HYDROBROMIC ACID

MEMBER OF THE ICL GROUP

JUNE, 2002

HBr Safety Handbook

Caring for Your Future - Today
HYDROBROMIC ACID

HBr Safety Handbook

JUNE, 2002
6. OPERATORS GUIDE

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This Safety Handbook has been compiled by the Dead Sea Bromine Group/Bromine Compounds Ltd. (DSBG) as a part of its continuing commitment to the principles of Product Stewardship, and is intended to provide a guide to the safe handling and use of its hydrobromic acid products.

Whether you are a manufacturer, transporter, distributor or end user, we hope that the information contained in this Safety Handbook will prove useful in your handling of these products. Information is also provided to assist regulatory and transportation authorities in determining whether hydrobromic acid is being handled or transported properly, and to assist medical personnel in case of accident involving this product.

Hydrobromic acid is not a substance to be used casually. It is a hazardous chemical which can be used safely if its properties are understood and the necessary safety precautions are observed. Safety is the personal responsibility of everyone working with hydrobromic acid. Managers and supervisors should be well versed in the safe handling practices required and enforce their implementation. Operators should be well trained in the use of safety equipment and safety procedures.

Note: The relevant Material Safety Data Sheet should be consulted before undertaking any activities involving hydrobromic acid.

Hydrobromic acid has several applications in various industries. For example, it is used as a catalyst, an intermediate or bromine carrier in the manufacture of various industrial and agricultural chemicals, in the pharmaceutics and vitamin industries, in metals welding, and in chemicals used for photographic applications.

The handling of hydrobromic acid is strictly regulated by international agreements and government regulations. As new information is continuously becoming available, anyone handling this substance must keep up-to-date on relevant practices and regulations.

DSBG emphasizes the need for the safe handling of hydrobromic acid, the integrity of the containers and the prominent display of instructions and warnings.

For further information on hydrobromic acid and its formulations, please contact your local DSBG office or:

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Tel: +972-8-6297356
Fax: +972-8-6297807
website: www.dsbg.com

We also welcome your comments and input on the content and presentation of this Safety Handbook, which should be sent to the above address.

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# Glossary of Commonly Used Abbreviations

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<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAR</td>
<td>American Association of Railroads</td>
</tr>
<tr>
<td>ACC</td>
<td>American Chemistry Council (US), formerly Chemical Manufacturers Assoc.</td>
</tr>
<tr>
<td>ACEP</td>
<td>Approved Continuous Examination Program (CSC)</td>
</tr>
<tr>
<td>ACGIH</td>
<td>American Conference of Governmental Industrial Hygienists</td>
</tr>
<tr>
<td>ACOP</td>
<td>Approved Code of Practice (UK)</td>
</tr>
<tr>
<td>ADR</td>
<td>European Agreement concerning the International Carriage of Dangerous Goods by Road</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>C</td>
<td>Ceiling Limit Value (For TLV)</td>
</tr>
<tr>
<td>CAF</td>
<td>Compressed Asbestos Fiber</td>
</tr>
<tr>
<td>CAS</td>
<td>Chemical Abstract Service</td>
</tr>
<tr>
<td>CEFIC</td>
<td>European Chemical Industry Council</td>
</tr>
<tr>
<td>CERCLA</td>
<td>Comprehensive Environmental Response, Compensation &amp; Liability Act (US)</td>
</tr>
<tr>
<td>CDG</td>
<td>Carriage of Dangerous Goods (UK)</td>
</tr>
<tr>
<td>CFR</td>
<td>Code of Federal Regulations (US)</td>
</tr>
<tr>
<td>CGA</td>
<td>Compressed Gas Association (US)</td>
</tr>
<tr>
<td>CHEMTREC</td>
<td>Chemical Transportation Emergency Center (US)</td>
</tr>
<tr>
<td>COMAH</td>
<td>Control of Major Accident Hazards Regulations</td>
</tr>
<tr>
<td>COSHH</td>
<td>Control of Substances Hazardous to Health Regulations (UK)</td>
</tr>
<tr>
<td>CPL</td>
<td>Classification, Packaging and Labelling of Dangerous Substances Regulations (UK)</td>
</tr>
<tr>
<td>CSC</td>
<td>International Convention for Safe Containers (IMO)</td>
</tr>
<tr>
<td>CWA</td>
<td>Clean Water Act (US)</td>
</tr>
<tr>
<td>DOT</td>
<td>Dept of Transportation (US)</td>
</tr>
<tr>
<td>DSBG</td>
<td>Dead Sea Bromine Group</td>
</tr>
<tr>
<td>EAC</td>
<td>Emergency Action Code</td>
</tr>
<tr>
<td>EMSno.</td>
<td>Emergency Schedule Number (IMO)</td>
</tr>
<tr>
<td>EPA</td>
<td>Environmental Protection Agency (US)</td>
</tr>
<tr>
<td>FM</td>
<td>Factory Mutual System (US)</td>
</tr>
<tr>
<td>HAP</td>
<td>Hazardous Air Pollutant</td>
</tr>
<tr>
<td>HBr</td>
<td>Hydrobromic acid</td>
</tr>
<tr>
<td>HDPE</td>
<td>High Density Polyethylene</td>
</tr>
<tr>
<td>HSE</td>
<td>Health and Safety Executive (UK)</td>
</tr>
<tr>
<td>IARC</td>
<td>International Agency for Research on Cancer</td>
</tr>
<tr>
<td>IATA</td>
<td>International Air Transport Association</td>
</tr>
<tr>
<td>IDLH</td>
<td>Immediately Dangerous to Life or Health</td>
</tr>
<tr>
<td>IMDG</td>
<td>International Maritime Dangerous Goods code</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organization</td>
</tr>
<tr>
<td>IPIC</td>
<td>Israel Poisons Information Center</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>ISO</td>
<td>International Standards Organization</td>
</tr>
<tr>
<td>MAK</td>
<td>Maximum Concentration at the Workplace (Germany)</td>
</tr>
<tr>
<td>MEL</td>
<td>Maximum Exposure Limit (UK)</td>
</tr>
<tr>
<td>MFAG</td>
<td>Medical First Aid Guide (IMO)</td>
</tr>
<tr>
<td>MSDS</td>
<td>Material Safety Data Sheet</td>
</tr>
<tr>
<td>NA</td>
<td>North America (US)</td>
</tr>
<tr>
<td>NATICH</td>
<td>National Air Toxics Information Clearing House (US)</td>
</tr>
<tr>
<td>NESHAP</td>
<td>National Emission Standard For Hazardous Air Pollutants (US)</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association (US)</td>
</tr>
<tr>
<td>NIHHS</td>
<td>Notification of Installation Handling Hazardous Substances Regulations (UK)</td>
</tr>
<tr>
<td>NIOSH</td>
<td>National Institute of Occupational Safety &amp; Health (US)</td>
</tr>
<tr>
<td>NOS</td>
<td>Not Otherwise Specified</td>
</tr>
<tr>
<td>NTP</td>
<td>National Toxicology Program (US)</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Administration (US)</td>
</tr>
<tr>
<td>OES</td>
<td>Occupational Exposure Standard (UK)</td>
</tr>
<tr>
<td>PEL</td>
<td>Permissible Exposure Limit (US)</td>
</tr>
<tr>
<td>PGR</td>
<td>Road Traffic (Carriage of Dangerous Substances in Packages etc.) Regulations (UK)</td>
</tr>
<tr>
<td>PP</td>
<td>Polypropylene</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resources Conservation and Recovery Act (US)</td>
</tr>
<tr>
<td>REL</td>
<td>Recommended Exposure Limit</td>
</tr>
<tr>
<td>RID</td>
<td>Regulations concerning the International Carriage of Dangerous Goods by Rail</td>
</tr>
<tr>
<td>RQ</td>
<td>Reportable quantity (US)</td>
</tr>
<tr>
<td>SARA</td>
<td>Superfund Amendments and Reauthorization Act (US)</td>
</tr>
<tr>
<td>SCBA</td>
<td>Self-Contained Breathing Apparatus</td>
</tr>
<tr>
<td>STEL</td>
<td>Short-term Exposure Limit</td>
</tr>
<tr>
<td>TEFC</td>
<td>Totally Enclosed Fan Cooled electric motor</td>
</tr>
<tr>
<td>TLV</td>
<td>Threshold Limit Value (ACGIH) (US)</td>
</tr>
<tr>
<td>TQ</td>
<td>Threshold Quantity</td>
</tr>
<tr>
<td>TREMCARD</td>
<td>Transport Emergency Card</td>
</tr>
<tr>
<td>TSCA</td>
<td>Toxic Substances Control Act (US)</td>
</tr>
<tr>
<td>TWA</td>
<td>Time Weighted Average</td>
</tr>
<tr>
<td>UIC</td>
<td>International Union of Railways (Europe)</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories (US)</td>
</tr>
<tr>
<td>UN</td>
<td>United Nations</td>
</tr>
</tbody>
</table>
PRODUCT DESCRIPTION

