment of premiums or assessments for any deductibles which all are at the sole responsibility and risk of Contractor.
3) The term "County" or "Pinellas County" shall include all Authorities, Boards, Bureaus, Commissions, Divisions, Departments and Constitutional offices of County and individual members, employees thereof in their official capacities, and/or while acting on behalf of Pinellas County.
4) All policies shall be written on a primary, non-contributory basis. The minimum insurance requirements and limits for this Agreement, which shall remain in effect throughout its duration and for two (2) years beyond final acceptance for projects with a Completed Operations exposure, are as follows:

1) Workers' Compensation Insurance Worker's Compensation Insurance is required if required pursuant to Florida law. If, pursuant to Florida law, Worker's Compensation Insurance is required, employer's liability, also known as Worker's Compensation Part B, is also required in the amounts set forth herein.

Limits

Employers' Liability Limits	Florida Statutory
Per Employee	$ 500,000
Per Employee Disease	$ 500,000
Policy Limit Disease	$ 500,000

If Contractor/Contractor is not required by Florida law, to carry Workers Compensation Insurance in order to perform the requirements of this Agreement, County Waiver Form for workers compensation must be executed, submitted, and accepted by Risk Management. Failure to obtain required Worker's Compensation Insurance without submitting and receiving a waiver from Risk Management constitutes a material breach of this Agreement.

2) Commercial General Liability Insurance including, but not limited to, Independent Contractor, Contractual Liability Premises/Operations, Products/Completed Operations, and Personal Injury.

Limits

Combined Single Limit Per Occurrence	$ 1,000,000
Products/Completed Operations Aggregate	$ 2,000,000
Personal Injury and Advertising Injury	$ 1,000,000
General Aggregate	$ 2,000,000

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3) **Business Automobile or Trucker's/Garage Liability Insurance** covering owned, hired, and non- owned vehicles. If the Consultant does not own any vehicles, then evidence of Hired and Non-owned coverage is sufficient. Coverage shall be on an "occurrence" basis, such insurance to include coverage for loading and unloading hazards, unless Consultant can show that this coverage exists under the Commercial General Liability policy.

Limit

Combined Single Limit Per Accident	$1,000,000

4) **Excess or Umbrella Liability Insurance** excess of the primary coverage required, in paragraphs (1), (2), and (3) above.

Limits

Each Occurrence	$ 1,000,000
General Aggregate	$ 1,000,000

5) **Pollution Legal/Environmental Legal Liability Insurance** for pollution losses arising from all services performed to comply with this contract. Coverage shall apply to sudden and gradual pollution conditions including the discharge, dispersal, release or escape of smoke, vapors, soot, fumes, acids, alkalis, toxic chemicals, liquids or gases, waste materials or other irritants, contaminants, or pollutants into or upon land, the atmosphere or any watercourse or body of water, which results in Bodily Injury or Property Damage. If policy is written on a Claims Made form, a retroactive date is required, and coverage must be maintained for 3 years after completion of contract or "tail coverage must be purchased. Coverage should include and be for the at least the minimum limits listed below:

a. Bodily injury, sickness, disease, mental anguish, or shock sustained by any person, including death; property damage including physical injury to or destruction of tangible property including the resulting loss of use thereof, cleanup costs, and the loss of use of tangible property that has not been physically injured or destroyed.

b. Defense including costs, charges and expenses incurred in the investigation, adjustment, or defense of claims for such compensation damages.

c. Cost of Cleanup/Remediation.

Limits

Per Claim or Occurrence	$2,000,000
General Aggregate	$ 2,000,000

For acceptance of Pollution Legal/Environmental Legal Liability coverage included within another policy coverage required herein, a statement notifying the certificate holder must be included on the certificate of insurance and the total amount of said coverage per occurrence must be greater than or equal to the amount of Pollution Legal/Environmental Legal Liability and other coverage combined.

6) **Property Insurance** Contractor will be responsible for all damage to its own property, equipment and/or materials.

EXHIBIT C - PAYMENT SCHEDULE

Location	Estimated Annual Quantity	Unit of Measure	Unit Price	Total
W.E. Dunn Water Reclamation Facility 4111 Dunn Drive Palm Harbor, FL 34683	160	One (1) Ton Cylinders	$ 2,800.00	$448,000.00
South Cross Bayou Wastewater Plant 7401 54th Avenue North St. Petersburg, FL 33709	480	One (1) Ton Cylinders	$ 2,800.00	$1,344,000.00
			TOTAL FOR ONE (1) YEAR:	$1,792,000.00

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EXHIBIT D - PAYMENT/INVOICES

PAYMENT/INVOICES:

CONTRACTOR shall submit invoices for payment due as provided herein with such documentation as required by Pinellas County and all payments shall be made in accordance with the requirements of Section 218.70 et. seq, Florida Statutes, "The Local Government Prompt Payment Act." Invoices shall be submitted to the address below unless instructed otherwise on the purchase order, or if no purchase order, by the ordering department:

Finance Division Accounts Payable
Pinellas County Board of County Commissioners
P. O. Box 2438
Clearwater, FL 33757

Each invoice shall include, at a minimum, the Contractor's name, contact information and the standard purchase order number. In order to expedite payment, it is recommended the Contractor also include the information shown in below. The County may dispute any payments invoiced by CONTRACTOR in accordance with the County's Dispute Resolution Process for Invoiced Payments, established in accordance with Section 218.76, Florida Statutes, and any such disputes shall be resolved in accordance with the County's Dispute Resolution Process.

INVOICE INFORMATION:

Contractor Information Company name, mailing address, phone number, contact name and email address as provided on the PO

Remit To Billing address to which you are requesting payment be sent

Invoice Date Creation date of the invoice

Invoice Number Company tracking number

Shipping Address Address where goods and/or services were delivered

Ordering Department Name of ordering department, including name and phone number of contact person

PO Number Standard purchase order number

Ship Date Date the goods/services were sent/provided

Quantity Quantity of goods or services billed

Description Description of services or goods delivered

Unit Price Unit price for the quantity of goods/services delivered

Line Total Amount due by line item

Invoice Total Sum of all of the line totals for the invoice

Pinellas County offers a credit card payment process (ePayables) through Bank of America. Pinellas County does not charge Contractors to participate in the program; however, there may be a charge by the company that processes your credit card transactions. For more information, please visit Pinellas County purchasing website at (www.pinellascounty.org/purchase).

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EXHIBIT E - DISPUTE RESOLUTION FOR PINELLAS COUNTY BOARD OF COUNTY COMMISSIONERS IN MATTERS OF INVOICE PAYMENTS:

Payment of invoices for work performed for Pinellas County Board of County Commissioners (County) is made, by standard, in arrears in accordance with Section 218.70, et. seq., Florida Statutes, the Local Government Prompt Payment Act.

If a dispute should arise as a result of non-payment of a payment request or invoice the following Dispute Resolution process shall apply:

A. Pinellas County shall notify a Contractor in writing within 10 days after receipt of an improper invoice, that the invoice is improper. The notice should indicate what steps the Contractor should undertake to correct the invoice and resubmit a proper invoice to the County. The steps taken by the Contractor shall be that of initially contacting the requesting department to validate their invoice and receive a sign off from that entity that would indicate that the invoice in question is in keeping with the terms and conditions of the agreement. Once sign off is obtained, the Contractor should then resubmit the invoice as a "Corrected Invoice" to the requesting department which will initiate the payment timeline.

    1. Requesting department for this purpose is defined as the County department for whom the work is performed.

    2. Proper invoice for this purpose is defined as an invoice submitted for work performed that meets prior agreed upon terms or conditions to the satisfaction of Pinellas County.

B. Should a dispute result between the Contractor and the County about payment of a payment request or an invoice then the Contractor should submit their dissatisfaction in writing to the Requesting Department. Each Requesting Department shall assign a representative who shall act as a "Dispute Manager" to resolve the issue at departmental level.

C. The Dispute Manager shall first initiate procedures to investigate the dispute and document the steps taken to resolve the issue in accordance with section 218.76 Florida Statutes. Such procedures shall be commenced no later than 45 days after the date on which the payment request or invoice was received by Pinellas County and shall not extend beyond 60 days after the date on which the payment request or invoice was received by Pinellas County.

D. The Dispute Manager should investigate and ascertain that the work, for which the payment request or invoice has been submitted, was performed to Pinellas County's satisfaction, and duly accepted by the Proper Authority. Proper Authority for this purpose is defined as the Pinellas County representative who is designated as the approving authority for the work performed in the contractual document. The Dispute Manager shall perform the required investigation and arrive at a solution before or at the 60 days' timeframe for resolution of the dispute, per section 218.76, Florida Statutes. The County Administrator or his or her designee shall be the final arbiter in resolving the issue before it becomes a legal matter. The County Administrator or his or her designee will issue their decision in writing.

E. Pinellas County Dispute Resolution Procedures shall not be subject to Chapter 120 of the Florida Statutes. The procedures shall also, per section 218.76, Florida Statutes, not be intended as an administrative proceeding which would prohibit a court from ruling again on any action resulting from the dispute.

F. Should the dispute be resolved in the County's favor interest charges begin to accrue 15 days after the final decision made by the County. Should the dispute be resolved in the Contractor's favor the County shall pay interest as of the original date the payment was due.

G. For any legal action to recover any fees due because of the application of sections 218.70 et. seq., Florida Statutes, an award shall be made to cover court costs and reasonable attorney fees, including those fees incurred as a result of an appeal, to the prevailing party If it is found that the non-prevailing party held back any payment that was the reason for the dispute without having any reasonable lawful basis or fact to dispute the prevailing party's claim to those amounts.

Attachment A

THE CHLORINE INSTITUTE

Pamphlet 1

Chlorine Basics

Edition 8

A LEGACY OF 1924 since SAFETY STEWARDSHIP

May 2014

Table of Contents

1. INTRODUCTION

1.1 CHLORINE BASICS

The first Chlorine Manual was published by The Chlorine Institute in 1947. It was a comprehensive compilation of information to assist chlorine producers, packagers, and end users in the safe handling, storage, shipment, and use of chlorine. In the years since the original Chlorine Manual was published, the Institute has developed numerous documents that provide more detailed information on safe chlorine management.

With Edition 7 of Pamphlet 1 (2008), the Chlorine Manual was renamed Chlorine Basics. This change reflected the fact that a single document could no longer adequately communicate the detailed information required to safely handle, store, transport, and use chlorine. This pamphlet remains a valued resource, providing basic information for general users and providing an overview and references to more detailed information in other publications available from The Chlorine Institute.

The principal target audiences for this pamphlet are:

- Operations personnel – this is a primary resource document for this group, especially in small companies
- Engineering personnel – this is a roadmap to more detailed information in other pamphlets
- New employees – this is a good "primer" for new employee training and orientation, where the needs are the same as for operations personnel
- Users of Chlorine Institute Emergency Kits A, B, and C (since this document is included in each Kit) – the needs are the same as for operations personnel

For more detailed information, an online catalog is available on the Chlorine Institute's website – www.chlorineinstitute.org.

1.2 CHLORINE INSTITUTE STEWARDSHIP PROGRAM

The Chlorine Institute (CI) 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 extends to giving continued attention to the security of chlorine handling operations.

Chlorine Institute members are committed to adopting CI safety and stewardship initiatives including pamphlets, checklists, and incident sharing that will assist members in achieving measurable improvement. For more information on CI's stewardship program visit the CI website at www.chlorineinstitute.org.

1.3 DISCLAIMER

The information in this pamphlet is drawn from sources believed to be reliable. CI and its members, jointly and severally, make no guarantee, and assume no liability, in connection with any of this information. Moreover, it should not be assumed that every acceptable procedure is included, or that special circumstances may not warrant modified or additional procedures. The user should be aware that changing technology or regulations may require changes in the recommendations contained herein. Appropriate steps should be taken to ensure that the information is current, when used. These recommendations should not be confused with federal, state, provincial or municipal regulations, insurance requirements, or with national safety codes.

1.4 APPROVAL

CI's Customer Stewardship Issue Team approved Edition 8 of this pamphlet on May 19, 2014.

1.5 REVISIONS

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

1.6 SIGNIFICANT REVISIONS IN CURRENT EDITION

This edition includes numerous enhancements, e.g. more illustrations, updated content and expanded text, especially in the following Sections:

- Section 2 – Specific manufacturing and use hazards
- Section 4 – Tank car and cargo tank manway arrangements
- Section 7 – Hazards to health and first aid
- Section 8 – Engineering and maintenance
- Section 10 – Reactivity and flammability

These changes were implemented to make the document more useful to the diverse audience that values it as a source of basic information on chlorine.

1.7 CHECKLISTS

Several pamphlets contain checklists to assist members and non-members in self-audits or other reviews.

Because this pamphlet only summarizes some of the information contained in other pamphlets, the reader should refer to specific referenced pamphlets and their checklists. These checklists are designed to emphasize major topics and highlight the key recommendations for someone who has already read and understood the pamphlets.

The Chlorine Institute encourages the use of the pamphlets and checklists.

1.8 ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials, now referred to as ASTM International
CAS	Chemical Abstracts Service
CFR	Code of Federal Regulations
CI	The Chlorine Institute
DHS	U.S. Department of Homeland Security
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
IMDG	International Maritime Dangerous Goods
kPa	Kilopascal
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
ppm	Parts per million
psia	Pounds per square inch, absolute pressure
psig	Pounds per square inch, gauge pressure
PSM	Process Safety Management
RMP	Risk Management Plan

SDS	Safety Data Sheet (Material Safety Data Sheet)
TC	Transport Canada
TEMA	Tubular Exchanger Manufacturers Association, Inc.
TLV	Threshold Limit Value

2. GENERAL INFORMATION

2.1 WHAT IS CHLORINE?

Chlorine is one of 90 natural elements, the basic building blocks of our world. Since it is highly reactive, it is usually found chemically bonded to other elements. Sodium chloride, or common table salt, is one example.

Chlorine plays a vital role in many key uses and applications:

- Chlorine is used to control bacteria and viruses in drinking water that can cause devastating illnesses such as cholera and typhoid. Approximately 98% of modern drinking water systems in the U.S. use chlorine chemistry to ensure the drinking water remains safe from bacterial contamination.
- 93% of all pharmaceuticals rely on chlorine chemistry, including medicines that treat heart disease, cancer, AIDS, and many other life-threatening diseases.
- Chlorine chemistry is involved in the production of over 86% of crop protection chemicals.
- Chlorine is used to produce polyvinyl chloride (PVC) and other plastics. These plastics are used in many diverse products that you use every day.
- The chlorine industry contributes more than $46 billion to the North American economy annually and helps provide thousands of essential products.

2.2 CHLORINE MANUFACTURE

Most chlorine is manufactured electrolytically by the diaphragm, membrane, or mercury cell process. The use of mercury cell technology is declining. Any new or updated production facility will most likely use the membrane process. In each process, a salt solution (sodium or potassium chloride) is electrolyzed by the action of direct electric current which converts chloride ions to elemental chlorine. Chlorine is also produced in a number of other ways, for example, by electrolysis of molten sodium or magnesium chloride to make elemental sodium or magnesium metal; by electrolysis of hydrochloric acid; and by non-electrolytic processes. Euro Chlor (www.eurochlor.org) has a very detailed animated production process description that can be found at http://eurochlor.org/the-chlorine-universe/how-is-chlorine-produced.aspx.

$$Salt + Water + Electricity \rightarrow Chlorine + Caustic + Hydrogen$$
$$NaCl + H_2O + e^- \rightarrow \tfrac{1}{2}Cl_2 + NaOH + \tfrac{1}{2}H_2$$

Figure 2.1. Basic Chlor-Alkali Chemical Reaction Equation

Chlorine production for 2012 is estimated to be as follows:

Table 2.1 Chlorine Production

Area	Million Short Tons
Globally	69
United States	11.4
Canada	0.6
Mexico	0.3

2.2.1 Diaphragm Cell Technology

Currently in North America, a large percentage of chlorine production is from diaphragm cell technology (Fig. 2.2). The products of this type of cell are chlorine gas, hydrogen gas, and cell liquor composed of sodium hydroxide and sodium chloride solution.

A nearly saturated sodium chloride solution (brine) enters the diaphragm cell anode compartment and flows through the diaphragm to the cathode section. Chloride ions are oxidized at the anode to produce chlorine gas. Hydrogen gas and hydroxide ions are produced at the cathode. Sodium ions migrate across the diaphragm from the anode compartment to the cathode side to produce cell liquor containing 10% to 12% sodium hydroxide. Some chloride ions also migrate across the diaphragm resulting in the cell liquor containing 12 - 16% sodium chloride. The cell liquor is typically concentrated to 50% sodium hydroxide by an evaporation process. The salt recovered in the evaporation process is returned to the brine system for reuse.

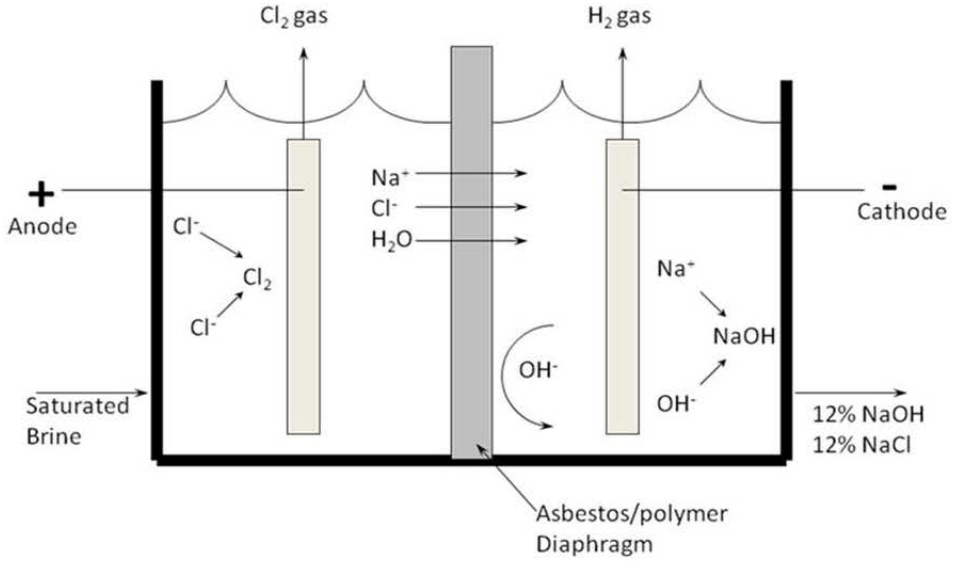


Figure 2.2 – Diaphragm Cell Technology

2.2.2 Membrane Cell Technology

Membrane cell technology (Fig. 2.3) uses sheets of perfluorinated polymer ion exchange membranes to separate the anodes and cathodes within the electrolyzer. Ultra-pure brine is fed to the anode compartments, where chloride ions are oxidized to form chlorine gas. The membranes are cation selective resulting in predominantly sodium ions and water migrating across the membranes to the cathode compartments. Water is reduced to form hydrogen gas and hydroxide ions at the cathodes. In the cathode compartment, hydroxide ions and sodium ions combine to form sodium hydroxide.