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1.1 HYDROBROMIC ACID PRODUCTS

Hydrobromic acid solution (UN 1788) is commonly supplied in liquid form as the following products:
• Hydrobromic acid, 48% solution in water
• Hydrobromic acid, 52% solution in water
• Hydrobromic acid, 62% solution in water

1.2 IDENTIFICATION

Chemical Abstract Service (CAS) number: 10035-10-6

Empirical Formula: HBr

Synonyms: Hydrogen bromide solution in water
            Hydrobromic acid

Chemical Family: Inorganic acid

Appearance: Colorless to yellow liquid, turns dark on exposure to air and light
            Irritating, pungent odor
### 1.3 PHYSICAL PROPERTIES

*Note:* Physical properties are presented for hydrobromic acid 48% solution, as a representative product. Values for other products can be found on the relevant MSDS.

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point</td>
<td>126°C**</td>
</tr>
<tr>
<td>Melting Point</td>
<td>-63°C</td>
</tr>
<tr>
<td>Critical Temperature *</td>
<td>89.8°C</td>
</tr>
<tr>
<td>Critical Pressure *</td>
<td>84 atm.</td>
</tr>
<tr>
<td>Flash Point*</td>
<td>None</td>
</tr>
<tr>
<td>Auto Ignition Temperature *</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Decomposition Temperature *</td>
<td>Not available</td>
</tr>
<tr>
<td>Molecular Weight *</td>
<td>80.9</td>
</tr>
<tr>
<td>Liquid Density</td>
<td>1.4882 g/ml at 20°C</td>
</tr>
<tr>
<td>Vapor Density at 760 mm Hg and 25°C (Air = 1) *</td>
<td>2.71</td>
</tr>
<tr>
<td>Latent Heat of Evaporation *</td>
<td>51.3 cal/g</td>
</tr>
<tr>
<td>Latent Heat of Fusion *</td>
<td>7.1 cal/g</td>
</tr>
<tr>
<td>Flammable Limits in Air *</td>
<td>Not flammable</td>
</tr>
<tr>
<td>Solubility in Water *</td>
<td>194 g/100 ml at 20°C</td>
</tr>
</tbody>
</table>

* Refers to 100% Hydrogen Bromide  
** As constant boiling mixture 47.63%
PACKAGING

2.1  L-RING HDPE DRUMS (220 LITER).................................................................15
2.2  STEEL PE DRUMS (204 & 62 LITER)...............................................................18
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2.5  LABELLING .....................................................................................................23
Hydrobromic acid products are supplied in the following packagings:

- Steel PE Drums (204 Liter)
- Steel PE Drums (62 Liter)
- L-Ring PE Drums (220 Liter)
- Intermediate Bulk Containers - IBCs (1360 Liter)
- Isotanks (20,000, 17,500, 15,500 Liter)

### 2.1 L-RING HDPE DRUMS (220 LITER)

L-RING drum made of HDPE, (UN type 1H1, Plastic Drum, Non-Removable head). The drum plugs or bungs are made of polypropylene with an approved sealing gasket. The optimal plug closing torque is 35 newton-meter. The plugs should be opened and closed with correct size bung wrenches, which are available commercially.

The drums are loaded on pallets and banded together with polypropylene bands.

The palletized drums are stacked in the container in a manner which prevents any movement of the contents during the container handling. (See the sketches on page 17).

These drums are especially designed for their corrosion resistance, strength, tightness of closure and ease in emptying.

**NOTE:** These drums are to be used only for hydrobromic acid. Drums should be kept tightly closed, except when being emptied.
**Products:**

- 220 Liter: HBr 48%

<table>
<thead>
<tr>
<th>Nominal volume (Liter)</th>
<th>220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>HBr 48%</td>
</tr>
<tr>
<td>Color</td>
<td>Blue</td>
</tr>
<tr>
<td>Dimensions (cm)</td>
<td>58 x 94 dia.</td>
</tr>
<tr>
<td>Closure type</td>
<td>2 x 2&quot; dia. bung</td>
</tr>
<tr>
<td>Tare wt. for 1 unit (kg)</td>
<td>10</td>
</tr>
<tr>
<td>Net wt. for 1 unit (kg)</td>
<td>300</td>
</tr>
<tr>
<td>No. of units per pallet</td>
<td>4</td>
</tr>
<tr>
<td>Tare wt. per pallet (kg)</td>
<td>65</td>
</tr>
<tr>
<td>Net wt. per pallet (kg)</td>
<td>1200</td>
</tr>
<tr>
<td>No. of pallets per container (20 ft.)</td>
<td>16</td>
</tr>
<tr>
<td>Net wt. per container (kg)</td>
<td>19,200</td>
</tr>
</tbody>
</table>
TYPICAL ARRANGEMENT AND DUNNAGE OF HYDROBROMIC ACID DRUMS IN A CONTAINER
For L-Ring HDPE and Steel PE Drums

UPPER LEVEL

Plan View

View from the doors

rear barrier

upper level end lashing

2 layers of cardboard, 10 mm (minimum) thick

LOWER LEVEL

lower level end lashing
2.2 STEEL PE DRUMS (204 and 62 LITER)

Steel composite drum with an inner lining of HDPE (UN type 6HA1 - Plastic Receptacles in Steel Drum, Non-Removable Head). The drum plugs or bungs are made of polypropylene with an approved sealing gasket. The optimal plug closing torque is 35 newton-meter. The plugs should be opened and closed with correct size bung wrenches, which are available commercially.

The drums are loaded on pallets and banded together with polypropylene bands.

The palletized drums are stacked in the container in a manner which prevents any movement of the contents during the container handling. (See the sketches on page 17).

These drums are especially designed for their corrosion resistance, strength, tightness of closure and ease in emptying.

NOTE: These drums are to be used only for hydrobromic acid. Drums should be kept tightly closed except when being emptied.
## Products marketed in steel PE drums:

- 204 Liter: HBr 48% and HBr 62%
- 60 Liter: HBr 62%

<table>
<thead>
<tr>
<th>Nominal volume</th>
<th>204 Liter</th>
<th>62 Liter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product</strong></td>
<td>HBr 48%</td>
<td>HBr 62%</td>
</tr>
<tr>
<td><strong>Color</strong></td>
<td>Black</td>
<td>Blue</td>
</tr>
<tr>
<td><strong>Dimensions (cm)</strong></td>
<td>59 x 88 dia.</td>
<td>59 x 88 dia.</td>
</tr>
<tr>
<td><strong>Closure type</strong></td>
<td>2 x 2&quot; dia. bung</td>
<td>2 x 2&quot; dia. bung</td>
</tr>
<tr>
<td><strong>Tare wt. for 1 unit (kg)</strong></td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td><strong>Net wt. for 1 unit (kg)</strong></td>
<td>285</td>
<td>300</td>
</tr>
<tr>
<td><strong>No. of units per pallet</strong></td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Tare wt. per pallet (kg)</strong></td>
<td>125</td>
<td>124</td>
</tr>
<tr>
<td><strong>Net wt. per pallet (kg)</strong></td>
<td>1,140</td>
<td>1,200</td>
</tr>
<tr>
<td><strong>No. of pallets per container (20 ft.)</strong></td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td><strong>Net wt. per container (kg)</strong></td>
<td>19,380</td>
<td>19,200</td>
</tr>
</tbody>
</table>
2.3 INTERMEDIATE BULK CONTAINERS (IBCs)

An IBC is of a cubic shape and consists of an inner container made from HDPE (UN type 31HZ1 composite with plastic inner receptacle for liquids). Filling of the IBC is via a 6" dia. connection on the top. Discharge is via a 2" dia. PP ball valve on its lower side.