Membrane electrolyzers typically produce 30% to 35% sodium hydroxide, containing less than 100 ppm of sodium chloride. The sodium hydroxide can be concentrated further, typically to 50%, using evaporators.

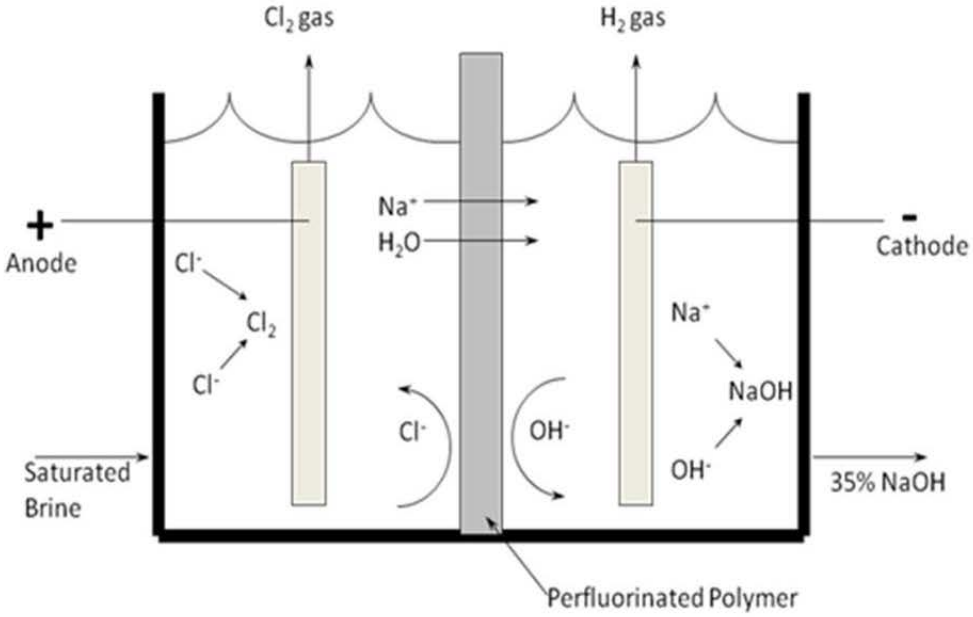


Figure 2.3 Membrane Cell Technology

2.2.3 Mercury Cell Technology

Mercury cell technology (Fig. 2.4) uses a stream of mercury flowing along the bottom of the electrolyzer as the cathode. The anodes are suspended parallel to the base of the cell, a few millimeters above the flowing mercury. Brine is fed into one end of the cell box and flows by gravity between the anodes and the cathode. Chlorine gas is evolved and released at the anode.

The sodium ions are deposited along the surface of the flowing mercury cathode. The alkali metal dissolves in the mercury, forming a liquid amalgam. The amalgam flows by gravity from the electrolyzer to the carbon-filled decomposer, where deionized water is added. The water chemically strips the alkali metal from the mercury, producing hydrogen and 50% sodium hydroxide. The mercury is then pumped back to the cell inlet, where the electrolysis process is repeated.

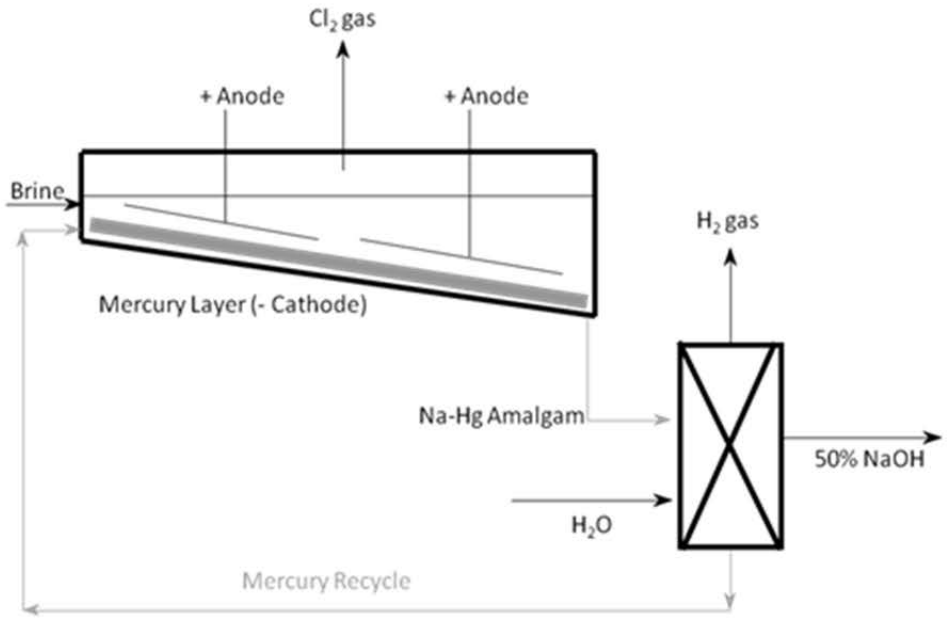


Figure 2.4 – Mercury Cell Technology

2.3 CHLORINE TRANSPORTATION

2.3.1 General

Chlorine is normally shipped as a liquefied compressed gas. The transportation of chlorine by all modes is controlled by various regulations. It is the responsibility of each person shipping or transporting chlorine to know and to comply with all applicable regulations.

2.4 OTHER REGULATORY ASPECTS

Chlorine manufacturers, packagers, and most consumers are subject to workplace regulations pertaining to chlorine.

2.4.1 United States

There are many regulations at the federal, state, and local levels that apply to chlorine manufacture, transport, and use. Agencies such as OSHA, EPA, DOT, and DHS regulate various aspects of the chlorine industry and should be consulted. Refer to Section 9 of this pamphlet for more information.

Table 2.2 Chlorine Classification

Country	Hazard Class	Division	Key Regulation	Other
United States	Primary: 2 Secondary: 5, 8	Primary: 2.3 Poison Gas Secondary: 5.1 Oxidizer Secondary: 8 Corrosive	Land: 49 CFR Barge: 33 CFR and 46 CFR	Poison Zone B inhalation hazard material rating. Various state and/or local regulations.
Canada	Primary: 2 Secondary: 5	Primary: 2.3 Poison Gas Secondary: 5.1 Oxidizer	Transportation of Dangerous Goods Act and Regulations (TDG)	Various provincial and/or local regulations
Mexico	Primary: 2 Secondary: 5	Primary: 2.3 Poison Gas Secondary: 5.1 Oxidizer	Regulation for Surface Transportation of Hazardous Materials and Waste	Various state and/or local regulations.
International			International Maritime Dangerous Goods Code (IMDG)	Designation for chlorine: UN1017

2.4.2 Canada

There are many regulations at the federal, provincial, and local levels that apply to chlorine manufacture, transport, and use. Agencies such as Health Canada, Environment Canada, and Transport Canada regulate various aspects of the chlorine industry and should be consulted.

2.5 TERMINOLOGY

2.5.1 Elemental Chlorine

Chlorine's symbol is Cl, its atomic number is 17, and its atomic weight is 35.453. Elemental chlorine almost always exists as a molecule with two chlorine atoms bound together as Cl_2. Its molecular weight is 70.906. The CAS registry number is 7782-50-5.

2.5.2 Liquid Chlorine

Liquid chlorine is chlorine (Cl_2) which has been cooled and compressed to a liquid form. Under atmospheric temperature and pressure, liquid chlorine evaporates quickly, with one pound of liquid forming about 5.4 cubic feet of chlorine gas.

Liquid chlorine is NOT the same as a hypochlorite or chlorine bleach solutions and this terminology should not be used to describe such solutions.

2.5.3 Chlorine Gas

At atmospheric conditions, chlorine is a gas.

2.5.4 Dry Chlorine/Wet Chlorine

Dry chlorine is defined as chlorine with its water content dissolved in solution. If a condition is reached anywhere in the system that will allow the water to exceed its solubility and form a second aqueous liquid phase, the chlorine is defined as wet chlorine. Wet chlorine will form corrosive compounds affecting the safety and integrity of the system. See CI Pamphlet 100 *(11.1)*.

Dry Chlorine is NOT a dry chlorinating compound such as calcium hypochlorite or chloroisocyanurates and this terminology should not be used to describe such a substance.

2.5.5 Moist Chlorine

Synonymous with wet chlorine.

2.5.6 Saturated Chlorine Gas

Chlorine gas in such condition that the removal of any heat or an increase in pressure will cause some portion of it to condense to a liquid. This term does not describe or refer to the relative moisture content of the chlorine.

2.5.7 Saturated Chlorine Liquid

Chlorine liquid in such condition that the addition of any heat or a decrease in pressure will cause some portion of the chlorine to vaporize to a gas. This term does not describe or refer to the relative moisture content of the chlorine.

2.5.8 Chlorine Solution (Chlorine Water)

A solution of chlorine in water (see Figure 10.3).

A chlorine solution is NOT the same as hypochlorite or chlorine bleach solutions and this terminology should not be used to describe such solutions.

2.5.9 Liquid Bleach

An aqueous solution of hypochlorite, usually sodium hypochlorite (NaOCl).

2.5.10 Container

In this publication, a container is a pressure vessel authorized by an applicable regulatory body for the transport of chlorine. It does not include pipelines or stationary storage tanks.

2.5.11 Filling Density

By DOT and TC regulation, the weight of chlorine that is loaded into a container may not exceed 125% of the weight of water at 60°F (15.6°C) that the container will hold.

2.5.12 Sodium Hydroxide

Normally sodium hydroxide (NaOH) is the co-product produced as a solution when chlorine is generated through the electrolytic decomposition of sodium chloride solution. Sodium hydroxide is frequently referred to as caustic soda or lye.

2.5.13 Potassium Hydroxide

A co-product produced as a solution when chlorine is generated through the electrolytic decomposition of potassium chloride salt solution. Potassium hydroxide (KOH) is frequently referred to as caustic potash.

2.6 SPECIFIC MANUFACTURING AND USE HAZARDS

Refer to your supplier's Safety Data Sheet (SDS) and referenced CI pamphlets for additional safety and handling precautions.

2.6.1 Hydrogen

Hydrogen (H_2) is a co-product of all chlorine manufactured by the electrolysis of aqueous brine solutions. Within a known concentration range, mixtures of chlorine and hydrogen are flammable and potentially explosive. The reaction of chlorine and hydrogen can be initiated by direct sunlight, other sources of ultraviolet light, static electricity, or sharp impact. See CI Pamphlet 121 *(11.1)*.

2.6.2 Nitrogen Trichloride

Small quantities of nitrogen trichloride (NCl_3), an unstable and highly explosive compound, can be produced in the manufacture of chlorine. When liquid chlorine containing nitrogen trichloride is evaporated, the nitrogen trichloride may concentrate to hazardous concentrations in the residue (see CI Pamphlets 21 and 152 *(11.1)*).

2.6.3 Oils and Grease

Chlorine can react, at times explosively, with a number of organic materials such as oil and grease from sources such as air compressors, valves, pumps, oil-diaphragm instrumentation, pipe thread lubricants. Equipment and piping must be cleaned prior to use to remove any oils. See CI Pamphlet 6 *(11.1)*. Ensure that non-reactive lubricants are used in chlorine service (e.g. Fluorolube® and Krytox®).

2.6.4 Fire

Chlorine is neither explosive nor flammable. Chlorine will support combustion under certain conditions. Many materials that burn in oxygen (air) atmospheres will also burn in chlorine atmospheres.

2.6.5 Chemical Action/Reactions

Chlorine has a very strong chemical affinity for many substances. It will react with many inorganic and organic compounds, usually with the evolution of heat. Chlorine reacts with some metals under a variety of conditions (see Section 10.3.3). It is especially important to not use any titanium in dry chlorine service. Chlorine will react with steel and other metals at temperatures above 149°C (300°F). Do not weld piping and other equipment without properly evacuating and purging chlorine from the equipment.

2.6.6 Corrosive Action on Steel and Other Metals

At ambient temperatures, dry chlorine, either liquid or gas, does not corrode steel. Wet chlorine is highly corrosive because it forms hydrochloric and hypochlorous acids. Precautions should be taken to keep chlorine and chlorine equipment dry. Piping, valves, and containers should be closed or capped when not in use to keep out atmospheric moisture such as precipitation or humidity. Materials of construction must be chosen carefully, depending on the conditions that are expected. If water is used on a chlorine leak, the resulting corrosive conditions will make the leak worse.

2.6.7 Volumetric Expansion

The volume of liquid chlorine increases with temperature. Precautions should be taken to avoid hydrostatic rupture of piping, vessels, containers, or other equipment filled with liquid chlorine (see Figure 10.4). Any time liquid chlorine can be trapped between two valves, an expansion device should be present.

2.6.8 Personal Protection

The most significant health hazard associated with chlorine is being exposed to chlorine vapors. Respiratory protection must be assured by process design, operating procedures and personal protective equipment. Skin contact with liquid chlorine can result in frostbite. See CI Pamphlet 65 *(11.1)*.

3. CYLINDERS AND TON CONTAINERS

3.1 <u>CONTAINER DESCRIPTIONS</u>

3.1.1 General

Cylinders and ton containers have many similarities in the way in which they are handled. The terms “cylinder,” “ton cylinder,” or “drum” should not be used to describe the ton container. Emergency and other equipment for handling ton containers is different from that used for cylinders and confusion can be avoided if the proper terms are used.

In this document, "container" will be used to refer to any vessel that holds chlorine for the purpose of transporting the product. This may include cylinders, ton-containers, cargo tanks, tank cars, and barges. If the information provided is specific to the type of container, it will be specified.

Site chlorine inventories exceeding the threshold quantity are subject to regulations such as as RMP and PSM. Check with federal, state, and provincial agencies for threshold requirements.

3.1.2 Cylinders

Chlorine cylinders are of seamless construction with a capacity of 1 to 150 lb (0.45 to 68 kg); those of 100 and 150 lb (45.4 and 68 kg) capacity predominate. The only opening in the cylinder is the valve connection at the top of the cylinder. The steel valve protective housing should be utilized to cover the valve during shipment and storage. Care must be taken with the protective cap since the cylinder neck-ring to which it is attached is not physically welded to the cylinder.

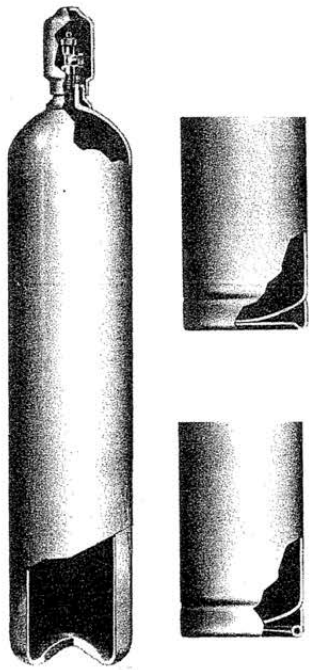


Figure 3.1 – Chlorine Cylinder
(Left – bump-bottom; Upper right – double-bottom; Lower right - foot ring)

3.1.3 Ton Containers

Ton containers are welded tanks having a capacity of one short ton, 2000 lb (907 kg), and a loaded weight of as much as 3650 lb (1655 kg). The sides are crimped inward at each end to form chimes which provide a substantial grip for lifting beams. The ton container valves are protected by a removable steel valve protective housing.

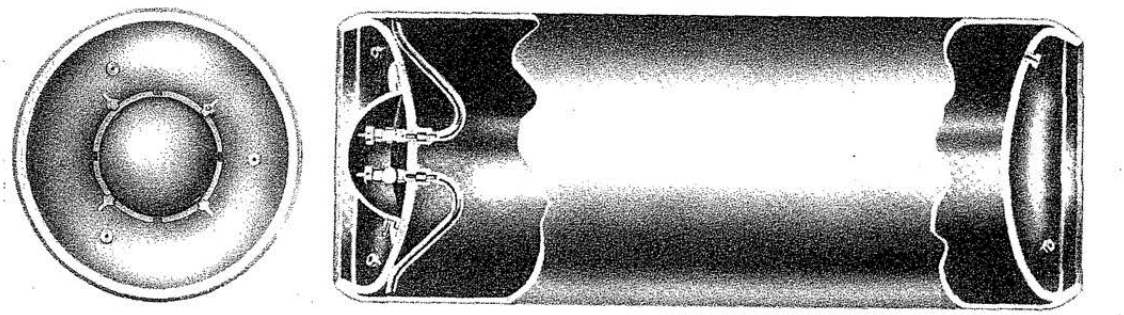


Figure 3.2 – Chlorine Ton Container

3.2 CONTAINER VALVES

3.2.1 Cylinder Valves

The typical cylinder is equipped with one valve. The valve outlet threads are not standard pipe threads, but are special straight threads. These outlet threads are intended for securing the valve outlet cap and not for connecting unloading connections or other devices. Typical cylinder connections are made with a yoke and adapter. See CI Pamphlet 17 *(11.1)*. The valve is also equipped with a fusible metal pressure relief device or, as more commonly named, a fusible plug.

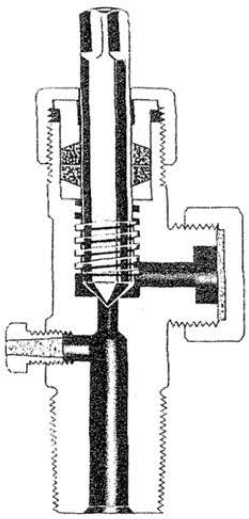


Figure 3.3 – One Typical Style of a Cylinder Valve (Other designs may also be in use)

3.2.2 Ton Container Valves

Each ton container is equipped with two identical valves near the center of one end. They are different from the typical cylinder valve in that they have no fusible metal plug and usually have a larger internal passage. Each valve connects to an internal eduction tube. See CI Pamphlet 17 *(11.1)*.