IBCs can be stacked in a warehouse 3 high and inside a closed sea container 1 high.

The container is protected within a wire mesh frame in which it is held by HDPE pads.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Liter)</td>
<td>1360</td>
</tr>
<tr>
<td>Dimensions (cm)</td>
<td>W102 x L122 x H158</td>
</tr>
</tbody>
</table>
| Closure type           | Top: 6" dia. PP bung  
                         | Bottom: 2" dia. PP ball valve |
| Unit load dimensions (cm) | W114 x L114 x H105 |
| Net weight (kg)        | 1800          |
| Gross weight (kg)      | 2025          |
| Tare weight (kg)       | 225           |
| No. of units per container (20 ft.) | 10           |

Note:
- Tank must not be pressurized.
- Vacuum relief must be provided whilst discharging contents.
2.4 PORTABLE TANKS (ISOTANKS)

Isotank

Carbon, Steel, Rubber lined Isotank, with "top filling and discharging", designed according to latest regulations of ADR/RID IMO regulations.

<table>
<thead>
<tr>
<th>Unit Type</th>
<th>Volume (Liter)</th>
<th>Max Net Weight Kg</th>
<th>Tare Weight Kg</th>
<th>Max Working Pressure BAR (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van Hool</td>
<td>20,000</td>
<td>24,340</td>
<td>6,140</td>
<td>4 (58)</td>
</tr>
<tr>
<td>Welfit Oddy</td>
<td>17,500</td>
<td>24,600</td>
<td>4,750</td>
<td>6 (87)</td>
</tr>
<tr>
<td>Consani</td>
<td>15,500</td>
<td>21,800</td>
<td>4,200</td>
<td>4 (58)</td>
</tr>
</tbody>
</table>
TYPICAL HBr ISOTANK

Legend:
1. Filling & unloading 3” butterfly valve painted yellow with long dip pipe - flanged 3” dia. ANSI 150#.
2. Vent/pressurizing 1½” dia. butterfly valve painted red - flanged 1½” dia. ANSI 150#.
3. 3” dia. relief valve.
5. Standard Isoframe 20’ x 8’ x 8’.
## 2.5 LABELLING

### A. Transportation
Labels are used for marking drums. Placards are used for marking bulk transport units.

<table>
<thead>
<tr>
<th><em>Diamond shaped danger label and placard</em></th>
<th>UN</th>
<th>IMDG</th>
<th>DOT</th>
<th>ADR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosive (8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Label size (mm)</td>
<td>100 x 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placard size (mm)</td>
<td>250 x 250</td>
<td>273 x 273</td>
<td>250 x 250</td>
<td></td>
</tr>
<tr>
<td>Reference</td>
<td>5.2.2</td>
<td>5.2</td>
<td>49 CFR 172.442/558</td>
<td>5.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Orange UN Number Panel</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (mm)</td>
</tr>
<tr>
<td>120 x 300</td>
</tr>
<tr>
<td>Hazard Identification</td>
</tr>
<tr>
<td>Not required</td>
</tr>
<tr>
<td>(Kemler) Code</td>
</tr>
<tr>
<td>Code: 80</td>
</tr>
<tr>
<td>Reference</td>
</tr>
<tr>
<td>5.3.2</td>
</tr>
</tbody>
</table>

### B. Product Labels

**Notes:**
* Symbol
(liquids, spilling from two glass vessels and attacking a hand and a metal):
black; background: upper half white; lower half black with white border;
Figure "8" in bottom corner.

** UN Number panel
1.1 Manufacturer’s nameplate.
1.2 International Convention for Safe Containers (CSC) Safety Approval Plate.
1.3 Customs seal.
1.4 Tank inspection stamp.
1.5 Isotank number on tank.
1.6 International Union of Railways (UIC) registration.
1.7 Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) approval (Europe).
1.8 European Agreement concerning the International Carriage of Dangerous Goods by Road. (ADR)
1.9 American Association of Railroads (AAR 600).
2.0 Maximum allowable working pressure.
2.1 Name of the substance: HYDROBROMIC ACID 48%, Chemical Abstract Service (CAS) number 10035-10-6.
2.2 Class 8 (Corrosive) Hazard Diamond.
2.3 UN & ADR Number Panel.
2.4 Ladder location marking.
2.5 Maximum gross weight.
2.6 Tare weight.
2.7 Maximum payload volume.
2.8 Emergency response instructions.
2.9 Valve identification marking.
3.0 Emergency instructions, 7 language product label.
TRANSPORTATION

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3.2 DRIVER'S LOADING CHECKLIST .................................................................33
3.3 DRIVER'S ROAD REMINDERS .................................................................35
The following is a summary of the main regulations and requirements regarding the transportation of hydrobromic acid products according to international regulations. The shipper should ensure that the transport of hydrobromic acid conforms to all relevant local regulations as well.

### 3.1 PACKAGING AND TRANSPORTATION

**United Nations (Orange Book)**

There has been considerable harmonization between the Orange Book and the various international regulations. These model regulations have been adopted in the various regulations, agreements and codes specified in this section. Many of the sections are numbered in the same way and much of the text is identical.

UN 1788 and Class 8 are applicable to all of the following regulations, in addition to the details provided in each section.

**US Department of Transportation Regulations (DOT)**

(As reflected by the changes published in the Federal Register, 2001)

Table of Hazardous Materials: 49 CFR 172.101

**Shipping Name:** hydrobromic acid

There are some differences between solutions less than and greater than 49%.

Emergency response information: 49 CFR 172.600

Emergency Response Guidebook, 2000

Guide number: 154

**Packaging**

Non-bulk packaging: 49 CFR 173.202

Non bulk packaging for certain medium hazard liquids: 49 CFR 173.242

Plastic receptacles within outer steel drums: 6HA1 49 CFR 178.522

Plastic drums: 1H1 - 49 CFR 178.509

**Carriage by vessel**

Vessel Stowage category "C"

- Cargo and passenger ships on deck only

**Carriage by aircraft**

- Cargo aircraft 30 liters per package
- Passenger aircraft 1 liter per package
DOT training requirements are specified in 49 CFR 172.704

A label or placard conforming to the UN recommendations may be used.
Corrosive placard:
• Sections 172.500, 172.519 and 172.558
• For marking vehicles
• Size: 273 mm x 273 mm (10.8" x 10.8")
Details of the placard holder are shown in Appendix C of section 172

**IMDG Code**
Packing and Stowage Regulations

**Stowage, Chapter 7.1**
Hydrobromic acid is in stowage category "C" and is transported on deck

**Segregation table, chapter 7.2**
"Separate from": Explosives
Infectious substances
Organic peroxides
Oxidizing materials
Radioactive materials

"Away from": Flammable gases
Flammable solids

For the purpose of segregation provisions, refer to IMDG code section 7.2.1.17 to determine the provisions for a specific type of vessel.

**Special provisions in the event of an incident and fire precautions involving dangerous goods are included in section 7.3.**

The emergency procedures for ships carrying dangerous goods are contained in the supplement.
**For hydrobromic acid, the emergency schedule is 8-03.**

The Medical First Aid Guide (MFAG) is also contained in the supplement and is for use in accidents involving dangerous goods.
**ADR (Europe)**

Regulations concerning the International Carriage of Dangerous Goods by Road.

Hydrobromic acid is classified as "C1"
Corrosive substance without subsidiary risk - Inorganic, Liquid.