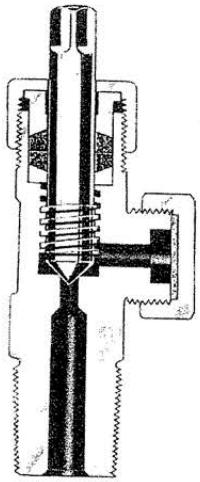


Figure 3.4 – One Style of a Chlorine Ton Container Valve (Other designs may also be in use)

3.3 PRESSURE RELIEF DEVICES

3.3.1 General

Cylinders and ton containers are equipped with a metal relief device or fusible plug. The fusible metal is designed to comply with the requirements of 49 CFR Part 173.301(f), and therefore, will melt between 158°F and 165°F (70°C and 74°C). These devices will relieve pressure when subjected to temperatures at or above the melting point of the fusible metal. The devices will not function in the absence of high temperature.

3.3.2 Cylinders

Cylinder valves are equipped with one fusible metal relief device or fusible plug.

3.3.3 Ton Containers

Ton containers are equipped with fusible metal pressure relief devices. Most have six fusible metal plugs, three in each end.

3.4 CONTAINER SHIPPING

3.4.1 Cylinders

Cylinders may be shipped by highway, rail, or water. Suitable restraints are necessary to prevent cylinders from shifting during transportation. See CI Pamphlet 76 *(11.1)*.

3.4.2 Ton Containers

Most ton containers are shipped by highway. Trucks must have suitable hold-down devices to prevent the ton containers from shifting during transportation. Trucks are sometimes equipped with a crane and lifting beam to facilitate loading and unloading. See CI Pamphlet 76 *(11.1)*.

3.5 CONTAINER MARKING/LABELING AND VEHICLE PLACARDING

Containers in transportation must be marked and labeled and the vehicle placarded as required by regulations.

3.6 CONTAINER HANDLING

3.6.1 General

Chlorine containers must be handled with care. During shipment and storage, container valve protective housings should be in place. Containers should not be dropped and no object should be allowed to strike them with force. Containers should be secured to prevent them from rolling. See CI Pamphlet 76 *(11.1)*.

3.6.2 Cylinders

Cylinders can be moved using a properly balanced hand truck. The hand truck should have a clamp or chain two-thirds of the way up the cylinder wall to hold the cylinder in place. If cylinders must be elevated by hoist, a specially designed cradle or carrier should be used. Slings and magnetic devices are unacceptable. Cylinders must not be lifted by the valve protective housing because the neck-ring to which the housing is attached is not designed to carry the weight of the cylinder.

3.6.3 Ton Containers

Ton containers are typically moved using a monorail or crane with a lifting beam (see Drawing 122). They can be rolled on rails or roller conveyors designed for this purpose. If a forklift truck is used, the ton container must be adequately restrained to prevent it from falling off, particularly when the truck changes direction. The forklift truck must be rated to handle the gross weight of the ton container.

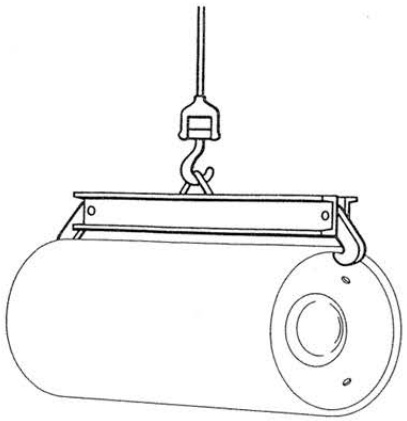


Figure 3.5 – Lifting Beam for Handling Chlorine Ton Containers

3.7 CONTAINER STORAGE

Containers may be stored indoors or outdoors. The storage area should comply with federal and state regulations.

If stored outdoors, the storage area should be clean so that accumulated trash or other combustible material does not present a fire hazard. Containers should not be stored near elevators or ventilating systems because dangerous concentrations of gas may spread rapidly if a leak occurs. All containers should be stored to minimize external corrosion.

Exposure of containers to flame, intense radiant heat or to steam lines must be avoided. If the metal in the vicinity of the fusible plug reaches approximately 158°F (70°C), the fusible metal plug is designed to melt and chlorine will be released.

See CI Pamphlets 17 and 155 *(11.1)* for more detail on storage considerations.

3.8 CONTAINER USE

3.8.1 General

Before connecting or disconnecting a container, the operator should make sure that all safety and emergency equipment is available and operable. Containers and valves must not be modified, altered, or repaired by anyone other than the owner.

3.8.2 Gas Discharge

Chlorine gas discharge rates vary significantly because of local ambient temperature, humidity and air circulation, as well as the variations in the piping system and feeding equipment connected to the container. See CI Pamphlet 155 for details *(11.1)*.

If the gas discharge rate from a single container will not meet the flow requirements, two or more may be connected to a manifold. Alternately, liquid from one or more containers may be sent to a vaporizer for increasing the chlorine gas delivery rate (see Section 3.8.3).

When discharging through a gas manifold, all containers should be at the same temperature to prevent transfer of gas from a warm container to a cool container.

3.8.3 Liquid Discharge

Discharging liquid chlorine has special design requirements. See CI Pamphlet 6 *(11.1)*.

Liquid chlorine is delivered from the lower valve of a ton container. See the picture of eductor tubes in Figure 3.2. Very high liquid withdrawal rates can be obtained. The rate depends on the temperature of the chlorine in the ton container and on the backpressure. The dependable continuous discharge rate of liquid chlorine under normal temperature conditions and against a pressure of 35 psig (241 kPa gauge) is at least 400 lb/hr (181 kg/hr) for ton containers. When connected to a manifold, ton containers discharging liquid chlorine should include precautions to equalize the pressure. Drawing 183 depicts a system for equalizing pressures for gas valves

connected to a manifold. It is not sufficient to depend on ton containers reaching the same pressure merely by storing them in the same working area. Piping evacuation procedures should be established so liquid chlorine is not trapped in the system.

3.8.4 Weighing

Because chlorine is shipped as a compressed liquefied gas, the pressure in a container depends on the temperature of the chlorine (Figure 10.1). The pressure is not related to the amount of chlorine in the container. Container contents can be determined accurately only by weighing.

3.8.5 Connections

A chlorine compatible flexible connection must be used between the container and a pressurized piping system. Copper tubing with a diameter of 1/4-inch or 3/8-inch is recommended. Flexible metallic hoses or fluoroplastic hoses as described in CI Pamphlet 6 *(11.1)* are also acceptable materials. If a system is to remain in operation while containers are being connected or disconnected, auxiliary (isolating) container valves must be used. Flexible connections should be inspected and replaced on a regular basis. A flat gasket on the face of the valve is part of the connection. A new gasket should be used each time a connection is made (see CI Pamphlets 6 and 155 (11.1) and Drawing 189).

3.8.6 Opening Valves

The container valve is opened by turning the valve stem in a counter-clockwise direction. One full turn of the stem typically permits an appropriate feed rate. More stem turns should not be made unless recommended by the supplier. A wrench (50 ft/lbs maximum torque), no longer than 8 inches, should be used. Never use a wrench extension (cheater bar) as the valve may be damaged preventing gas-tight shutoff. Once the valve is opened, the wrench should be left in place so that the valve can be closed quickly. Do not loosen the packing nut unless authorized by the supplier.

To connect a line to the container, ensure the valve is closed. Make certain that the packing nut is at least hand tight; if it is not, contact your supplier for advice. Remove the valve outlet cap and attach the line to the valve with a yoke. Use a new gasket each time a connection is made. Make sure connections are tight.

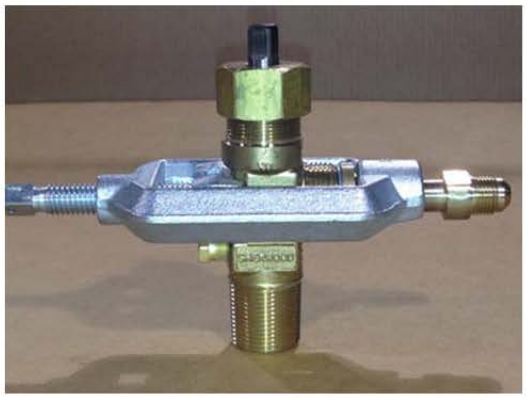


Figure 3.6 – Open Yoke Adapter – Type Connector

Once connections have been made, pressurize the system with a small amount of chlorine, and check for leaks. If a leak is found, it must be remedied before proceeding (see CI Pamphlet 155 *(11.1)*).

3.8.7 Closing Valves

Apply 25-30 foot-pounds to the valve stem. Check for leaks. If any leaks still exist, the torque may be increased up to 40 foot-pounds. If the leak has not stopped at 40 foot-pounds, increase the torque on the valve stem to 50 foot-pounds. Foreign objects such as rust flakes or other debris can prevent positive shutoff of chlorine valves. If the container remains connected to the process and it is safe to do so, a complete cycling of the valve may dislodge the foreign material and allow positive valve shutoff. Always verify the valve is being turned clockwise for closing. If this fails to work, contact your supplier.

3.8.8 Disconnecting Containers

As soon as a container is empty, the valve should be closed (see Section 3.7.7). Prior to disconnecting, reconfirm that the valve is closed and provide a means of removing the chlorine trapped in the flexible connecting line. This can be accomplished by either purging the line with dry air or nitrogen with a dew point of -40°F (-40°C) or lower or by applying a vacuum. Personal Protective Equipment should be used as appropriate for the task. See CI Pamphlet 65 *(11.1)*. The container should be cautiously disconnected in case residual chlorine remains in the lines. The outlet cap should be applied promptly and the valve protective housing should be replaced. The open end of the disconnected flexible line should be capped promptly to keep atmospheric moisture from entering the system.

4. BULK SHIPPING CONTAINER

4.1 General

Bulk chlorine is shipped by pipeline, tank cars, tank motor vehicles, portable tanks, and barge tanks.

4.2 Tank Cars

4.2.1 General

The following is generalized information on chlorine tank cars. See CI Pamphlet 66 *(11.1)*.

4.2.2 Specifications

The most commonly used tank cars have a chlorine capacity of 90 tons. By regulation, tank cars may not be loaded with chlorine in excess of the nominal weight.

Table 4.1 Key Government Specifications

United States	49 CFR 179.102-2	49 CFR 176-314 (c) note 12
Transport Canada	79.102-2	73.314 (c) note 12

The regulations require tank cars to be equipped with a pressure relief device whose setting is stenciled on the side of the car. Tank cars must be thermally protected with four inches of insulating material.

4.2.3 Manway Arrangement

The only opening into a chlorine tank car is through a manway on top, where the valves are enclosed with a steel cover.

Most chlorine tank cars have four angle valves. They also have one pressure relief device designed to release excess pressure buildup within the tank. Two of the angle valves are located on the longitudinal center of the car. These valves are connected to eduction pipes that run to the bottom of the tank and are used to unload liquid chlorine. Two angle valves are located on a line perpendicular to the car's length and are connected to the vapor phase. These valves should never be used for gas withdrawal, but can be used to pressurize the car when needed to increase the rate of liquid withdrawal. In cars built prior to 2009, the liquid valves are equipped with excess flow valves designed to close at flow rates of 7,000, 15,000 or 32,000 lb per hour. The flow rate is usually stenciled on the side of the car. Unstenciled cars have 7,000-lb-per-hour valves.

Starting in 2009, chlorine tank cars began to be equipped with an alternate valve design. The primary feature that is different on the alternate design is that a check valve is used in place of an excess flow valve. The check valve is designed to remain closed during transport, so in the unlikely event of a rollover where valves shear off, the valve port remains closed and prevents an accidental release. Arrangements consisting of the alternate design may have wider bases and can consist of either 3 or 4 liquid/vapor valves and one pressure relief device.

The CI Emergency Kit C is designed to be used for stopping leaks on chlorine tank cars. See CI Pamphlet 66 *(11.1)*. It is important to know if an alternate valve design or the traditional valve design is used on a tank car because the C-Kit will need to be applied differently, depending on the valve design encountered.

For additional guidelines, recommended practices, and other useful information concerning chlorine tank cars, refer to CI Pamphlets 66, 166 and 168 *(11.1)*.

4.2.4 Transfer Operations

The following is general information. See CI Pamphlet 66 *(11.1)*.

Precautions

Every site handling chlorine in bulk containers should have RMP and PSM programs.

Special attention should be directed to the appropriateness of emergency procedures and to equipment to be used in an emergency.

Chlorine transfer operations must be performed only by personnel who are trained as required by applicable hazardous material regulations.

DOT (49 CFR), OSHA (29 CFR) and TC (Sec. 10.2) have specific training requirements applicable to handling of hazardous materials.

All personnel responsible for transfer operations should be knowledgeable about the facility's emergency response plan for handling spills and leaks of products. See CI Pamphlet 66 *(11.1)*.

Before beginning transfer operations, a number of things should be considered. Details can be found in CI Pamphlet 66. A partial list of topics includes:

- Connections
- Pressure padding
- Monitoring
- Disconnecting

4.3 CARGO TANK MOTOR VEHICLES

4.3.1 General

The following is generalized information on chlorine cargo tank motor vehicles. See CI Pamphlet 49 *(11.1)*. In North America, they usually have a capacity ranging from 15 to 22 tons (13,600 kg to 20,000 kg) with certain exceptions. DOT specifications apply only to the tank.

4.3.2 Manway Arrangement

The manway arrangement is the same as that on chlorine tank cars (see Section 4.2.3) except that special excess-flow valves are required under the gas valves.

4.3.3 Transfer Operations

Procedures for transferring chlorine to/from cargo tanks are essentially the same as for tank cars. There is, however, more variation in facilities and conditions at customers' plants, and these may require modifications of methods and equipment.

4.3.4 Precautions

The engine should be shut off, hand brakes must be set, and wheel chocks must be in place during transfer. The tank motor vehicle must be attended at all times. The tank motor vehicle must not be moved when loading or unloading connections are attached to the vehicle (see discussion of tank car transfer, Section 4.2.40, for additional, applicable precautions).

4.3.5 Emergency Equipment

Approved respiratory equipment is required on the transport vehicle. An Emergency Kit "C" must be on the transport vehicle. Proper training on the use of emergency equipment is required (OSHA 29 CFR 1910.134).

It also is required that the transport vehicle have 2-way communication such as a cell phone or radio.

4.3.6 Connections/Disconnecting

See discussion for tank cars (Section 4.2.4).

The driver should recheck all equipment by a visual inspection before starting the vehicle.

4.3.7 Pressure Padding

See discussion for tank cars (Section 4.2.4).

4.4 PORTABLE TANKS

Tanks suitable for multi-modal transportation (road, rail, and water) of chlorine should be built under the provisions of DOT 51 and special provisions for chlorine. See CI Pamphlet 49 *(11.1)*.

4.5 TANK BARGES

Consult your supplier for information on chlorine barges.

5. EMERGENCY MEASURES

5.1 GENERAL

A chlorine emergency may occur during manufacture, use, or transportation. Trained employees, along with a comprehensive, written emergency response plan are necessary to mitigate the consequences of the emergency. Regular drills and reviews of emergency response plans with all involved organizations are encouraged. See CI Pamphlet 64 *(11.1)*. Federal, state and provincial regulations, as well as various local fire and building codes, regulate chemical emergency preparedness and response. All persons responsible for the handling of chlorine must be familiar with those requirements. Regulatory requirements deal generally with preparation and response to chemical and other emergencies. See CI Pamphlet 64 *(11.1)*. Help is also available from CHLOREP (see Sections 5.5.1 to 5.5.3) which can be accessed through CHEMTREC (U.S.). In Canada, CANUTEC may provide advice, as well as contact information for the appropriate CHLOREP Team.

5.2 RESPONSE TO A CHLORINE RELEASE

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 chlorine leak occurs, authorized, trained personnel equipped with respiratory and appropriate other PPE should investigate and take proper action. Personnel should not enter into atmospheres containing concentrations of chlorine in excess of the IDLH Concentration of 10 ppm without appropriate personal protective equipment and backup personnel.

CI Pamphlet 65 *(11.1)* provides 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.

When evacuation is necessary, potentially exposed persons should move to a point upwind of the leak. To escape in the shortest time, persons already in a contaminated area should move crosswind. Because chlorine is heavier than air, higher elevations are preferable.

When inside a building and sheltering-in-place is selected, shelter by closing all windows, doors and other openings, and turning off air conditioners and air intake systems. Personnel should move to the side of the building furthest from the release.

Care must be taken not to position personnel without an escape route. A safe position may be made hazardous by a change in wind direction. New leaks may occur or the existing leak may get larger.

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 container involved
- Corrective measure being applied
- Other pertinent information, i.e., weather conditions, injuries, etc.

There are specific government requirements for reporting a hazardous chemical release. Releases must be reported in a timely manner. See CI Pamphlet 64 *(11.1)*.

5.3 RESPONSE TO A FIRE

If fire is present or imminent, chlorine containers and equipment should be moved away from the fire, if it is possible to do so safely. 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 forming 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 cool 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 cooled.

Containers exposed to fire should be isolated and the supplier should be contacted as soon as possible.

5.4 RELEASES

5.4.1 General

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

5.4.2 Detection of Minor Releases and Leaks

A plastic squeeze bottle containing 26° Baumé (30 wt.%) aqua ammonia can be used to detect a minor release or leak. If ammonia vapor is directed at a leak, a white cloud will form indicating the source of the leak. If a wash bottle is used, the dip tube should be cut off so that squeezing the bottle directs vapor, not liquid, out of the nozzle. Avoid contact of aqua ammonia with brass or copper. Portable electronic chlorine monitors can also be used to detect leaks. If a leak occurs from equipment or piping, the chlorine supply should be shut off, the pressure relieved and necessary repairs made.

Leaks around shipping container valve stems usually can be stopped by tightening the packing gland. If such tightening does not stop the leak, the container valve should be closed. Leaks at the packing nut will always stop when the valve is closed. See CI Pamphlet 66 *(11.1)*. If simple corrective measures are not sufficient, the appropriate Chlorine Institute Emergency Kit should be applied or the cylinder should be placed in a recovery vessel designed to contain the leak, and the chlorine supplier notified (see Section 5.8).