Packing group II - Corrosive substances

Hydrobromic acid is listed in Table A

Packaging instructions P001 and IBC 02 apply

ADR tank code "L4BN" (Tank suitable for liquids, designed for 4 bar pressure, bottom discharge, fitted with safety valve).

Hydrobromic acid to be transported in "AT" vehicle designed for dangerous goods

Transport category 2.

Transport Emergency Card (TREMCARD) requirements hydrobromic acid.
Transport Emergency Card (Road), TEC(R) - 80G01b.

Hazard identification number for labeling transport units.
Hazard Identification Number: 80
Corrosive or slightly corrosive substance.

**RID (Europe)**

Regulations concerning the International Carriage of Dangerous Goods by Rail

These regulations are similar to the ADR agreement.
IATA
International Air Transport Association Regulations
• Section 4.2, List of Dangerous Goods
  Class 8, Corrosives
  more than 49% strength is Forbidden to be transported on passenger or cargo aircraft.
• Section 4.4, Special Provisions, Remark A2 Hydrobromic acid more than 49%
  may be transported on passenger and on cargo aircraft, only with the prior approval of the appropriate authority of the State of origin under the written conditions established by the authority. In addition, for passenger aircraft, written prior approval must be obtained from countries of transit, overflight and destination. In each case, a copy of the authorization showing the quantity limitations, packing and labelling requirements must accompany the consignment.
• Aircraft Emergency Response Guidance, ERG Code 8L.

UNITED KINGDOM
The Emergency Action Code (EAC) for hydrobromic acid is:

2R

2 - Use fine water spray for extinguishing a fire

R - Wear chemical protective clothing with breathing apparatus
  May be washed down to drain with a large quantity of water
### 3.2 DRIVER'S LOADING CHECKLIST

The following is a suggested checklist, based on European Agreement concerning the Carriage of Dangerous Goods by Road (ADR) regulations and good practice. The shipper should also ensure that all local regulations are complied with.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Vehicle is marked clearly in front and rear with the UN No. (1788), Hazard Identification no. 80 and Hazard Placard no. 8, corrosive substances. Vehicles are marked on the sides and rear, containers on both sides and at each end.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Vehicle is equipped with two suitable portable fire extinguishers or equivalent, of at least two and six kg capacity, checked within the past year. Do not use dry chemical powder extinguishers on hydrobromic acid.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Approved portable lamps are available to each member of the crew.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 4.  | Vehicle has the following emergency equipment:  
- Emergency tools.  
- Wheel blocks.  
- Two self-standing warning signs.  
- Suitable warning vests or clothing for each member of the crew.                                                                                   |     |     |
| 5.  | An eye wash bottle is readily available.                                                                                                                                                                     |     |     |
| 6.  | Vehicle has a valid license for hazardous materials (Hazmat license). The validity of the license shall expire not later than one year after inspection date.                                                    |     |     |
| 7.  | Driver and assistant driver have valid licenses to operate hazardous material vehicles (Hazmat license), issued or renewed within the past five years.                                                          |     |     |
| 8.  | Hydrobromic acid Transport Emergency Card (TREM CARD) is readily accessible (see sample on page 36).                                                                                                          |     |     |
| 9.  | Hazardous transport unit does not consist of more than one trailer.                                                                                                                                          |     |     |
| 10. | The vehicle is not carrying any materials incompatible with hydrobromic acid at the same time (Explosives, flammables, radio-active materials, organic peroxides and oxidizing substances, infectious substances, or strong bases and metals). |     |     |
11. Hydrobromic acid will be kept apart from food stuffs and animal feed.

12. Shipping papers include
   - Product name: hydrobromic acid
   - UN Identification Number: 1788
   - Permit to transport hydrobromic acid
   - Quantity being shipped.

13. All papers concerning the transport of the hazardous material are kept in a holder on the inside of the door on the driver’s side of the vehicle.

14. Driver has approved route to destination with specified stops.
    No alternative routes will be used or unauthorized stops made.

15. Vehicle has a full fuel tank before loading the hydrobromic acid.

16. Containers have been fastened with all the twist lock corner fittings.
3.3 DRIVER'S ROAD REMINDERS

The driver and assistant driver of any vehicle transporting hydrobromic acid should comply with the following requirements:

Supervision of vehicles (ADR Section 8.4)

- Parking the hazardous goods transport unit should be under one of the following conditions:
  (a) Supervised parking lot, attendant aware of the nature of the load, and how to contact the driver.
  (b) Vehicle parking lot where unit is not likely to suffer damage.
  (c) Open space separated from public highway and public dwellings, where public does not normally pass.

Miscellaneous requirements (ADR Section 8.3)

- No passengers are allowed.
- The crew shall know how to use fire-fighting appliances.
- A driver or driver’s assistant may not open a package containing hydrobromic acid.
- Hydrobromic acid receptacles are not to be checked with open flames.
- No smoking is permitted around the transport unit or in the vicinity of the vehicle during handling operations.
- The engine is to be shut off during all handling operations unless required to drive pumps, hoist, etc.
- Parking brakes are to be applied whenever parked.
- If the vehicle is parked on a road at night or with poor visibility, warning signs are to be placed 10 meters both in front of and behind the vehicle.
TRANSPORT EMERGENCY CARD (Road)

LOAD:
CONCENTRATED CORROSIVE OR SLIGHTLY CORROSIVE INORGANIC ACIDS (except hydrofluoric acid)

Name of substance(s):
• Colourless or yellowish - Fuming liquid - Perceptible odour.
• Completely miscible with water.

NATURE OF DANGER:
• Corrosive. Contact with liquid causes severe damage: to eyes, to skin. / Slightly corrosive. Contact with liquid causes strong irritation: to eyes, to skin.
• May evaporate quickly.
• The vapour may be invisible. Production of mist on contact with moist air.
• Attack many metals with liberation of hydrogen which is flammable and forms explosive mixture with air.
• Heating will cause pressure rise with risk of bursting.

PERSONAL PROTECTION:
• Goggles or face shield,
• Light protective clothing,
• Protective gloves,
• Protective footwear
• Eyewash bottle with clean water.
• Two self-standing warning signs, handlamp, warning vest.

GENERAL ACTIONS BY THE DRIVER:
• Stop the engine.
• No naked lights. No smoking.
• Mark roads with self-standing warning signs and warn other road users or passers-by.
• Keep public away from danger area. Keep upwind.
• Notify police and fire brigade as soon as possible.

ADDITIONAL AND/OR SPECIAL ACTIONS BY THE DRIVER:
• Any action only if without personal risk.
• Avoid direct contact with substance.
• Stop leaks if without risk.
• Contain or absorb leaking liquid with sand or earth or other suitable material, using shovel or broom.
• Do not use metal containers for spilled liquid.
• If substance has entered a water course or sewer or been spilt on soil or vegetation, advise police.

FIRE (information for the driver in case of fire):
• Do not attempt to deal with any fire involving the load.

FIRST AID:
• If substance has got into the eyes, immediately wash out with plenty of water. Continue treatment until medical assistance is provided.
• Remove contaminated clothing immediately and drench affected skin with plenty of water, then wash with soap and water.
• Seek medical treatment when anyone has symptoms apparently due to inhalation or contact with skin or eyes.

SUPPLEMENTARY INFORMATION FOR EMERGENCY SERVICES:
• Drench with water.
• Do not use metal containers for spilled liquid.
• Contain or absorb leaking liquid with sand or earth or other suitable material, using shovel or broom.
• Keep container(s) cool by spraying with water if exposed to fire.

Additional information

EMERGENCY TELEPHONE: ....................
UN No.: 1788...
HI No.: .....

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APPLIES ONLY DURING ROAD TRANSPORT ENGLISH
Issued: 2000

SAMPLE TREMCARD

36 TRANSPORTATION HBr
Since hydrobromic acid is a hazardous material, storage areas should be carefully supervised. Local regulations must be complied with.

This guide provides some standard precautions to be taken at a hydrobromic acid installation. The storage areas can be supplier distribution warehouses, third party distribution houses or user storage areas.

- Storage facilities for hydrobromic acid should be outside populated areas, and located so that prevailing winds will not blow vapors towards inhabited areas, offices, workshops or any areas of employee concentration.

- The storage area should be located at least 100 meters (preferably 200 meters) from any school, hospital or concentration of 10 or more private dwellings, and at least 25 meters from the nearest occupied building.

- "Corrosive" hazard signs should be prominently displayed at any facility where hydrobromic acid is stored.

- Where freezing temperatures can be expected, 48% hydrobromic acid should be stored at a temperature above -11°C.

Following is a general guide for choosing and supervising a storage area, especially for storage of quantities of 10 tons or more.

Note that all local laws and regulations and codes must be strictly followed; the precautions listed below are in addition to those specified in local codes.
Storage Facilities

- The amount of hydrobromic acid stored at the user site should be kept to a minimum.

- Low curbs or walls (called dikes) about 200 mm high, should enclose the worksite to protect the area from external flooding and to minimize the dispersal of hydrobromic acid liquid and vapor spills. The minimum diked volume should be equivalent to the largest storage tank plus 10%.

- The diked area can be connected to the sewer system if the connection has a quick closing device to prevent the entry of hydrobromic acid into the sewer system in case of emergency. Provide an adequate size sump in the diked area for collecting hydrobromic acid spills and pumping away collected contaminated rain water and fire fighting water.

- Provide adequate ventilation of the worksite, taking into account that hydrobromic acid vapors are heavier than air.

- **Hydrobromic acid should never be stored in a basement.** Drums containing hydrobromic acid should be stored at least 1.2 meters (4 feet) from a wall or ceiling. Minimize areas where hydrobromic acid liquid or vapors can accumulate, such as pits or confined spaces.

- Buildings should be at least 10 meters apart to allow for strengthened approach roads for emergency vehicles on two sides of the installation.

- Building construction should be fire resistant and provisions made for potential fire fighting activities, according to relevant local and national codes, and in consultation with local fire-fighting professionals. The fire-fighting installation should include provision for an adequate supply of water. Fire extinguishers and hydrants should be distributed around the area. Fire-fighting water run-off should be prevented from polluting water sources. Do not use dry chemical powder extinguishers for fighting fires when hydrobromic acid may be involved.
• Floors should be of impervious construction, preferably concrete.

• **Piping** between 20 mm (1/2") and 110 mm (4") diameter should be solid PVDF (polyvinyliden fluoride) pipe, stress relieved, with plain ends for fusion socket welding connection PN-16, as per DIN 8077. Piping of 160 mm (6") and 225 mm (8") diameters should be according to PN-10, for butt welding connection. Flanges should have a backing ring fabricated from carbon steel, drilled to ANSI 150 pounds rating, painted with epoxy 240 micron. Flange gaskets should be a PTFE (teflon) sandwich, 3 mm thick with a non-asbestos filler. Teflon lined flanged plug or diaphragm valves are preferred.

  **Solid black polypropylene piping may also be used**, if it is basically as specified above, but PN-10 (for 20 through 110 mm diameter) and PN-6 (for 160 mm through 315 mm, diameter), according to DIN 8077.

• **Hoses** should be PTFE with stainless steel braid covering and carbon steel flanges. Screwed fittings are not to be used.

• **Electrical installation**: Junction boxes and light fittings should be dust and vapor tight. Cast iron (epoxy-base coated) or a non-metallic material is suitable. **Do not use aluminum or aluminum alloys unless suitably coated.** Use TEFC (Totally Enclosed Fan Cooled) motors of cast iron or steel construction with epoxy-base coating.
Safety and Security Measures

- Any area where hydrobromic acid is used or stored should be enclosed so that unauthorized persons and animals are prevented from entering the area. Adequate lighting should be provided to allow sufficient night surveillance. Surveillance should be provided 24 hours a day.

- Provide clearly marked personnel escape routes that are unobstructed and have adequately sized doors and windows.

- Locate facilities for offices, eating, smoking, showering and changing upwind and remote from the area where hydrobromic acid is used or stored. Provide an adequate supply of clean water for washing and showers.

- A telephone should be provided which is freely available and readily accessible for the reporting of accidents or emergency situations.

- A windsock indicating wind velocity and direction should be clearly visible from all points on the site and replaced as required.

- Emergency respirator equipment cabinets should be installed not more than 30 meters or ten seconds walking distance from any location in a storage area.

- Non-freeze safety showers and eyewash fountains shall be provided, clearly marked, well lighted and with unobstructed access. They should be installed close to the hydrobromic acid storage area and not more than 30 meters or ten seconds walking distance from any location in a storage area. Provide alternative sources of water supply.

Handling

All management and operating personnel involved in the use or handling of hydrobromic acid should undergo safety training in addition to their specific task training.

Only experienced well-trained operators should be allowed to receive and unload hydrobromic acid receptacles.

The management should assure that emergency response plans have been made and coordinated with the local emergency response authorities.
Precautions should be taken from the moment the shipment of hydrobromic acid arrives at the site gate. Any handling of hydrobromic acid should be carried out with a high standard of housekeeping and personal hygiene.

- Ensure that road and rail vehicles cannot be moved during a transfer operation.
- Goggles, rubber gloves, boots and full body covering clothing should be worn while unloading and handling drums containing hydrobromic acid.
- Hydrobromic acid is shipped in freight containers. When opening a container at its destination, cautiously open the doors completely and allow the container to be aired for at least 15 minutes before entering and before any of the unloading operations are started. If there are any signs of spills or leakage, take appropriate action as indicated in Section 5, Emergency Response.
- The drums should not be handled roughly.
- No open flame heating is allowed.
- When the hydrobromic acid drums are not in use, or after emptying the closures should be in place to prevent any accidental spillage. The drums should be kept dry and tightly closed.
- Avoid the use of metals which are attacked by hydrobromic acid. Non-metallic materials are typically used for handling hydrobromic acid, either as construction materials, such as polyethylene, polypropylene, Teflon and Kynar, or as a lining for metallic materials.
- Provide sufficient neutralizing materials. The following table, which shows the approximate amounts (tons) of neutralizing materials required for a ton of spilled material, can be used as a guide for estimating the amount of neutralizing materials which should be kept on hand.

<table>
<thead>
<tr>
<th>Spilled material</th>
<th>Slaked Lime slurry Ca(OH)₂</th>
<th>Soda Ash Na₂CO₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>48% HBr</td>
<td>0.25</td>
<td>0.32</td>
</tr>
<tr>
<td>52% HBr</td>
<td>0.27</td>
<td>0.35</td>
</tr>
<tr>
<td>62% HBr</td>
<td>0.30</td>
<td>0.42</td>
</tr>
</tbody>
</table>

- Provide clean, dry, empty receptacles or overpacks for damaged hydrobromic acid drums.
## Sample Checklist for a Hydrobromic Acid Handling Facility

| Good housekeeping and personal hygiene | Yes | No |
| Corrosive hazard signs displayed | Yes | No |
| Minimum amount is being stored | Yes | No |
| Area surrounded by curb or dike | Yes | No |
| Sewer connections with quick closure | Yes | No |
| Sump | Yes | No |
| Minimize pits and confined spaces | Yes | No |
| Nearest building - 10 m gap | Yes | No |
| Reinforced road for emergency vehicles | Yes | No |
| Ventilation | Yes | No |
| Clear space 1.2 m from walls and ceiling | Yes | No |
| Fire resistant building construction | Yes | No |
| Fire-fighting hydrants | Yes | No |
| Fire-fighting extinguishers (no chemical powder type) | Yes | No |
| Prevent contamination of sewer and water courses | Yes | No |
| Correct piping specification | Yes | No |
| No aluminum electrical fittings | Yes | No |
| Dust and vapor tight electrical fittings | Yes | No |
| TEFC electric motors | Yes | No |
| Impervious floor | Yes | No |
| Prevent freezing temperatures | Yes | No |
| Area enclosed and secure | Yes | No |
| Clearly marked escape routes | Yes | No |
| Remote eating, changing and smoking areas | Yes | No |
| Telephone | Yes | No |
| Wind sock | Yes | No |
| Emergency equipment cabinets, showers and eye-wash | Yes | No |
| Prevent vehicles from moving during handling operations | Yes | No |
| No open flame heating | Yes | No |
| Personal protection equipment used when unloading or handling | Yes | No |
| Provide neutralizing agents | Yes | No |
4.2 PROCESS SAFETY MANAGEMENT REGULATIONS