5.4.3 Area Affected

The area affected by a chlorine release and the duration of the exposure depend upon the total quantity released, the rate of release, the height of the release point and weather conditions, as well as the physical form of the chlorine being released. These factors are difficult to evaluate in an emergency situation. Chlorine downwind can vary from barely detectable to high concentrations. CI Pamphlet 74 *(11.1)* provides information on the area affected by specific chlorine release scenarios.

5.4.4 Physical Form of the Chlorine Released

Typically, chlorine is stored and transported as a liquid under pressure. Liquid chlorine expands in volume by nearly 460 times when it vaporizes; therefore, a liquid chlorine leak can have significantly greater downwind effect than a gaseous chlorine leak.

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.

5.4.5 Effect of Chlorine on the Environment

Vegetation

Plants in the path of a chlorine release may be damaged. Leaves may be bleached and browning and leaf loss may occur. Healthy plants will usually recover with time.

Animals

Seek medical attention for evaluation or treatment for pets and other animals that experience irritation or any signs of respiratory distress.

Aquatic Life

Chlorine is only slightly soluble in water and there would be little absorption from a cloud of chlorine gas. If chlorine is released into a lake or stream, it may harm aquatic plants and animals until it dissipates.

5.5 TRANSPORTATION EMERGENCIES

DOT and TC require that any person who offers chlorine for transportation must provide a staffed 24-hour emergency response telephone number that can be called in the event of an emergency involving chlorine. The SDS, provided by the chlorine supplier, contains this contact information. This information may also be found on the bill of lading and the shipping container.

5.5.1 CHLOREP

The Chlorine Emergency Plan (CHLOREP) was established in January 1973 by CI as an industry-wide program to improve the speed and effectiveness of response to chlorine emergencies in the United States and Canada.

The primary purpose of the Plan is to minimize the risk of injury arising from the actual or potential release of chlorine during emergencies occurring in the course of transportation at distribution points, or at chlorine user locations. Under this Plan, the United States and Canada have been divided into regional sectors where trained emergency teams from producing, packaging, distribution, and consuming plants are available on a 24-hour basis to handle possible or actual chlorine releases.

5.5.2 CHEMTREC, CANUTEC, & SETIQ

During a chlorine emergency, any carrier, customer, or civil authority can obtain basic emergency information and contact information for the closest chlorine emergency group through CHEMTREC (U.S.), CANUTEC (Canada), SETIQ (Mexico), or their chlorine supplier. The emergency response call center, i.e. CHEMTREC and CANUTEC, provides immediate advice for those at the scene of emergencies. CHEMTREC will promptly contact the appropriate responder group as required. CANUTEC will provide contact information and participate on a call to the appropriate responder, which must be initiated by the incident scene contact. In many cases, the responder will be the shipper. However, in some cases, the designated response group is called and then the shipper is notified.

Table 5.1 Emergency Contact Information

Dispatch Agency	Country	Phone Number
CHEMTREC	Continental United States	1-800-424-9300
CHEMTREC	Alaska and Hawaii	1-703-527-3887
CHEMTREC	Marine radio telephone	1-703-527-3887
CHEMTREC	Collect calls anywhere in the US	1-703-527-3887
CANUTEC	Canada	1-613-996-6666 (collect calls accepted)
SETIQ	Mexico	01-800-00214-00
SETIQ	Mexico – from outside the country	011-55-5-5591588

5.5.3 In-Transit Emergency Response

If a chlorine leak develops in transit, appropriate emergency measures should be taken as quickly as possible.

If a vehicle transporting chlorine cylinders or ton containers is disabled and there is any possibility of fire, the containers should be removed from the vehicle to a safe distance if possible.

If a tank car or cargo tank trailer is disabled and chlorine is leaking, appropriate emergency procedures should be instituted in consultation with local authorities. Clearing of track or highway should not be started until safe working conditions are established. See Section 5.3 for action to take if a fire occurs.

The specific actions taken by emergency responders will vary. Some items to consider acting upon are:

- Is it possible to safely turn the container so that gas instead of liquid escapes? The quantity of chlorine that escapes from a gas leak is much less than the amount that escapes from a liquid leak through the same size hole.
- Is it possible to safely reduce the pressure in the container by removing the chlorine as gas (not as liquid) to a process or a disposal system? (See Sections 5.6 and 5.7).
- Can the container be safely moved to an isolated spot where the consequences can be minimized?
- Is it possible to safely apply the appropriate Chlorine Institute Emergency Kit or place the cylinder in a recovery vessel designed to contain the leak? (See Section 5.8).

A leaking chlorine 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.

Specific government regulations must be followed for the shipment of a leaking chlorine container or a container which has been exposed to fire, whether full or partially full. In such cases, special arrangements are required and the chlorine supplier should be consulted first.

5.6 CHLORINE LEAK AT A CONSUMING LOCATION

In addition to leak mitigation efforts, the following may be considered:

- It may be best to consume the chlorine through the regular process. If the consuming process cannot handle chlorine under emergency conditions, a standby alkali absorption system or a scrubber should be considered.
- It must be recognized that systems consuming liquid chlorine at low rates may not significantly reduce pressure in the supply container. In order to reduce pressure in the supply container, chlorine must be removed as a gas at a rate high enough to cause cooling of the remaining liquid. (See Section **Error! Reference source not found.**).

5.7 ABSORPTION SYSTEMS

Chlorine is readily absorbed in and reacted with an alkaline solution. The alkaline solution consists of water and sodium hydroxide, sodium carbonate, or potassium hydroxide. Contact your chlorine supplier and consult CI Pamphlet 89 *(11.1)*

5.8 EMERGENCY KITS AND RECOVERY VESSELS

Chlorine Institute Emergency Kits and cylinder recovery vessels are designed to contain most leaks which may be encountered from chlorine containers. The following kits and recovery vessels are available:

- Kit A - for 100 lb and 150 lb cylinders

- Kit B - for ton containers.

- Kit C - for tank cars and tank trucks.

- Recovery vessels for cylinders.

The kits contain step-by-step instructions for the use of the devices. The necessary tools are included, but personal protective equipment is not included. CI Pamphlets IB/A, IB/B, and IB/C *(11.1)* provide information on these kits and their use.

Chlorine recovery vessels are commercially available equipment designed to hold an entire cylinder. A leaking cylinder can be placed in a recovery vessel which is then closed, thus containing the leak. The chlorine can then be recaptured from the recovery vessel.

For chlorine barges, contact your supplier for information or equipment for leak mitigation.

Chlorine consumers should incorporate plans for the use of these kits in their emergency programs, provide instruction to the emergency responders, and properly maintain the equipment. Further information on the utility, availability, and purchase of kits, kit components, and audio visual training aids is available from the Institute or the chlorine supplier.

Chlorine use or storage locations should have either the appropriate emergency kit(s) or containment vessel(s) readily available with emergency responders trained in their use or have a formal arrangement with an outside emergency response group that can respond to emergencies using such equipment.

5.9 Reporting

Most governmental agencies have reporting requirements for chlorine releases. Producers, transporters, and users of chlorine should be aware of the "reportable quantity" and of all relevant requirements.

6. EMPLOYEE TRAINING AND SAFETY

6.1 Employee Training

Safety in handling chlorine depends, to a great extent, upon the effectiveness of employee training, proper safety instructions and the use of suitable equipment. It is the responsibility of the employer to train employees and to document such training as appropriate and as required by regulation. It is the responsibility of employees to carry out correct operating procedures safely and to properly use the safety equipment provided.

Employee training should include but is not limited to:

- Instruction and periodic refresher courses in operation of chlorine equipment and handling of chlorine containers.
- Instruction in the properties and physiological effects of chlorine, including the information on the Safety Data Sheet (SDS).
- An SDS should be provided by the chlorine supplier.
- Instruction to report to the proper authority all equipment failures and chlorine leaks.

Instruction and periodic drills regarding:

- Locations, purpose, and use of chlorine emergency equipment, firefighting equipment, fire alarms and shutdown equipment such as valves and switches.
- Use and installation of emergency kits, such as the Chlorine Institute Emergency Kits A, B, or C and the recovery vessel if they are part of emergency equipment and planning at the location.
- Locations, purpose, and use of personal protective equipment.
- Locations, purpose, and use of safety showers, eye washes, or the closest source of water for use in emergencies.
- Locations, purpose, and use of any specialized first aid equipment.

6.2 PERSONAL PROTECTIVE EQUIPMENT

6.2.1 Availability and Use

There is a potential for exposure to chlorine whenever chlorine is handled, stored, or used. If chlorine is used in widely separated locations, personal protective equipment should be available near each use point. Personal protective equipment (PPE) for emergency use should be available away from areas of likely contamination. CI Pamphlet 65 *(11.1)* provides recommendations on appropriate PPE for specific tasks including loading/unloading, initial line entry, material sampling, and emergency response.

6.2.2 Respiratory Equipment

Respiratory equipment should be selected based on evaluation of hazards and degree of potential exposure. The need to protect the eyes from chlorine should be part of the evaluation of appropriate respiratory equipment. See CI Pamphlet 65 *(11.1)*.

All personnel entering areas where chlorine is stored or handled should carry or have immediately available appropriate respiratory protection.

A self-contained breathing apparatus (SCBA), with full face piece, is required for performing tasks when chlorine may be present unless air sampling verifies the chlorine concentration is such that a lower level of respiratory protection is sufficient.

Fit testing and regular maintenance programs for respirator equipment are necessary. Documented, regularly scheduled training is required to assure competency with self-contained breathing apparatus (29 CFR 1910).

6.2.3 Minimizing Chlorine Inhalation Risk

During activities that have the potential to release chlorine, such as line breaking, leak investigation, hose connecting, taking samples, loading/unloading, returning equipment to chlorine service, or other maintenance activities, consideration should be given to ensure adequate personal protection is implemented and maintained throughout the activities. For individuals directly involved, requirements for donning personal protective equipment in relation to job progression should be specified along with conditions to downgrade, if desired, including confirmation that concentrations are below permissible exposure limits. Adjacent, downwind, or potentially impacted areas should be evaluated for risk of exposure to individuals not directly involved. Consideration should be given to limiting/restricting access to the areas and communication of higher risk activity throughout the area (area announcement, barricades, operational attendance, etc.).

6.3 CONFINED SPACE ENTRY

Confined space entry procedures must comply with all applicable local codes and regulations. The OSHA standard 29 CFR 1910.146 must be adhered to by most facilities in the United States.

CONFINED SPACE ENTRY TIPS

- Suitable respiratory and other protective equipment for anyone entering the confined space;
- Safety harness and lifeline for all workers in the confined space;
- Supervision of the operation from outside the confined space at all times;
- No entry for rescues without appropriate respiratory protection, safety harness, lifeline and backup personnel;
- See OSHA standard 29 CFR1901.164.

6.4 PERSONAL EXPOSURE MONITORING

Because the odor of chlorine in itself is an inadequate indicator of concentration, it is essential that some quantitative measure of exposure be determined. Exposure guidelines are listed on the SDS, including OSHA PEL and American Conference of Governmental Industrial Hygienists (ACGIH) TLV.

7. MEDICAL ASPECTS AND FIRST AID

7.1 HAZARDS TO HEALTH

Chlorine gas is primarily a respiratory irritant. At low concentrations, chlorine gas has an odor similar to household bleach. As the concentrations increase from the level of detection by smell, so do the symptoms in the exposed individual. Depending on the level of exposure to chlorine, the effects may become more severe for several days after the incident. Observations of exposed individuals should be considered part of the medical response program.

The following list is a compilation of potential chlorine exposure thresholds and potential responses in humans, with considerable variation among subjects:

Table 7.1	Chlorine Exposure Thresholds, Limits, and Guidelines (ppm)
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	ACGIH TLV-TWA (8-hour time-weighted average)
1	OSHA PEL (ceiling) ACGIH TLV-STEL (15 minutes) AIHA ERPG-1: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

Table 7.1	Chlorine Exposure Thresholds, Limits, and Guidelines (ppm)
1 – 3	Mild mucous membrane irritation, tolerated up to 1 hour
3	AIHA ERPG-2: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
5 – 15	Moderate irritation of the respiratory tract. 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 is trapped or unconscious
10	NIOSH IDLH: The airborne concentration that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere. Values are based on a 30-minute exposure.
20	AIHA ERPG-3: The maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
30	Immediate chest pain, vomiting, dyspnea (shortness of breath), and cough
40 – 60	Toxic pneumonitis (inflammation of the lungs) and pulmonary edema (accumulation of fluid in the lungs)
430	Lethal over 30 minutes
1000	Fatal within minutes.

Note: Values presented in Table 7.1 that are not designated as ACGIH, AIHA, NIOSH or OSHA values are from "Medical Toxicology: Diagnosis and Treatment of Human Poisoning," Ellenhorn, M.J. and D.G. Barceloux, Eds., Elsevier, New York (1988). pp. 878-879.

7.1.1 Acute Toxicity

The toxic effects of chlorine are due to its corrosive properties. Chlorine is primarily removed by the upper airways. Exposure to low concentrations of chlorine gas may cause irritation to the nose, respiratory tract, and eyes (burning discomfort, blinking, redness, conjunctivitis, and tearing). As concentrations increase, so does the irritating effect on the upper and lower respiratory tract, manifested as coughing with eventual difficulty breathing. Inhalation of chlorine gas at greater than 15 ppm may lead to airway constriction and accumulation of fluid in the lungs (pulmonary edema). As duration of

exposure and/or concentration increase, the affected individual may develop rapid breathing, wheezing and hemoptysis (blood in spit). In extreme cases difficulty in breathing can progress to the point of death through cardiovascular collapse from respiratory failure. An exposed person with a preexisting respiratory condition can have an exaggerated response.

7.1.2 Chronic Toxicity

Most studies indicate no significant connection between adverse health effects and chronic exposure to low concentrations of chlorine. However, a 1983 Finnish study (Grenquist-Norden, B.: Institute of Occupational Health, pp. 1-83, 1983) did show an increase in chronic coughs and a tendency for hypersecretion of mucous among workers. These workers showed no abnormal pulmonary function in tests or chest x-rays.

7.1.3 Eye and Skin Contact

Contact of liquid chlorine with eyes will result in serious thermal and/or chemical burns. Prolonged contact of gaseous chlorine with eyes can cause irritation at low concentrations and serious eye injury at higher concentrations. Care should be taken when using respiratory protection to avoid or limit eye exposure. Contact with skin will cause local chemical or thermal (frostbite) burns.

7.2 FIRST AID

First aid is the immediate temporary treatment given to an exposed individual before the services or recommendations of a physician are obtained. Prompt action is essential. Reassurance to the individual will help to alleviate anxiety. Medical assistance must be obtained as soon as possible. Never give anything by mouth to an unconscious or convulsing person. If chlorine has saturated an exposed person's clothes or skin, decontamination should be done by removing affected clothing and showering as recommended on the SDS.

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

CI Pamphlet 63 *(11.1)* contains detailed guidance on first aid for chlorine exposure, including:

- Inhalation
- Respiratory Assistance
- Oxygen Administration
- Skin Contact
- Eye Contact
- Medical Management of Chlorine Exposures

- Delayed Effects

A brief summary of key first aid points follows below.

7.2.1 Inhalation

An individual with chlorine inhalation exposure should be evaluated by the first responder for adequate airway, breathing, and circulation. If the airway is obstructed remove the obstruction. If breathing has apparently ceased, the victim should be given cardiopulmonary resuscitation (CPR) immediately. If breathing has not ceased, the exposed individual should be placed in a comfortable position. In severe cases the person should lie down with the head and trunk elevated to a 45-60° position (unless there is a medical contraindication). Slow, deep breathing should be encouraged.

Historically, oxygen therapy has been considered the primary treatment for chlorine inhalations. While it may not be necessary for all cases of chlorine inhalation, oxygen therapy is recommended in any case in which an individual continues to be symptomatic after leaving the area of exposure. Oxygen should be administered by first aid providers trained in the use of the specific oxygen equipment. Humidified oxygen is preferred since the humidity soothes the irritation to the mucous membranes, while oxygen without humidity can have a drying effect, potentially aggravating the irritant symptoms. However, oxygen without humidity should not be withheld if oxygen therapy is indicated.

Suitable equipment for the administration of oxygen and personnel trained in the use of the equipment should be available either on-site or at a nearby facility. Such equipment should be periodically tested.

The inhalation of any irritating gas may lead to delayed reactions, such as pulmonary edema. Since physical exercise appears to have some relation with the incidence of delayed reaction, it is recommended that any patient who has had a severe inhalation exposure should be kept at rest for a period of observation. Irritants (cigarette smoke, dust, etc.) should be avoided during this period of observation. The length of the period of observation will depend on the clinical assessment of the exposed individual.

7.2.2 Contact with Skin

If liquid chlorine has contaminated the skin or clothing, an emergency shower should be used immediately and the contaminated clothing should be removed under the shower. Flush contaminated skin with copious amounts of tepid water for 15 minutes or longer. Do not attempt chemical neutralization or apply any salves or ointment to damaged skin. Refer to a qualified health care provider if irritation persists after irrigation or if skin is broken or blistered.

7.2.3 Contact with Eyes

If eyes have been exposed to liquid chlorine or become severely irritated due to exposure to high concentration of chlorine gas they should be flushed immediately with copious amounts of tepid water for at least 15 minutes. Do not attempt to neutralize with chemicals. The eyelids should be held apart to ensure water contacts all accessible tissue of the eyes and lids. Medical assistance must be obtained as soon as possible. If

such assistance is not immediately available continue eye irrigation for a second 15-minute period.

7.3 MEDICAL SURVEILLANCE

The Chlorine Institute recommends a medical surveillance program, which would include baseline and periodic examinations, for personnel working in chlorine production, use, or handling facilities who are potentially exposed to chlorine, at or above the ACGIH® guideline of 0.5 ppm TWA or 1 ppm STEL during normal operations. Additional information on a medical surveillance program can be found in CI Pamphlet 63 *(11.1)*.

8. ENGINEERING DESIGN AND MAINTENANCE

8.1 STRUCTURES

Buildings and structures to house chlorine equipment or containers should conform to local building and fire codes. Any building used to house chlorine equipment or containers should be designed and constructed to protect all elements of the chlorine system from hazards. If flammable materials are stored or used in the same building, then a fire wall should be erected to separate the two areas. Non-combustible construction is recommended.