4.2.1 USA

- Facilities handling HIGHLY HAZARDOUS CHEMICALS over a threshold quantity (40 CFR 1910.119):

  For Hydrogen Bromide (UN 1048), the threshold quantity is 5000 lbs (2272 kg).
  As hydrobromic acid is not specified as such, then the equivalent threshold quantity would be as follows:
  48% hydrobromic acid 10,417 lbs (4735 kg)
  52% hydrobromic acid 9615 lbs (4371 kg)
  62% hydrobromic acid 8065 lbs (3666 kg)

  The management is required to prepare EMERGENCY ACTION PLANS to minimize the consequences of a hazardous release of this material. This written emergency action plan describes the measures taken to prevent any release and the activities of the workers and community services in the event of a release.

  Workers, including contract workers, are to be given adequate training and refresher courses to implement this emergency action plan.

  Safety audits are to be made before starting up a facility and after changes have been made in a facility or its operation procedures. Deficiencies and the corrections made are to be documented to ensure that the facility can be put into safe operation. Changes may have to be reflected in emergency action plans. A safety audit is to be repeated every three years.

  All incidents which result in a release of hazardous materials or could have resulted in a release are to be investigated. The results of the investigation and corrective actions recommended and taken are to be documented.

  - Toxic Chemical Release Reporting (40 CFR 372)
    Hydrogen bromide is not listed

  - CERCLA (40 CFR 302)
    Hydrogen bromide is not listed
4.2.2 Europe & UK - Directive 82/501/ EEC, COMAH

This directive is aimed to prevent and limit the consequences of major accidents involving a dangerous substance. Neither hydrogen bromide nor hydrobromic acid are named substances in these regulations. Also, corrosive substances do not fall under the general categories of inventories to be reported. Therefore specific safety reports and emergency plans do not have to be prepared and accidents involving hydrobromic acid do not have to be reported under these regulations. Note, however, that local regulations may have other requirements and inventory levels whereby hydrobromic acid needs to be included in the safety report.
4.3 HAZARDOUS EXPOSURE LIMITS

Exposure limit values go under different names in the various standards, countries, time periods and populations.

Generally, the exposure limit is specified as TWA, Time Weighted Average, for an eight or a ten hour workday and STEL, Short Term Exposure Limit for fifteen minute periods or a ceiling value not to be exceeded. Some of the limits are called TLV, Threshold Limit Values (ACGIH), REL, Recommended Exposure Limit (NIOSH) or OES, Occupational Exposure Standard (UK - HSE - COSHH).

There is also an ERPG, Emergency Response Planning Guideline value for planning exposure limits for the civilian population that includes children, the elderly and disabled persons.

The following are representative values established by US and UK authorities for hydrogen bromide:

**Threshold Limit Values,**

<table>
<thead>
<tr>
<th></th>
<th>USA</th>
<th></th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACGIH, 2001</td>
<td>TLV-C, Ceiling</td>
<td>3 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No indication of being human carcinogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OSHA, 2001</td>
<td>Hydrogen bromide, Ceiling</td>
<td>3 ppm</td>
<td>10 mg/m³</td>
</tr>
<tr>
<td>NIOSH 1997</td>
<td>IDLH</td>
<td>30 ppm</td>
<td></td>
</tr>
<tr>
<td><strong>UNITED KINGDOM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEL, (15 minutes reference period)</td>
<td>3 ppm</td>
<td>10 mg/m³</td>
<td></td>
</tr>
</tbody>
</table>
4.4 DETECTION METHODS

Air sampling is used to determine the presence and/or concentration of hydrogen bromide vapor at levels that may be harmful to human health. There are a variety of sampling techniques and types of equipment for determining the air concentration of hydrogen bromide. The technique and/or equipment chosen will depend on the type of monitoring system needed to meet a specific regulatory requirement. Types of sampling include time weighted average (TWA) exposure, continuous monitoring and point-in-time exposure measurements.

Different types of detectors are available to identify and quantify specific chemicals. The suitability of a given type of detector varies, depending on the situation. Suppliers of these devices can provide additional information about the advantages and limitations of specific detection systems. It is also possible that the presence of other airborne chemical vapors may interfere with sampling results.

**Tube Detectors**

The tube detector method is an officially approved analysis method. The apparatus is simple and hand pump operated.

Detector tubes should meet one of the standards issued by competent authorities.

Tubes for hydrochloric acid are available which also give an indication of the hydrogen bromide concentration in air. For example the Dräger 1/a tube will indicate hydrogen bromide at approximately a third of sensitivity and can be used to measure hydrogen bromide concentrations between 0-10 ppm. Other suppliers such as Kitagawa and Rae systems can also supply hydrochloric acid detector tubes with similar sensitivities.

All tubes should be stored and used in strict conformance with the directions supplied by the manufacturer, including shelf life and disposal.
Electronic Gas Sensor

Electronic gas sensors have been developed for the detection of halogen gases, including hydrogen bromide. These sensors can respond to traces at concentrations less than 1 ppm.

As in the other methods described above, there is the possibility of an erroneous indication of hydrogen bromide caused by the interference with other halogens.

If a continuous or a portable electronic monitor is required, then the PID (photoionization detector) type instruments of RAE Systems, USA (ToxiRAE PLUS personal gas monitor) and Dräger (Multiwarn monitor), Germany would be suitable instruments. The supplier should be contacted for expert advice on the type of instrument that can be used.
4.5 PROTECTIVE CLOTHING

As hydrobromic acid is corrosive, no worker should be alone in an area where there is a potential exposure to hydrobromic acid.

The protective clothing required for workers under routine operating conditions should be sufficient to allow the worker to escape the operating area in case there is a release of hazardous material.

For routine handling of hydrobromic acid receptacles, goggles, rubber gloves, boots, aprons and full body covering clothing should be worn. A safety helmet or other head covering should be worn where required.

Goggles should be worn for any operation where there is a possibility of a liquid splash. Otherwise, a full face shield should be worn.

All clothing exposed to hydrobromic acid should be thoroughly washed with water before reuse. Contaminated work clothes should be placed in closed containers until laundering. The clothes should be laundered under supervision by the employer and not laundered at home.

A gas mask with a new and valid vapor canister must be readily available for escape purposes.

Please refer to the relevant Material Safety Data Sheet for further information.
4.6 RESPIRATORY PROTECTION PROGRAM

Under routine operating conditions, where hydrobromic acid is contained within a closed system, a gas mask does not need to be worn at all times. However, each person working in an area where hydrobromic acid is being handled should be trained in the use of respirators in case hazardous fumes are released.

When there is an uncontrolled release of hydrobromic acid, a full face gas mask with a new and valid acid vapor canister should be used to escape the area. The face piece should be made of neoprene or other non-natural or non-butyl rubber elastomer. Eyeglasses cannot be worn with regular face pieces. Special face pieces or face piece adapter kits can be supplied for use with special eyeglass frames. Contact lenses must not be worn with a respirator.

Color coding of gas mask filters may vary depending on the relevant regulations for example:


European Standard, EN 141, Inorganic gases, Type B, Color coded: Grey.

It should be emphasized that the filter life is limited, even at low vapor concentrations (no more than 20 minutes continuous use). While wearing a gas mask, the operator should immediately leave the area on detecting any smell, taste or irritation of the eyes.

A self-contained breathing apparatus should be worn to re-enter an area when the oxygen content is less than 19.5%, the hydrobromic acid concentration is more than 150 ppm or if odor is detected while wearing the mask.

The self-contained breathing apparatus should be stored in a clean sanitary cupboard, conveniently located. Whenever possible, respirators should be individually assigned for hygienic purposes and to assure a good fit. After each use, they should be inspected, cleaned and disinfected. They should also be cleaned and disinfected each month, even if the respirator has not been used. A record should be kept of the inspection date, and what was found at the time. The breathing air cylinders of the self-contained breathing apparatus should be tested and maintained in accordance with the local pressure vessel regulations.
A new operator should be trained in respirator use, and the face piece should be fitted before starting his assignment. A record should be kept of the training and fitting dates.

Caution must be exercised, as hydrobromic acid vapors can seep through punctured ear drums when a respirator is being worn. Protection is possible with lubricated ear plugs, but hearing may be affected.

Canisters should not be used after expiration date.

**Respirator Regulations**

A respirator protection program is required in the US (29 CFR 1910.134(c)), and is recommended for other locations:

- Written standard procedures governing the selection and use of respirators shall be established.

- Written procedures shall be prepared covering safe use of respirators in dangerous atmospheres that might be encountered in normal operations or in emergencies.

- Training shall provide an opportunity to handle the respirator, have it fitted properly, test its facepiece-to-face seal, and wear it in normal air and a test atmosphere.

- A record shall be kept of inspection dates and findings for respirators maintained for emergency use.

- There shall be an annual inspection and evaluation to determine the effectiveness of the respiratory program including respirator condition and correct gas mask facepiece fitting.
4.7 UNLOADING PROCEDURE FOR HYDROBROMIC ACID ISOTANKS

General

Note: Unloading of isotanks should only be performed by personnel who are familiar with the physical and chemical properties of hydrobromic acid as well as first aid instructions. (See the Material Safety Data Sheet). If expert advice is needed, please contact your local supplier or the nearest DSBG sales office.

- Make sure that the identification number of the isotank corresponds with the shipping papers.
- Make sure that the correct placards are placed on the isotank: Class 8 (Corrosive) / UN 1788
- Position the isotank at the designated unloading location. Make sure that the isotank is level and stable.
- The suggested unloading procedure should be read together with isotank drawing (page 22).
- Wear the recommended personal protective clothing and equipment.
- Do not leave the isotank unattended while it is being unloaded.

Unloading Procedure

1. Open the hinged valve protection cover on the top of the isotank by lifting the doors and securing them on both sides.

2. Make sure that the isotank valves are closed and the blind flanges are in place.

3. On the top of the isotank (front side) there are two valves:
   Yellow valve: 3" dia. DN 80 "liquid inlet / outlet"
   Red valve: 1½" dia. DN 40 "vent / pressurizing"
4. Carefully remove the blind flange on the top of the red 1½” dia. vent / pressurizing valve. Connect the plant nitrogen flexible pipe using a Teflon gasket and tighten properly.

5. The nitrogen (or dry air) pressure should be regulated to a maximum of 3 bar (44 psi) for unloading the isotank.

6. Carefully remove the blind flange on the top of the yellow 3” dia. liquid inlet / outlet valve. Connect the plant liquid flexible pipe using a Teflon gasket and tighten properly. Open the plant valves in the liquid line. Slowly open the yellow 3” dia. valve in the isotank. If there is sufficient pressure in the isotank, the flow of hydrobromic acid will begin. Check for leaks.

7. Open the valves in the pressuring line in the plant, then slowly open the isotank’s red 1½” dia. valve.

8. Apply adequate nitrogen or dry air pressure to establish the hydrobromic acid flow to the plant storage tank.

9. Continuously check for leaks. In case of hydrobromic acid leak, shut off the isotank valves immediately. Wash off any spillage immediately with plenty of water to prevent corrosion. For further instructions, please see the Material Safety Data Sheet (MSDS). Allow the isotank pressure to vent to the scrubber. Proceed with the necessary repairs to stop the leak.

10. When the nitrogen/air is blown through the unloading line into the storage tank, the isotank is empty. Close the liquid and pressurizing valves.

11. Switch your pressurizing line to vent scrubber line to relieve the pressure on the isotank.

12. Once the isotank is depressurized, close the isotank’s red 1½” dia. valve and the plant line vent valve.

13. Disconnect the red and yellow valves, install the blind flanges using Teflon gaskets, tighten properly.

14. Close the hinged valve protection cover on the top of the isotank and secure with pin lock.
4.8 UNLOADING OF OTHER RECEPTACLES

Drums

- Empty drums completely.
- Ensure that drums are kept dry and tightly closed.
- It is recommended to store empty drums in a cool place.
- Before disposing of empty drums, wash them with 10% bicarbonate solution and rinse with water.

IBCs

- IBCs must not be pressurized.
- Vacuum relief must be provided while discharging contents.
- Do not re-use IBCs for any other material.
EMERGENCY RESPONSE

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5.8 EXPOSURE TO HYDROBROMIC ACID........................................69
5.1 FACILITY EMERGENCY ACTION PLANNING

- **USA - OSHA (29 CFR 1910.119n and 29 CFR 1910.120q)**
  - Emergency Action plans must be established and submitted to state and local authorities for any facility where Threshold Quantities (TQ) of hazardous substances are handled.

For Hydrogen Bromide (UN 1048), the threshold quantity is 5000 lbs (2272 kg).
  - As hydrobromic acid is not specified as such, then the equivalent threshold quantity would be as follows:
    - 48% hydrobromic acid 10,417 lbs (4735 kg)
    - 52% hydrobromic acid 9615 lbs (4371 kg)
    - 62% hydrobromic acid 8065 lbs (3666 kg)

- When there is a release of a hazardous material, the Emergency Planning Committee is to be advised of the following information (a transportation related release may be notified to the 911 emergency operator):
  - The released material, hydrobromic acid, is *corrosive*.
  - The quantity released, the time of the release and its duration.
  - The media into which the release occurred.
  - An indication of the health risks and sources for medical advice.
  - Precautions to be taken by the local community, preferably as established in a previously prepared emergency plan.
  - Names and phone numbers for receiving further information on the material.

- The Emergency Planning Committee is to be given the following follow-up information:
  - Actions that were taken to contain the release.
  - Any acute or chronic health problems that were the result of the release.
  - Medical advice that was given to the exposed individuals.
• EUROPE

The European Community has issued regulations on Major Accident Hazards, Directive 82/501/EEC.

This directive is aimed to prevent and limit the consequences of major accidents involving a dangerous substance. Neither hydrogen bromide nor hydrobromic acid are named substances in these regulations. Also, corrosive substances do not fall under the general categories of inventories to be reported. Therefore specific safety reports and emergency plans do not have to be prepared and accidents involving hydrobromic acid do not have to be reported under these regulations. Note, however, that local regulations may have other requirements and inventory levels whereby hydrobromic acid needs to be included in the safety report.
5.2 TRANSPORT EMERGENCY RESPONSE

The driver of a vehicle involved in an accident while transporting a hazardous material should immediately leave the vehicle, taking with him the shipping papers, and take reasonable measures to extinguish any small fires.

The driver should call for help, and furnish the following information about the hazardous material involved:

- UN number: 1788 (hydrobromic acid).
- Hazard Class Placard.
- Hazardous response markings (e.g. EAC Code, NFPA diamond numbers).
- Quantity of hazardous material involved.
- Emergency contact phone number.

The first responder is generally the local fire department, which should act to:

- Protect persons, property and environment.
- Contain the release from a safe distance.
- Do not get involved in stopping the release.
- Ensure that a qualified responder has been called.

Qualified responder, Hazardous Waste Operations & Emergency Response (HAZWOPER), is called by the shipper of the hazardous material or by the first responder if the shipper has not acted. The Hazardous Materials Technician is qualified to stop the release.

Hazardous Materials Specialist provides support to responders with information on the hazardous materials, but he is not authorized to become actively involved in response action. The Hazardous Material Specialist is called by the shipper, the first responder or the qualified responder when additional information or procedures are required.