Chlorine monitoring equipment which continuously samples the air and detects the presence of chlorine is available and should be considered in any storage or operating area where chlorine can be released. See CI Pamphlet 73 *(11.1)*.

At least two exits should be provided from each separate 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.

8.2 VENTILATION

The ventilation requirements must be determined on a site-specific basis.

8.2.1 General

The building ventilation system should provide fresh air for normal operation and should take into consideration the possibility of a chlorine leak. In some cases, natural ventilation may be adequate; otherwise, mechanical ventilation systems should be installed. Safeguards should be in place to ensure that persons do not remain in nor enter buildings where chlorine is present in the atmosphere due to a leak or equipment failure without the appropriate personal protective equipment. All ventilation systems for buildings that house equipment or containers should conform to applicable building code requirements and American Conference of Governmental Industrial Hygienists (ACGIH) recommendations.

8.2.2 Air Openings

Chlorine gas is heavier than air and has a tendency to collect at floor level. The exhaust air system should draw from a location at or near floor level. An elevated fresh air inlet must be provided and should be located for adequate cross ventilation. Multiple fresh air inlets and fans may be necessary to facilitate adequate ventilation. Fans, if used, should be made to start and stop from a safe, remote location.

Alternatively, it may be desirable to pressurize an installation with fresh air and to exhaust the contaminated air through outlets at floor level.

8.2.3 Heating

Rooms containing chlorinator feed equipment should be maintained at a normal indoor temperature to facilitate gas discharge rates from the container. Extreme room temperatures should be avoided in order to prevent an accidental chlorine release due to melting of the fuse plug.

8.3 MATERIAL FOR PROCESSING EQUIPMENT

Materials of construction for handling dry chlorine and wet chlorine are very different. Temperature also plays an important role in material selection. (See CI Pamphlets 6, 100, and 164 *(11.1)*).

8.3.1 General

Commercial liquid chlorine contains only minor amounts of impurities and is dry enough to be handled in carbon steel equipment. In the manufacturing process, certain properties unique to chlorine should be considered when considering the materials of construction.

8.3.2 Water in Chlorine

Wet chlorine may be safely handled with a variety of materials which can be chosen to suit the process conditions. Some materials, such as titanium, are suitable for wet chlorine but not for dry chlorine. Titanium reacts violently with dry chlorine. Titanium is a safe material in wet gaseous chlorine service provided the percentage of water in the chlorine vapor is sufficient to passivate the titanium metal. This is dependent on the total pressure and temperature of the system. Use CI Pamphlet 165 *(11.1)* to determine the safe conditions for titanium in wet chlorine service.

8.3.3 Temperature

Carbon steel used in the handling of dry chlorine must be kept within definite temperature limits. Where process temperatures are expected to exceed 300°F (149°C), the material used should be more resistant than carbon steel to high temperature corrosion by chlorine. Above 300°F (149°C) chlorine can rapidly attack and ignite the steel. Impurities in the chlorine and/or a high surface area of the steel may significantly lower the auto-ignition temperature of chlorine and steel.

There is also a possibility of brittle fracturing in certain chlorine processing equipment and storage tanks. Where this is the case, a type of steel should be used that can withstand the lowest temperatures possible in the process.

8.3.4 Alternative Materials

Several chemicals are normally involved in the manufacture of chlorine, including hydrogen, sulfuric acid, mercury, certain salts, oxygen and various products of their reaction with chlorine. Materials of construction should be selected to guard against these corrosive or hazardous materials that are present in the manufacturing process.

8.4 VAPORIZERS

High capacity chlorine gas feed systems may need a chlorine vaporizer (evaporator). Vaporizers are designed to convert liquid chlorine into chlorine gas. Steam or hot water jackets are used to provide the heat needed for vaporization. Temperature control is critical. Pressure relief through the use of a safety valve with a rupture disk is required for vaporizers. Careful attention must be given to the design and operation of such systems. Maintaining a heat source below 250°F (121°C) to avoid possible steel/chlorine reactions, controlling NCl_3 levels and monitoring condensate for chlorine leakage are examples of some prudent operating discipline steps that should be taken. Periodic cleaning is necessary and the manufacturer's recommendations should be followed. See CI Pamphlet 9 *(11.1)* for more detailed information on vaporizer operation & design.

8.5 SUPPORT EQUIPMENT

8.5.1 General

Equipment used in chlorine must be designed either for dry chlorine or wet chlorine applications so that proper materials of construction are selected. Most equipment used in chlorine service is built to a specific design code or regulation. Such codes or regulations include ANSI, API, ASME and TEMA standards and OSHA regulations. See CI Pamphlet 5 *(11.1)*.

8.5.2 Vessels

Materials of construction for vessels used in wet chlorine applications include certain plastic-lined or rubber-lined steel, reinforced polyesters, and titanium. Vessels used in dry chlorine service are usually carbon steel.

The minimum fabrication standard for metal vessels operating at greater than 15 psig is that given in the ASME Code (Reference 11.5.1) for pressure vessels. Vessels operating at less than 15 psig have no ASME code requirements, but should be designed according to manufacturer's specification. Vessels in vacuum service require special designs to prevent collapse.

8.5.3 Heat Exchangers

Heat exchangers should be designed and fabricated in accordance with the TEMA Standard and proper ASME material classifications and codes. Titanium is usually the choice for wet chlorine, and carbon steel is normally used for dry chlorine.

It is important to ensure the heat exchanger is cleaned and ready for chlorine service. The reaction of residual organics/lubricants in the equipment with chlorine presents a potential fire hazard. See CI Pamphlet 6 *(11.1)* for details on "Preparation for Use".

8.5.4 Pumps

Pumps for chlor-alkali service are constructed of a wide range of materials. A supplier of such pumps should be contacted for design and use, such as certain plastic-lined or rubber-lined steel, reinforced polyester and titanium.

Liquid chlorine pumps are special items with particular risks to be considered and managed. As with all rotating equipment in chlorine service an abrasion can result in a chlorine/metal fire and subsequent chlorine release. Appropriate interlocks/shutdowns should be put in place to minimize these risks.

8.5.5 Compressors and Blowers

Compressors used in dry chlorine service include centrifugal, non-lubricated reciprocating, and liquid-ring sealed (sulfuric acid). Compressors and blowers should be built in accordance with the applicable ASME code and supplier specifications. Aluminum, copper and copper alloys must be avoided.

As with all rotating equipment in chlorine service an abrasion can result in a chlorine/metal fire and subsequent chlorine release. Discharge temperatures should be designed and managed to assure that the limits of the equipment metallurgy are not exceeded.

Fans are sometimes used to boost pressure or move chlorine gas in vent or scrubber systems. In wet chlorine service, rubber-lined, fiberglass reinforced polyester or titanium are normally used. In dry chlorine service, carbon steel is normally used.

8.5.6 Scrubbers

While scrubbers are an effective means of absorbing chlorine, the need for a scrubber should be based on a site-specific hazard assessment that considers factors such as the quantity of chlorine on site, the likelihood of a release, and the consequences of a release. The design of the scrubber depends on the quantity of chlorine to be absorbed, the flow rate of air through the scrubber and the scrubbing liquid. See CI Pamphlet 89 *(11.1)*.

8.6 PIPING SYSTEMS FOR DRY CHLORINE

Piping as described in this section pertains only to above ground fixed piping. See CI Pamphlet 6 *(11.1)*.

8.6.1 Materials

In general, ASTM A106 Grade B Schedule 80 seamless carbon steel piping is recommended for handling dry chlorine when the process temperature range is from -20°F to 300°F (-29°C to 149°C). Stainless steels of the 300 series have useful properties for low temperature service but can fail due to chloride stress corrosion

cracking, particularly in the presence of moisture at ambient or elevated temperatures. Certain metal piping materials, including titanium, aluminum, gold, and tin, cannot be used with dry chlorine.

Some plastics can be used under certain conditions. See CI Pamphlet 6 *(11.1)*. Plastic piping can become brittle in chlorine service and has a limited service life. Periodic inspection and replacement is recommended.

8.6.2 Design and Installation

General Design

Piping arrangements should be routed for the shortest distance practical with respect to flexibility, line expansion, and good engineering practice. Piping systems should be properly supported, adequately sloped to allow drainage, and low spots should be minimized. Avoid installing lines next to steam lines, acid lines, or any other lines that could cause corrosion of the chlorine line. Chlorine piping should be protected from all risks of excessive heat or fire.

Periodic inspection and replacement is recommended for all piping systems in chlorine service.

For detailed information on piping material selection and general design, see CI Pamphlet 6 *(11.1)*. Items that should be considered for piping design in CI Pamphlet 6 include:

- Liquid Expansion - Liquid chlorine has a high coefficient of thermal expansion. If liquid chlorine is trapped between two closed valves, an increase in temperature of the trapped liquid will result in high pressures potentially leading to a rupture of the line. The causes of possible rupture must be considered in the design of any piping systems. Protection may be either a suitably designed, operated and maintained expansion chamber, a pressure relief valve, or a rupture disc.

- Condensation - Condensation or reliquefaction of chlorine may occur in chlorine gas lines which pass through areas where the temperature is below the temperature-pressure equilibrium. Condensation can usually be prevented by the use of a pressure reducing valve or heat tracing and insulating the line. Any heat tracing installation should be designed such that the surface temperature of the pipe shall not exceed 300°F (149°C) to limit the possibility of a chlorine/carbon steel reaction.

- Installation – Joints in chlorine piping may be flanged, screwed or welded depending on piping size, though flanged and screwed joints should be kept to a minimum. If screwed joints are used, extreme care should be taken to obtain clean and sharp threads. Before cutting or welding on a chlorine line, a determination must be made that the system is chlorine free. Dry chlorine can support combustion of carbon steel, nickel and other materials.

- Routing

- Valves
- Inspection and Maintenance
- Other Components

Preparation for Use

Cleaning

All portions of new piping systems must be cleaned before use because chlorine can react violently with cutting oil, grease, and other foreign materials. Cleaning must not be done with hydrocarbons or alcohols, since chlorine may react violently with many solvents. New valves or other equipment received in an oily condition should be dismantled and cleaned before use. See CI Pamphlet 6 *(11.1)*.

Pressure Testing

New chlorine piping systems should be tested according to one of the methods recommended in CI Pamphlet 6 *(11.1)*. Components which may be damaged during testing should be removed or blocked off. After testing, all moisture-absorbing gaskets and valve packings should be replaced; it is essential that chlorine systems be dried as described below prior to being placed into service.

Drying

Chlorine piping systems must always be dried prior to use. Even if water has not been purposely introduced into the system from hydrostatic testing or cleaning, drying is still required due to the introduction of moisture from the atmosphere or other sources during maintenance and new construction.

Drying can be facilitated as the system is cleaned by passing steam through the lines from the high end until the lines are heated. While steaming, the condensate and foreign matter is drained out. The steam supply then should be disconnected and all the pockets and low spots in the line drained. While the line is still warm, dry air or inert gas (e.g., nitrogen) having a dew point of -40°F (-40°C) or below should be blown through the line until the discharge gas is also at a dew point of -40°F (-40°C) or below.

If steam or dry utility system air are not available, particular care must be taken in cleaning sections of pipe and other equipment before assembly, and careful inspection is necessary as construction proceeds. The final assembled system should be purged with dry cylinder air or nitrogen until the discharge gas is at a dew point of -40°F (-40°C) or below.

Leak Testing

After drying, the system should be leak-tested with dry air or nitrogen. A soap solution should be utilized to test for leaks at piping joints. Chlorine gas may then be introduced gradually and the system further tested for leaks with 26° Baumé (30 wt.%) aqua ammonia vapor. Care must be taken that chlorine has diffused throughout the piping systems before testing for leaks. Never attempt to repair leaks by welding until all

chlorine has been purged from the system. When leaks have been repaired, the line should be retested.

8.7 PIPING SYSTEMS FOR WET CHLORINE

Wet chlorine is very corrosive to all of the more common construction metals. Materials must be selected with care.

At low pressures, wet chlorine can be handled in chemical stoneware, glass, or porcelain equipment and in certain alloys.

Hard rubber, unplasticized polyvinyl chloride, fiberglass reinforced polyester, polyvinylidene chloride or fluoride and fully halogenated fluorocarbon resins have been used successfully.

For higher pressures, lined metallic or compatible metallic systems should be used.

Hastelloy® C, titanium, and tantalum have been used.

Titanium may only be used with sufficiently wet chlorine but must not be used with dry chlorine under any circumstances, as it burns spontaneously on contact.

Tantalum is inert to wet and dry chlorine at temperatures up to 300°F (149°C).

8.8 STATIONARY STORAGE

Consumers receiving chlorine in barges, tank cars or trucks may require stationary storage facilities. The facilities should be properly designed and should be operated and periodically inspected in accordance with CI Pamphlet 5 *(11.1)*.

A tank should not be filled beyond its rated chlorine capacity because liquid chlorine will expand as it warms. At normal storage temperatures, the thermal expansion rate of liquid chlorine is high and, if room for expansion is not provided, could increase the hydrostatic pressure enough to rupture the tank. The maximum chlorine level should be determined by the filling density as discussed in Section 2.5.11.

8.9 EQUIPMENT MAINTENANCE

8.9.1 General

All chlorine piping and equipment should be carefully inspected on a regular basis. Inspections can be done using ultrasonic thickness testing, eddy current testing, magnetic flux testing, and other non destructive testing. See CI Pamphlet 6 *(11.1)*.

Maintenance of chlorine equipment and tanks should be under the direction of trained personnel. All precautions pertaining to safety education, protective equipment, health, and fire hazards should be reviewed and understood. Workers should not attempt to repair chlorine piping or other equipment while it is in service. When a chlorine system is to be cleaned or repaired, tanks, piping and other equipment should always be purged with dry air or non-reactive gas. All significant piping or process changes must follow a

Management of Change (MOC) process. See the OSHA Process Safety Management (PSM) regulations for MOC guidelines.

Decontamination is especially important where cutting or welding operations are undertaken because iron and steel can ignite in chlorine near 300°F (149°C). Immediate drying of chlorine equipment, piping, or containers into which water has been introduced or which has been opened for repairs or cleaning is essential to prevent corrosion.

Cleaning of piping and other equipment is addressed in CI Pamphlet 6 *(11.1)*.

8.9.2 Entering Tanks

Chlorine tank inspection, cleaning and repair are discussed in CI Pamphlet 5 *(11.1)*. OSHA has specific regulations concerning the entering of confined spaces. These regulations should be thoroughly understood and followed. See OSHA standard 29 CFR 1910.146.

8.10 CHLORINE NEUTRALIZATION

If a chlorine consuming process involves the discharge of a waste containing chlorine, special processes may be required. All governmental regulations regarding health and safety or the protection of natural resources must be followed. A system should be provided to neutralize any chlorine vented for maintenance preparation or process upset, such as a sudden failure of the chlorine compressor, trouble during the start-up of a circuit, or a breakdown of the tail gas handling system.

The neutralization is usually accomplished by causing the chlorine to react with sodium hydroxide solution or, in certain situations, with another alkaline compound. Neutralization can take place in an appropriately designed tank or in a scrubber. The sodium hydroxide concentration should be less than 20% to prevent precipitation of sodium chloride crystals (salting-out) and excessive heat of reaction. See CI Pamphlet 89 *(11.1)*.

9. U.S. REGULATIONS AND CODES

Note: The purpose of this section is to provide a list of some of the regulations that significantly affect the production, storage, packaging, distribution, or use of chlorine in the United States.

Additionally, information is provided on some of the Fire Codes that similarly affect chlorine. This section is not meant to cover all regulations affecting chlorine.

9.1 OCCUPATIONAL SAFETY AND HEALTH REGULATIONS -29 CFR PARTS 1904 AND 1910

9.2 NAVIGATION AND NAVIGABLE WATER REGULATIONS -33 CFR PARTS 1-26, 126, 127, 130, 153-156 AND 160-167

9.3 ENVIRONMENTAL REGULATIONS - 40 CFR: PROTECTION OF ENVIRONMENT; PARTS 61, 68, 82, 141, 152, 260-269, 302-355, 370-372, 415 AND 700-799

9.4 SHIPPING REGULATIONS - 46 CFR (WATER TRANSPORTATION); PARTS 2, 10-12, 30-40 AND 151

9.5 TRANSPORTATION REGULATIONS - 49 CFR PARTS 106, 107, 171-180 AND 190-195

9.6 DEPARTMENT OF HOMELAND SECURITY – 6 CFR PART 27

9.7 FIRE CODES

Numerous fire and building codes exist that affect chlorine production, storage, packaging, distribution, and use. To properly address these codes, the local government should be contacted to 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. New editions of the codes are published every third year. The code year is important in determining which code is applicable. The specific requirements are contained in the applicable code.

10. TECHNICAL DATA

10.1 GENERAL

Chlorine has a characteristic penetrating and irritating odor. The gas is greenish yellow in color and the liquid is clear amber. The data on physical properties of chlorine as determined by different investigators show some variations.

10.2 ATOMIC AND MOLECULAR PROPERTIES

Atomic Symbol - Cl

Atomic Weight - 35.453

Atomic Number - 17

Molecular Weight of Cl_2 - 70.906

10.3 CHEMICAL PROPERTIES

Table 10.1 Physical Properties

Property	Definition	Conditions	Value
Boiling Point (Liquefying Point)	The temperature at which liquid chlorine vaporizes	14.696 psia (101.325 kPa)	-29.15°F (-33.97°C)

Table 10.1 Physical Properties

Property	Definition	Conditions	Value
Critical Density	The mass of a unit volume of chlorine at the critical pressure and temperature		35.77 lb/ft^3 (573.0 kg/m^3)
Critical Pressure	The vapor pressure of liquid chloride at the critical temperature		1157.0 psia (7977 kPa)
Critical Temperature	The temperature above which chlorine exists only as a gas no matter how great the pressure		290.75°F (143.75°C)
Critical Volume	The volume of a unit mass of chlorine at the critical pressure and temperature		0.02795 ft^3/lb (0.001745 m^3/kg)
Density	The mass of a unit volume of chlorine at specified conditions of temperature and pressure.		See Figure 10.2.
Density of Cl_2 Gas		32°F, 14.696 psia (0°C, 101.325 kPa)	0.2006 lb/ft^3 (3.213 kg/m^3)
Density of Saturated Cl_2 Gas		32°F, 53.51 psia (0°C, 368.9 kPa)	0.7632lb/ft^3 (12.23 kg/m^3)
Density of Saturated Cl_2 Liquid		32°F, 14.696 psia (0°C, 101.325 kPa)	91.56 lb/ft^3 (1467 kg/m^3)
		60°F, 86.58 psia (15.6°C, 597.0 kPa)	88.76 lb/ft^3 11.87 lb/gal (1422 kg/m^3)
Latent Heat of Vaporization	The heat required to evaporate a unit weight of chlorine	At the normal boiling point	123.9 Btu/lb (288.1 kJ/kg)
Liquid-Gas Volume Relationship	The weight of one volume of liquid chlorine equals the weight of 456.5 volumes of chlorine gas.	32°F, 14.696 psia (0°C, 101.325 kPa)	
Melting Point (Freezing Point)	The temperature at which solid chlorine melts or liquid chlorine solidifies	14.696 psia (101.325 kPa)	-149.76°F (-100.98°C)

Table 10.1 Physical Properties

Property	Definition	Conditions	Value
Solubility in Water	The weight of chlorine which can be dissolved in a given amount of water at a given temperature when the total vapor pressure of chlorine and the water equals a designated value.	60°F,14.696 psia (15.6°C,101.325 kPa)	6.93 lbs/100gal ($8.30\ kg/m^3$) See Figure 10.3
Specific Gravity of Cl_2 Gas	The ratio of the density of chlorine gas at standard conditions to the density of air under the same conditions:	32°F, 14.696 psia (0°C, 101.325 kPa)	2.485 (Note: The density of air, free of moisture at the same conditions is $1.2929\ kg/m^3$)
Specific Gravity of Cl_2 Liquid	The ratio of the density of saturated liquid chlorine to the density of water at its maximum density - 39°(4°C)	32°F (0°C)	1.467
Specific Heat	The heat required to raise the temperature of a unit weight of chlorine one degree.		
Saturated Gas at constant pressure		32°F (0°C) 77°F (25°C)	0.1244 Btu/lb·°F (0.521 kJ/kg·K) 0.1347 Btu/lb·°F (0.564 kJ/kg·K)
Saturated Gas at constant volume		32°F (0°C) 77°F (25°C)	0.08887 Btu/lb·°F (0.372 kJ/kg·K) 0.09303 Btu/lb·°F (0.3895 kJ/kg·K)
Saturated Liquid		32°F (0°C) 77°F (25°C)	0.2264 Btu/lb·°F (0.948 kJ/kg·K) 0.2329 Btu/lb·°F (0.975 kJ/kg·K)
Ratio for Saturated Gas	Ratio of gas specific heat at constant pressure to gas specific heat at constant volume	32°F (0°C) 77°F (25°C)	1.400 1.448
Specific Volume	The volume of a unit mass of chlorine at specified conditions of temperature and pressure.		

Table 10.1 Physical Properties

Property	Definition	Conditions	Value
Gas		32°F, 14.696 psia (0°C, 101.325 kPa)	4.986 ft^3/lb (0.3113 m^3/kg).
Saturated Gas		32°F (0°C)	1.310 ft^3/lb (0.08179 m^3/kg).
Saturated Liquid		32°F (0°C)	0.01092 ft^3/lb (0.0006818 m^3/kg)
Vapor Pressure	The absolute pressure of chlorine gas above liquid chlorine when they are in equilibrium	32°F (0°C) 77°F (25°C)	53.51 psia (368.9 kPa) 112.95 psia (778.8 kPa)
Viscosity	The measure of internal molecular friction when chlorine molecules are in motion		
Saturated Gas		32°F (0°C) 60°F (15.6°C)	0.0125 cP (0.0125 mPa·s) 0.0132 cP (0.0132 mPa·s)
Liquid		32°F (0°C) 60°F (15.6°C)	0.3863 cP (0.3863 mPa·s) 0.3538 cP (0.3538 mPa·s)
Volume – Temperature Relationship	Volume – Temperature relationship of liquid chlorine in a container loaded to its authorized limit		Figure 10.4
Solubility of Water in liquid chlorine			Figure 10.5 and Figure 10.6

10.3.1 Flammability

Chlorine is neither explosive nor flammable. Chlorine will support combustion under certain conditions. Many materials that burn in oxygen (air) atmospheres will also burn in chlorine atmospheres. Many organic chemicals react readily with chlorine, sometimes violently. An important specific compound of concern is hydrogen. Chlorine reacts explosively with hydrogen in a range of 4% to 93% hydrogen. The reaction is initiated very easily much the same way as hydrogen and oxygen. See Pamphlet 121 for more information.

10.3.2 Valence

Chlorine usually forms compounds with a valence of -1 but it can combine with a valence of +1, +2, +3, +4, +5, or +7.

10.3.3 Chemical Reactions

Reactions with Water

Chlorine is only slightly soluble in water (0.3% to 0.7%) depending on the water temperature. However the resulting water phase is extremely corrosive, see Reactions with Metals below.

Reactions with Metals

The reaction rate of dry chlorine with most metals increases rapidly above a temperature which is characteristic for the metal. Two of the more common metals are titanium and steel. In the presence of dry chlorine, titanium is flammable. Care should be taken to make sure titanium materials are not used in dry chlorine service. Steel is the most common material used in dry chlorine service. At temperatures above 300°F (149°C) a chlorine/steel fire can result. It is important to make sure steel in chlorine service does not go above this temperature either through internal/external heating or mechanical abrasion. Moist chlorine, primarily because of the hydrochloric and hypochlorous acids formed through hydrolysis, is very corrosive to most common metals. Platinum, silver, tantalum and titanium are resistant. Consult CI Pamphlet 6 *(11.1)* for detailed information on reactivity with metals.

Reactions with Organic Compounds

Chlorine reacts with many organic compounds to form chlorinated derivatives. Some reactions can be extremely violent, especially those with hydrocarbons, alcohols and ethers. Proper methods must be followed, whether in laboratory or plant, when organic materials are reacted with chlorine.

10.4 PHYSICAL PROPERTIES

Figure 10.1 through Figure 10.6 are for pure chlorine.

Figure 10.1 Vapor Pressure of Liquid Chorine
(Calculated from data in CI Pamphlet 72)

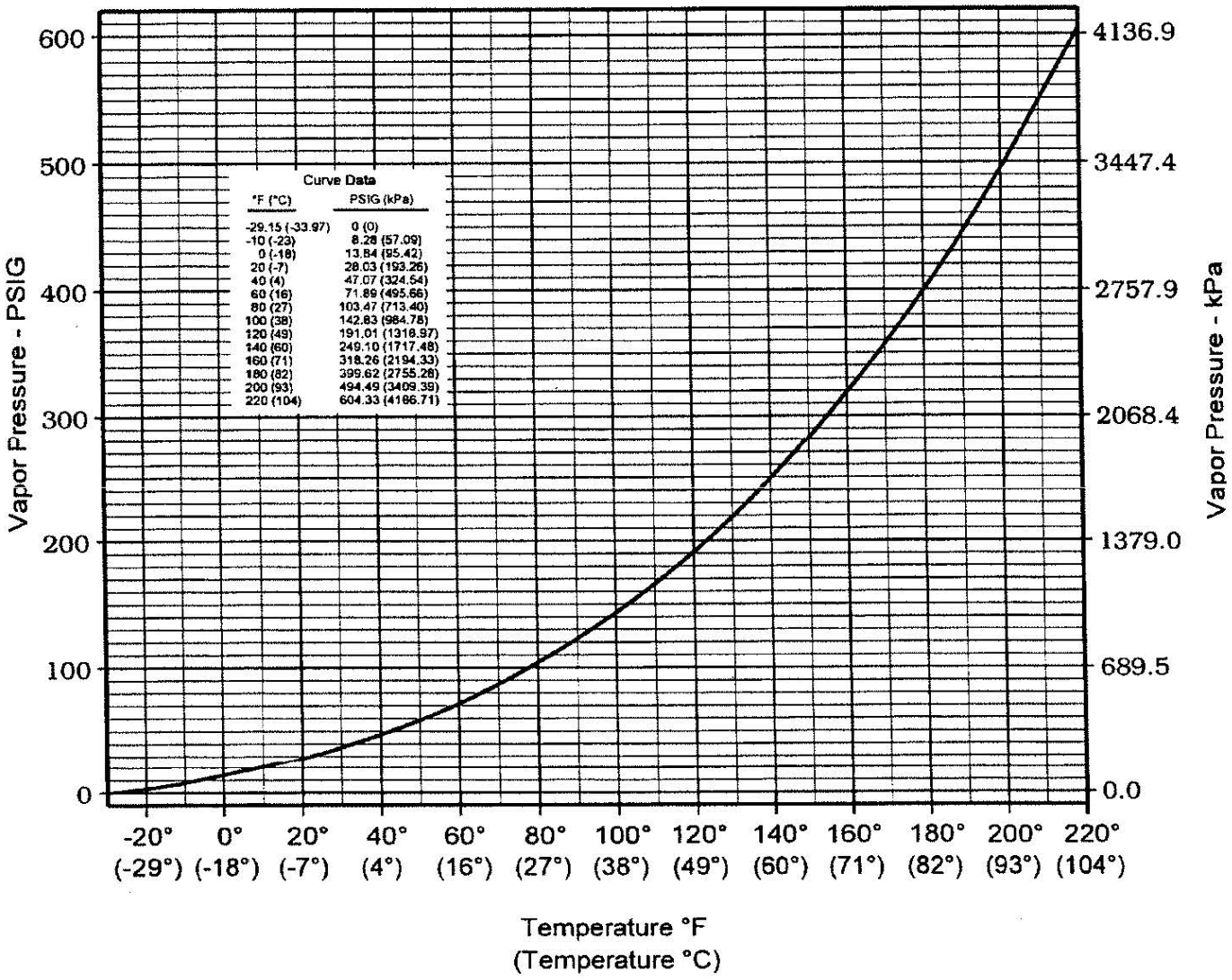


Figure 10.2 Temperature-Density Relation of Liquid Chlorine
(Calculated from data in CI Pamphlet 72)

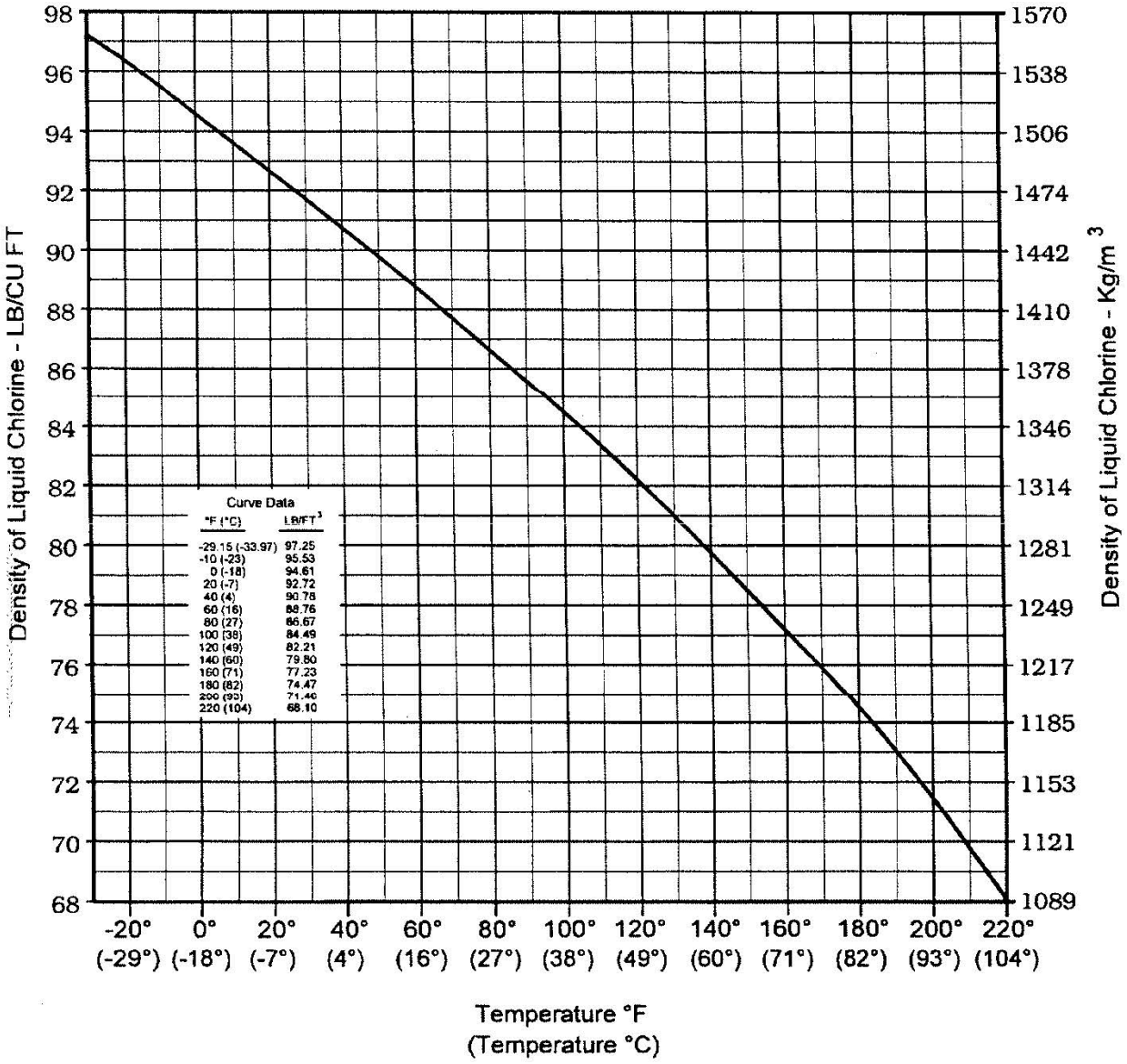


Figure 10.3 Equilibrium Solution of Chlorine In Water
(Reference 11.18.1)

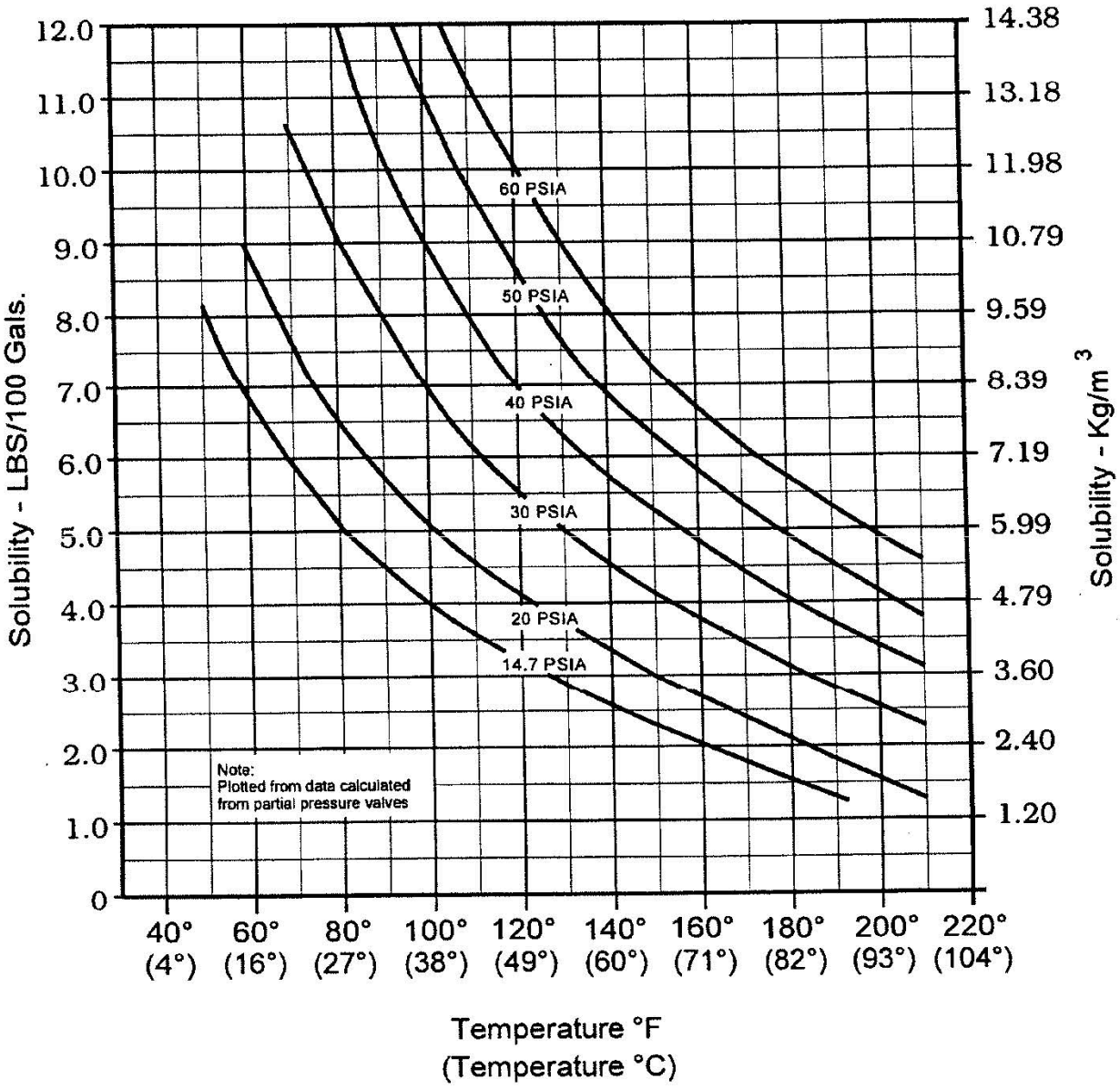


Figure 10.4 Volume-Temperature Relation of Liquid Chlorine in a Container Loaded to its Authorized Limit
(Calculated from data in CI Pamphlet 72)

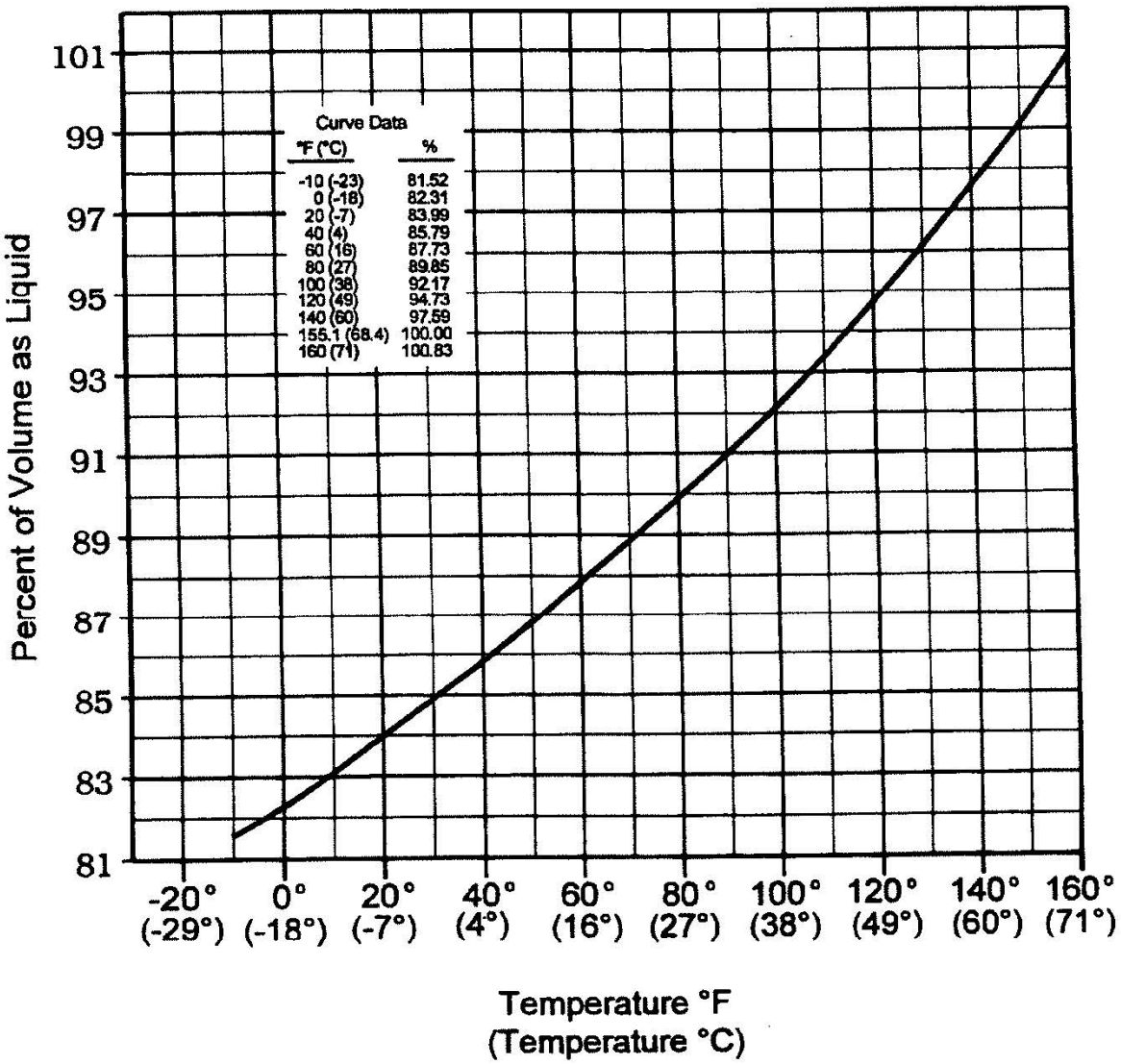
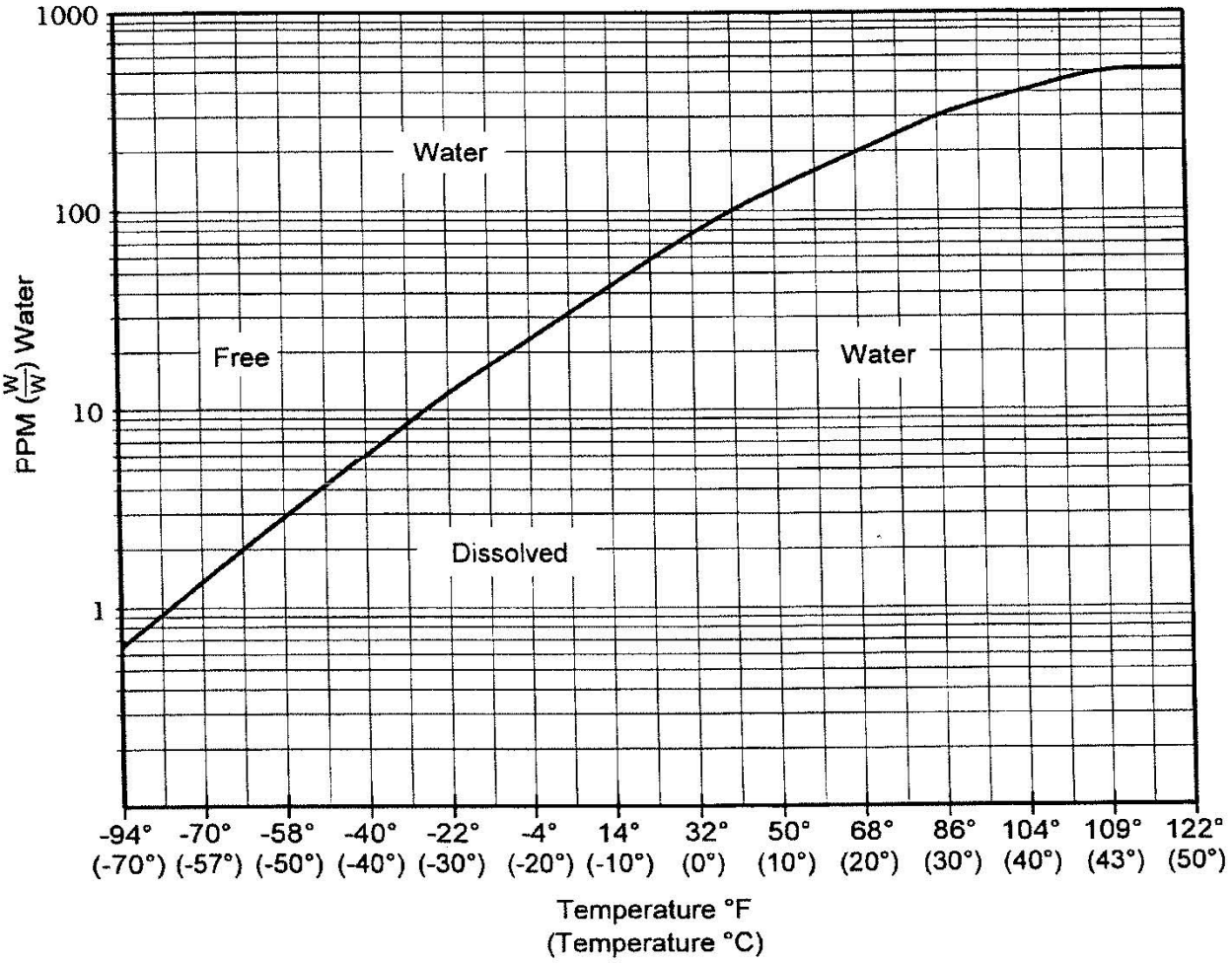


Figure 10.5 Solubility of Water in Liquid Chlorine
(Reference CI Pamphlet 100)



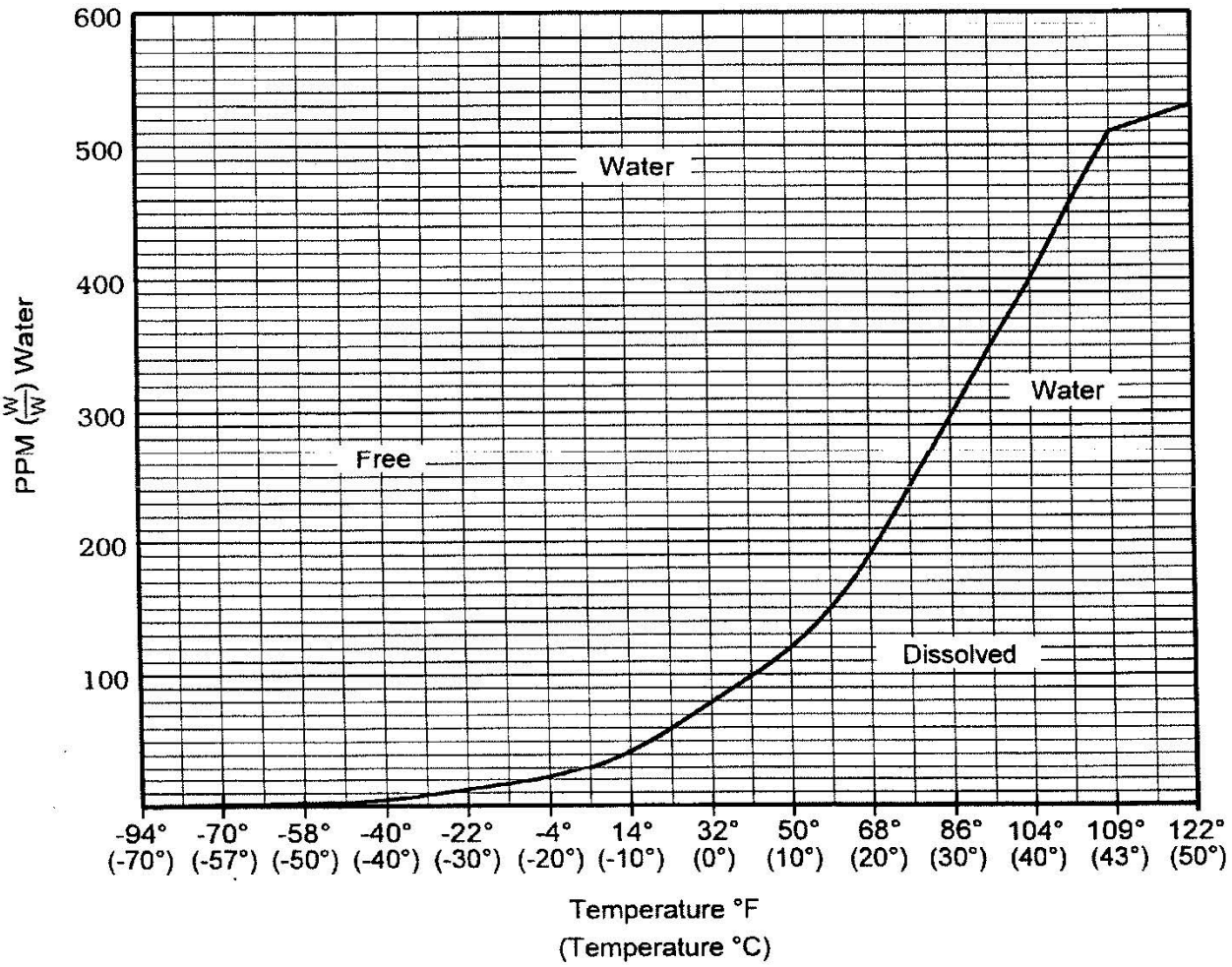
Note: Above the curve, the chlorine is wet. Below the curve, the chlorine is dry.

The following are examples using this figure:

- Chlorine with a water content of 30 ppm at a temperature of 50°F (10°C) is dry. If this same chlorine were at a temperature of -4°F (-20°C) the chlorine is wet.

- Chlorine at 41°F (5°C) is dry if the water content does not exceed 100 ppm.

Figure 10.6 Solubility of Water in Liquid Chlorine
(Reference CI Pamphlet 100)



Note: Above the curve, the chlorine is wet. Below the curve, the chlorine is dry. The following are examples using this figure:

- Chlorine with a water content of 30 ppm at a temperature of 50°F (10°C) is dry. If this same chlorine were at a temperature of -4°F (-20°C) the chlorine is wet.

- Chlorine at 41°F (5°C) is dry if the water content does not exceed 100 ppm.

11. REFERENCES

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

11.1 CHLORINE INSTITUTE REFERENCES

The following publications are specifically referenced in CI Pamphlet 1. The latest editions of CI publications may be obtained at www.chlorineinstitute.org.

Pamphlet #	Title
5	*Bulk Storage of Liquid Chlorine,* ed. 8; Pamphlet 5; The Chlorine Institute: Arlington, VA, **2011.**
6	*Piping Systems for Dry Chlorine,* ed. 16; Pamphlet 6; The Chlorine Institute: Arlington, VA, **2013.**
9	*Chlorine Vaporizing Systems*, ed. 7; Pamphlet 9; The Chlorine Institute: Arlington, VA, **2011.**
17	*Packaging Plant Safety and Operational Guidelines,* ed. 4, Rev. 2; Pamphlet 17; The Chlorine Institute: Arlington, VA, **2011.**
21	*Nitrogen Trichloride – A Collection of Reports and Papers,* ed. 6, Pamphlet 21; The Chlorine Institute: Arlington, VA, **2010**
49	*Recommended Practices for Handling Chlorine Bulk Highway Transports,* ed. 9; Pamphlet 49; The Chlorine Institute: Arlington, VA, **2009.**
63	*First Aid, Medical Management/Surveillance and Occupational Hygiene Monitoring Practices for Chlorine,* ed. 8; Pamphlet 63; The Chlorine Institute: Arlington, VA, **2011.**
64	*Emergency Response Plans for Chlor-Alkali, Sodium Hypochlorite, and Hydrogen Chloride Facilities,* ed. 6, Rev. 1; Pamphlet 64, Rev. 1; The Chlorine Institute: Arlington, VA, **2008.**
65	*Personal Protective Equipment for Chlor-Alkali Chemicals,* ed. 5; Pamphlet 65; The Chlorine Institute: Arlington, VA 2008
66	*Recommended Practices for Handling Chlorine Tank Cars,* ed. 4; Pamphlet 66; The Chlorine Institute: Arlington, VA, **2009.**
72	*Properties of Chlorine in SI Units*, ed. 3; Pamphlet 72; The Chlorine Institute: Arlington, VA, **2011.**
73	*Atmospheric Monitoring Equipment for Chlorine*, ed. 7; Pamphlet 73; The Chlorine Institute: Arlington, VA, **2003.**
74	*Guidance on Complying with EPA Requirements under the Clean Air Act by Estimating the Area Affected by a Chlorine Release,* ed. 5; Pamphlet 74; The Chlorine Institute: Arlington, VA, **2012.**
76	*Guidelines for the Safe Motor Vehicular Transportation of Chlorine Cylinders and Ton Containers*, ed. 5; Pamphlet 76; The Chlorine Institute: Arlington, VA, **2012.**

Pamphlet #	Title
89	*Chlorine Scrubbing Systems*, ed. 3, Rev. 1; Pamphlet 89; The Chlorine Institute: Arlington, VA, **2008.**
100	*Dry Chlorine: Behaviors of Moisture in Chlorine and Analytical Issues,* ed. 4; Pamphlet 100; The Chlorine Institute: Arlington, VA, **2011.**
121	*Explosive Properties of Gaseous Mixtures Containing Hydrogen and Chlorine,* ed. 3; Pamphlet 121; The Chlorine Institute: Arlington, VA, **2009.**
152	*Safe Handling of Chlorine Containing Nitrogen Trichloride*, ed. 3; Pamphlet 152; The Chlorine Institute: Arlington, VA, **2011.**
155	*Water and Wastewater Operators Chlorine Handbook*, ed. 3; Pamphlet 155; The Chlorine Institute: Arlington, VA **2014.**
164	*Reactivity and Compatibility of Chlorine and Sodium Hydroxide with Various Materials*, ed. 2; Pamphlet 164; The Chlorine Institute: Arlington, VA **2007.**
165	*Instrumentation for Chlorine Service*, ed. 2; Pamphlet 165; The Chlorine Institute: Arlington, VA, **2009.**
166	*Reactivity and Compatibility of Chlorine and Sodium Hydroxide with Various Materials*, ed. 2; Pamphlet 164; The Chlorine Institute: Arlington, VA **2007.**
168	*Guidelines for Dual Valve Systems for Bulk Chlorine Transport,* ed. 1; Pamphlet 168; The Chlorine Institute: Arlington, VA, **2013.**
IB/A	*Instruction Booklet: Chlorine Institute Emergency Kit "A" for 100- and 150-lb. Chlorine Cylinders,* ed. 12; Pamphlet IB/A; The Chlorine Institute: Arlington, VA, **2013.**
IB/B	*Instruction Booklet: Chlorine Institute Emergency Kit "B" for Chlorine Ton Containers,* ed. 10; Pamphlet IB/B; The Chlorine Institute: Arlington, VA, **2009.**
IB/C	*Instruction Booklet: Chlorine Institute Emergency Kit "C" for Chlorine Tank Cars and Tank Trucks,* ed. 9; Pamphlet IB/C; The Chlorine Institute: Arlington, VA, **2009.**

11.2 U.S. GOVERNMENT REGULATIONS AND SPECIFICATIONS

All U.S. regulations and specifications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20401. www.gpo.gov

11.2.1 Code of Federal Regulations (CFR), Various Sections.

11.3 CANADIAN REGULATIONS

Most Canadian regulations can be obtained from the Canadian Government Publishing Center. publications.gc.ca

11.4 AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)

1330 Kemper Meadow Drive
Cincinnati, OH 45240
www.acgih.org

11.4.1 *Threshold Limit Values and Biological Exposure Indices*, Published Annually.

11.4.2 *Industrial Ventilation: A Manual of Recommended Practice for Design*, 28th Edition, 2013.

11.5 AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Two Park Avenue
New York, NY 10016-5990.
www.asme.org

11.5.1 *Rules for Construction of Pressure Vessels*, Sections VIII, Division ASME Boiler, and Pressure Vessel Code ANSI/ASME BPV-VIII- 1.

11.6 ASTM INTERNATIONAL (ASTM)

(Formerly American Society for Testing and Materials)
100 Barr Harbor Drive
P.O. Box C700
West Conshohocken, PA 19428-2959
www.astm.org

11.6.1 ASTM-E410 (2008), *Standard Method of Testing for Moisture and Residue in Liquid Chlorine*.

11.6.2 ASTM-E649 (2011), *Standard Test Method for Bromine in Chlorine*.

11.6.3 ASTM-E806 (2008), *Standard Test Method for Carbon Tetrachloride and Chloroform in Liquid Chlorine by Direct Injection* (Gas Chromatographic Procedure).

11.6.4 ASTM-D2022 (2008), *Standard Methods of Sampling and Chemical Analysis of Chlorine-Containing Bleaches*.

11.7 COMPRESSED GAS ASSOCIATION (CGA)

14501 George Carter Way, Suite 103
Chantilly, VA 20151
www.cganet.com

11.7.1 Pamphlet C-1, *Methods for Pressure Testing Compressed Gas Cylinders*.

11.7.2 Pamphlet C-6, *Standard for Visual Inspection of Steel Compressed Gas Cylinders*.

11.7.3 Pamphlet P-1, *Safe Handling of Compressed Gases in Containers*.

11.7.4 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.)

11.8 NATIONAL ACADEMY OF SCIENCES (NAS)

Printing and Publishing Office
500 Fifth Street, NW
Washington, DC 20001
www.nationalacademies.org

11.8.1 Water Chemicals Codex, 1982.

11.9 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

Batterymarch Park
Quincy, MA 02169
www.nfpa.org

11.10 NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

1600 Clifton Road
Atlanta, GA 30333
www.cdc.gov/niosh/

11.10.1 *Pocket Guide to Chemical Hazards,* U.S. Department of Health and Human Services: 2010.

11.11 NSF INTERNATIONAL

789 N. Dixboro Road
Ann Arbor, MI 48105
www.nsf.org

11.11.1 *NSF/ANSI Standard 60 - Drinking Water Treatment Chemicals-Health Effects;* updated annually.

11.12 U.S. PHARMACOPEIAL CONVENTION

12601 Twinbrook Parkway
Rockville, MD 20852
http://www.usp.org/

11.12.1 *Food Chemicals Codex V*, Ninth Edition, 2014

CHLORINE

The Essential Element

Over 240 years ago, a young Swedish researcher, Carl Wilhelm Scheele, discovered chlorine. Because of its reactivity and bonding characteristics, chlorine has become a popular building block in chemistry and it is essential in everyday life. Drinking water, agricultural abundance, disinfected wastewater, essential industrial chemicals, bleaches, and fuels all depend on chlorine. Pharmaceuticals, plastics, dyes, cosmetics, coatings, electronics, adhesives, clothing, and automobile parts are examples of product groups that depend on chlorine chemistry.

PRODUCTS OF CHLORINE CHEMISTRY

Automotive
Air Bags
Brake Fluids
Bumpers
Dashboards
Floor Mats
Hoses, Belts and Wires
Instrument Panels
Paint
Seat Belts
Seat Cushions
Tire Cord

Construction
Carpeting
Coatings
Flooring
Paints
Pipes
Upholstery
Vinyl Siding
Wire Insulation

Defense
Bullet-Resistant Glass
Bullet-Resistant Vests
Helmets
Jet Engine Blades
Missiles
Parachutes
Riot Shields
Water Repellant Fibers

Electronics
CDs, DVDs
Fiber Optic Glass
Semiconductors
Wire Insulation

Food Production & Handling
Crop Protection Chemicals
Sterile Packaging
Surface Sanitizers
Thermal Insulation
Vitamins B1 & B6

Health Care
Artificial Joints
Cleaning Compounds
Electronic Instruments
Laboratory Reagents
Prescription Eye Wear
Sterile Packaging
Surgical Supplies

Medicines
Antibiotics
Antihistamines
CancerTreatment
Decongestants
Local Anesthetics
Pain Relievers

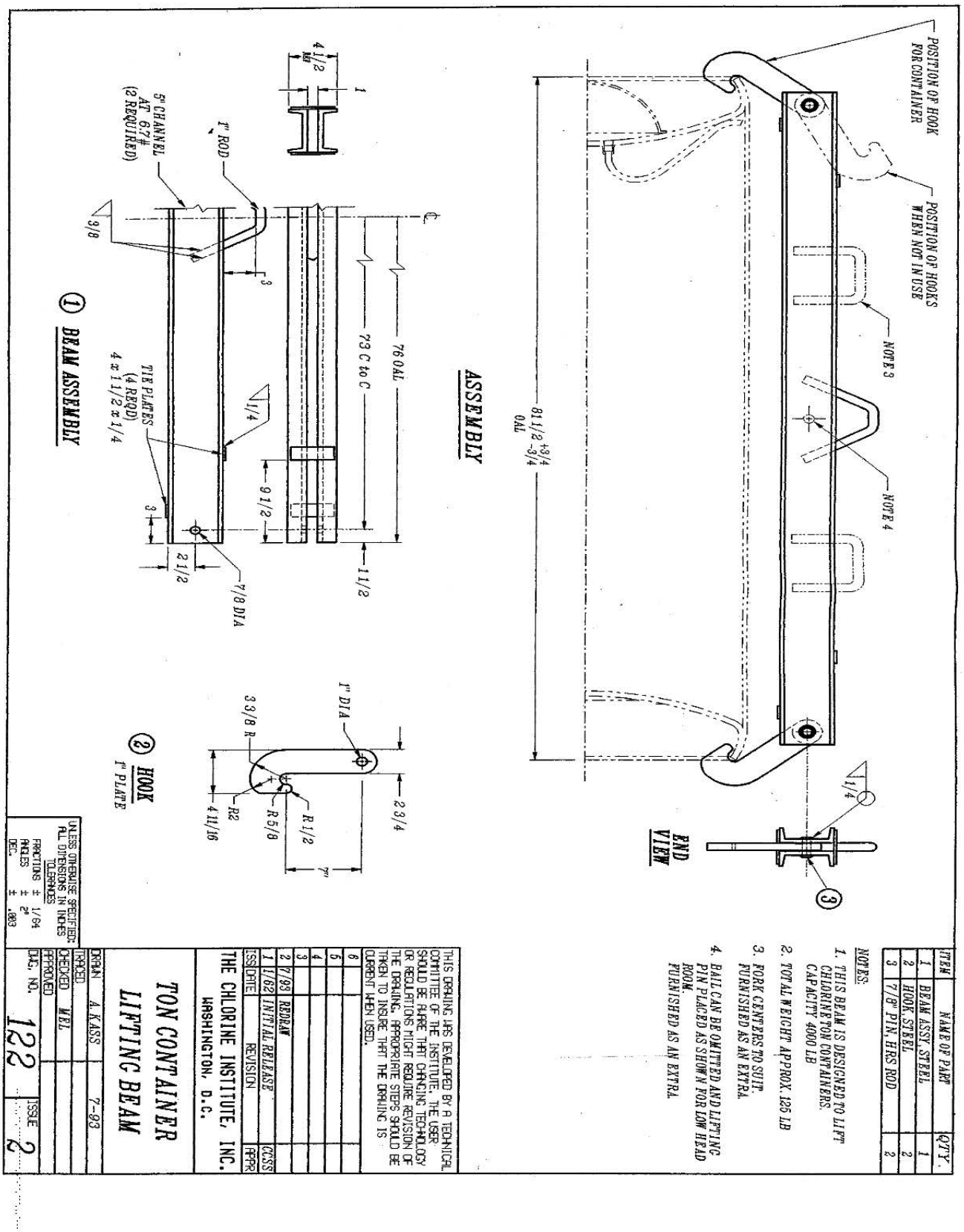
Metal Production
Bismuth
Magnesium
Nickel
Titanium
Zirconium
Zinc

Outdoor Recreation
Backpacks
Coats
Golf Club Grips
Inflatable Rafts
Neoprene Wet Suits
Nylon Ropes
Sleeping Bags
Surf Boards
Swimming Pool Disinfection
Tents
Waterproof Clothing

Water Treatment
Safe Drinking Water
Wastewater Treatment

DRAWINGS

DRAWING 122-2: TON CONTAINER LIFTING BEAM



ITEM	NAME OF PART	QTY.
1	BEAM ASSY, STEEL	1
2	HOOK, STEEL	2
3	7/8" PIN, HRS ROD	2

NOTES:

1. THIS BEAM IS DESIGNED TO LIFT CHLORINE TON CONTAINERS. CAPACITY 4000 LB
2. TOTAL WEIGHT APPROX. 125 LB
3. FORK CENTERS TO SUIT. FURNISHED AS AN EXTRA.
4. BAIL CAN BE OMITTED AND LIFTING PIN PLACED AS SHOWN FOR LOW HEAD ROOM. FURNISHED AS AN EXTRA.

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS IN INCHES
TOLERANCES
FRACTIONS ± 1/64
ANGLES ± 2°
DEC. ± .003

THIS DRAWING HAS DEVELOPED BY A TECHNICAL COMMITTEE OF THE INSTITUTE. THE USER SHOULD BE AWARE THAT CHANGING TECHNOLOGY OR REGULATIONS MIGHT REQUIRE REVISION OF THE DRAWING. APPROPRIATE STEPS SHOULD BE TAKEN TO INSURE THAT THE DRAWING IS CURRENT WHEN USED.

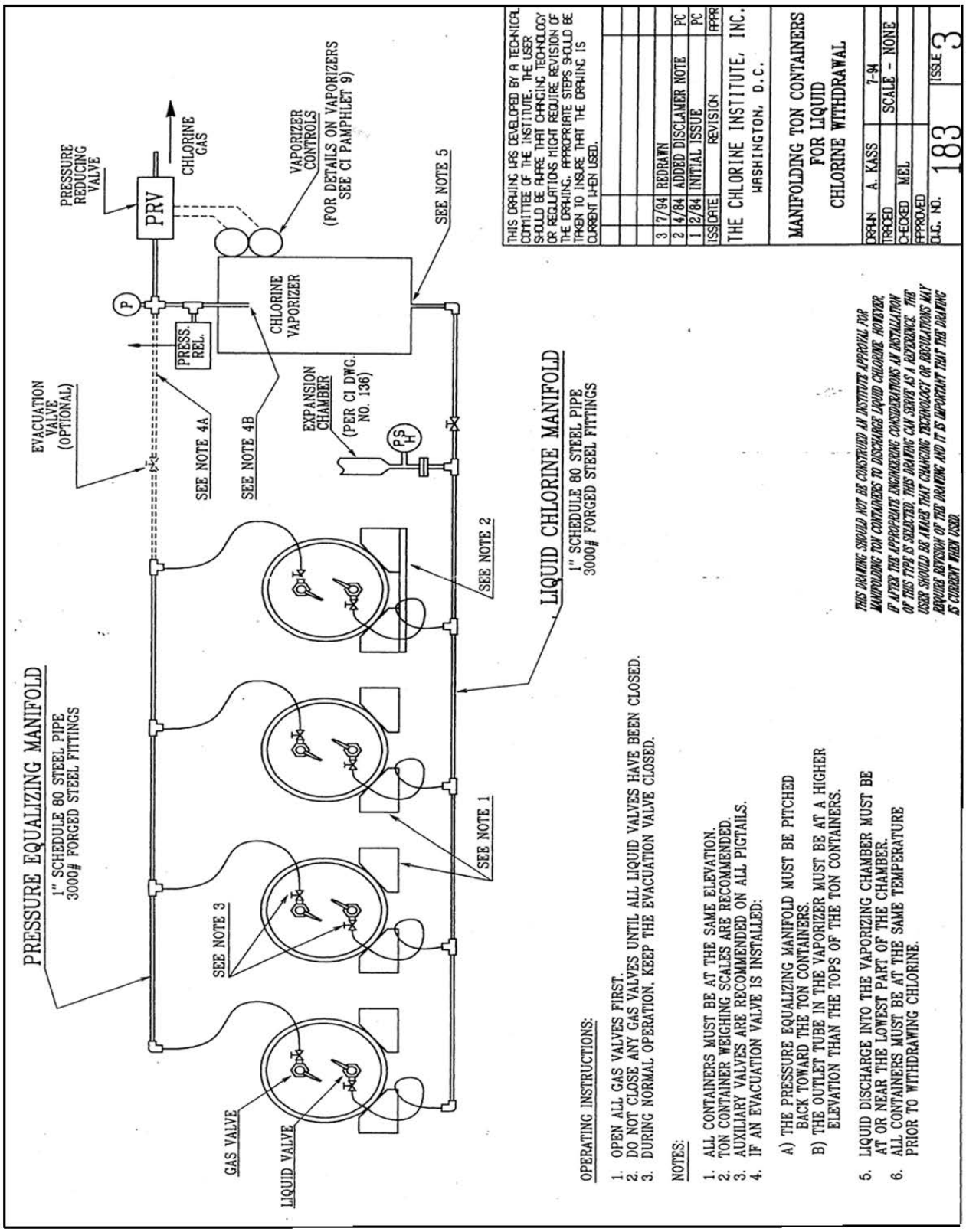
6			
5			
4			
3			
2	7/93	REDRAW	
1	11/82	INITIAL RELEASE	CCSS
ISS	DATE	REVISION	APPR

THE CHLORINE INSTITUTE, INC.
WASHINGTON, D.C.

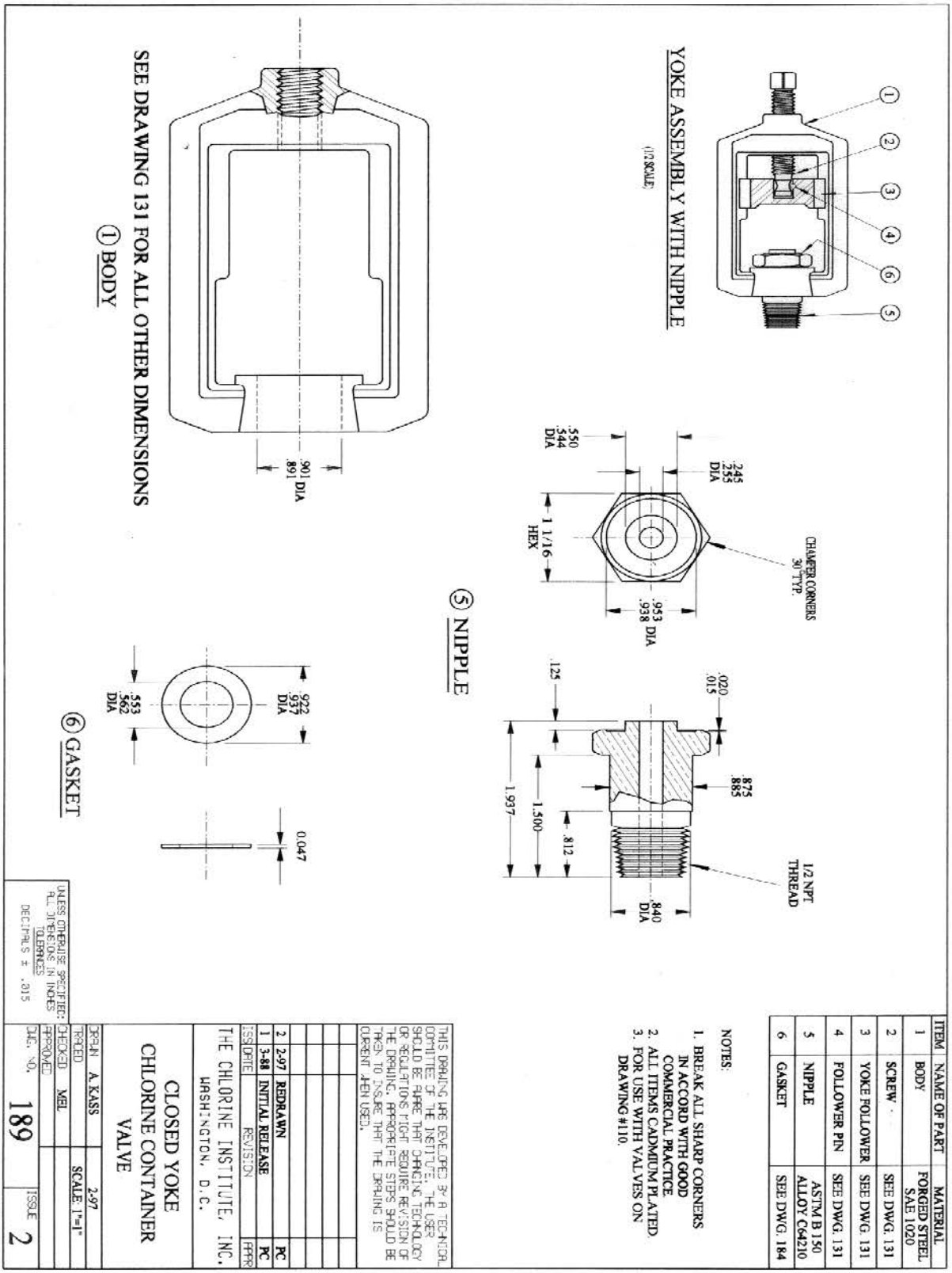
TON CONTAINER LIFTING BEAM

DRAWN	A. KASS	7-93
TRACED		
CHECKED	W.E.L.	
APPROVED		
DWG. NO.	122	ISSUE 2

DRAWING 183-3: MANIFOLDING TON CONTAINERS FOR LIQUID CHLORINE WITHDRAWAL



DRAWING 189-2: CLOSED YOKE CHLORINE CONTAINER VALVE



ITEM	NAME OF PART	MATERIAL
1	BODY	FORGED STEEL SAE 1020
2	SCREW	SEE DWG. 131
3	YOKE FOLLOWER	SEE DWG. 131
4	FOLLOWER PIN	SEE DWG. 131
5	NIPPLE	ASTM B 150 ALLOY C64210
6	GASKET	SEE DWG. 184

NOTES:

1. BREAK ALL SHARP CORNERS IN ACCORD WITH GOOD COMMERCIAL PRACTICE.
2. ALL ITEMS CADMIUM PLATED.
3. FOR USE WITH VALVES ON DRAWING #110.

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2	2-97	REDRAWN	PC
1	3-88	INITIAL RELEASE	PC
ISSUE	DATE	REVISION	APPR

THE CHLORINE INSTITUTE, INC.
WASHINGTON, D.C.

CLOSED YOKE
CHLORINE CONTAINER
VALVE

DRAWN	A.KASS	2-97
TRACED		SCALE: 1"=1"
CHECKED	MEL	
APPROVED		

UNLESS OTHERWISE SPECIFIED:
ALL DIMENSIONS IN INCHES
TOLERANCES
DECIMALS ± .015

DWG. NO. 189 ISSUE 2

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