Emergency Response Telephone Number should be clearly identified as "EMERGENCY CONTACT" on labels and shipping papers.

1. USA : CHEMTREC 1-800-424-9300
2. National Response Center 1-800-424-8802
3. UK : National Chemical Emergency Center "CHARECHEM 24" 44-1865-407-333
4. Material Suppliers: Broomchemie, Holland Clearon, USA 1-304-746-3000 DSBG, Beer-Sheva, Israel 972-8-623-0393
5.3 HAZARD IDENTIFICATION

ADR - Hazard Identification Number (Kemler Code), Europe
Hydrobromic acid UN 1788
Hazard identification number No. 80
Class 8 - Corrosive

EAC - Emergency Action Code
The UK CDG Road - Carriage of Dangerous Goods Regulations require the display of this code number in the UK.
The EAC - Emergency Action Code for hydrobromic acid is:

2 R

2: Use fine spray for extinguishing a fire.
R- Wear full body protective clothing with breathing apparatus plus protective gloves.
Spillage may be washed into drains with copious amounts of water.

NFPA Hazard Identification (USA)

<table>
<thead>
<tr>
<th>Hydrobromic acid</th>
<th>Health hazard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>Serious. Materials that under emergency conditions can cause serious or permanent injury. Areas should be entered only when wearing self-contained breathing apparatus and special protective clothing.</td>
</tr>
<tr>
<td>Flammability hazard</td>
<td>0</td>
<td>Hydrobromic acid does not burn. However, when hydrobromic acid reacts with metals, hydrogen (a flammable gas) is produced.</td>
</tr>
<tr>
<td>Reactivity Hazard</td>
<td>0</td>
<td>Materials that are normally stable, even under fire conditions.</td>
</tr>
</tbody>
</table>

Rest of the world
According to local regulations.
5.4 RISK AND SAFETY PHRASES


Following is the classification for hydrobromic acid EINECS No. 2331130 under the Directive:

- Corrosive, symbol required (C)
- Irritant

The following Risk and Safety Phases are assigned for hydrobromic acid:

**Risk Phrases:**
- R34 Causes burns.
- R37 Irritating to respiratory system.

**Safety Phrases:**
- S7/9 Keep container tightly closed and in well ventilated place.
- S26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S45 In case of accident or if you feel unwell, seek medical advice immediately (show the label when possible).
5.5 FIRE FIGHTING

It is very important that hydrobromic acid receptacles should not remain in a fire zone. The heat can lead to liberation of poisonous and corrosive fumes of hydrogen bromide. The hydrogen bromide attacks many metals, resulting in the evolution of hydrogen, which is flammable and forms an explosive mixture in air. Bromine may also be released in a thermal decomposition.

If possible, the hydrobromic acid receptacles should be physically removed from the fire zone. Sometimes it is possible to move the fire source away from the hydrobromic acid receptacles.

Closed hydrobromic acid receptacles involved in the fire should be cooled by the most practical means. However, direct contact of water with hydrobromic acid should be avoided unless copious amounts of water can be used.

A fire in an area containing hydrobromic acid should be extinguished with the most appropriate means available. If the hydrobromic acid is involved in the fire, use copious amounts of water to extinguish the fire and cool the hydrobromic acid. This will prevent and arrest its decomposition due to heat. This response is practical, even though hydrobromic acid becomes more reactive with limited amounts of water, because dilution and water cooling is still the most effective way of dealing with the primary fire hazard.

Do not use dry chemical powder extinguishers on hydrobromic acid.

If there is a hydrobromic acid spill at the same time as a fire, the safety procedure for spills should be immediately implemented:

1. Have all non-essential personnel leave the area immediately.
2. Provide self-contained breathing apparatus for the fire fighters.
3. Wear impervious and chemical resistant clothing.
   Note: This clothing may not be suitable for fire fighting.
4. Protect water sources from being contaminated by fire fighting water or spilled hydrobromic acid which has not been neutralized.

After the fire, all hydrobromic acid containers should be carefully inspected for leaks or any physical damage. The supplier should be immediately informed of any unusual conditions found.
**On the road**

If a vehicle carrying hydrobromic acid catches fire and no hydrobromic acid leak is detectable, the driver should move the vehicle to an open area, remove shipping and other emergency response documents (MSDS) from the vehicle and make reasonable efforts to extinguish any small fires. He should then:

- Notify the local police and the fire department.
- Warn other drivers and pedestrians of the danger.
- Notify the nearest hydrobromic acid handling facility.
- Stay at a safe distance until the incident has been declared resolved by the responder in charge on the scene.

If the driver cannot reasonably extinguish the fire and/or a hydrobromic acid leak is evident, "Spills or Leaks, On The Road" procedure (Section 5.6) should be followed immediately.
5.6 SPILLS OR LEAKS

Hydrobromic acid has been shipped for many years with very few accidents. This is due to the care taken in packaging and handling this material.

Only trained, suitably protected personal should respond to a hydrobromic acid emergency. See section 4.5 of this handbook for the personal protective equipment recommended for emergency response personnel.

If there should be an uncontrolled hydrobromic acid spill or leak, immediately call the fire department, giving them the maximum information. The competent authorities should be informed of the spill in accordance with local regulations.

Twenty-four hour telephone advice is available in most countries for hydrobromic acid road transport emergencies, as noted in section 5.2 above.

A spill or leak of 62% hydrobromic acid is very quickly apparent due to the harsh irritating odors which develop from the spilled material.

All non-essential personnel should be kept out of the spill area. The spill area should be entered only with a self-contained breathing apparatus. Impervious, fully encapsulated and chemically inert clothing should be worn. Note: This clothing may not be suitable for fire fighting.

There is generally no need for an evacuation alarm in case of a hydrobromic acid spill. However, nearby residents should be advised to stay indoors and to keep all windows closed.

Prevent the spilled liquid hydrobromic acid from penetrating a water source or sewer system unless it has been neutralized or diluted with copious amounts of water.

A hydrobromic acid spill should be contained and neutralized. Earth dams are sometimes convenient for containing the spill.

A hydrobromic acid resistant vacuum tanker or pump can be useful for collecting spilled material.
Neutralize hydrobromic acid in a manner similar to other strong acids. Soda ash (Na₂CO₃) or a slaked lime (Ca(OH)₂) water slurry are the preferred choices due to their ease and safety in handling.

The following table shows the approximate amounts (tons) of neutralizing materials required for one ton of spilled material.

<table>
<thead>
<tr>
<th>Spilled material</th>
<th>Slaked Lime slurry Ca(OH)₂</th>
<th>Soda Ash Na₂CO₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>48% HBr</td>
<td>0.25</td>
<td>0.32</td>
</tr>
<tr>
<td>52% HBr</td>
<td>0.27</td>
<td>0.35</td>
</tr>
<tr>
<td>62% HBr</td>
<td>0.30</td>
<td>0.42</td>
</tr>
</tbody>
</table>

In the area where the spillage has been contained, a 5% to 10% solution of caustic soda can also be used, but slow addition is necessary to avoid excessive heat build-up.

Neutralization of high concentrations of hydrobromic acid or hot solutions can be quite violent. In those cases, the spilled acid should be cautiously diluted and cooled before attempting neutralization.

The neutralized spilled liquid can be flushed into drains with copious amounts of water, or can be absorbed in inert absorbant materials such as sand, earth or vermiculite. The contaminated absorbant can then be carefully shovelled into an open-head drum for eventual authorized disposal.

With the approval of local authorities, the remains on the spill area and neutralized spilled liquid can be flushed into drains with copious amounts of water.

Used, empty receptacles can be rinsed with copious amounts of water and disposed of in the conventional manner.
**On The Road**

The driver of a vehicle leaking hydrobromic acid should try to get the vehicle to an unpopulated area, put on his escape gas mask, take with him all the shipping documents, and get to a safe spot upwind and higher than the vehicle.

From this safe spot, he should warn oncoming traffic and pedestrians and call for help. People not properly equipped should be kept out of the area.

In any hydrobromic acid road transport emergency, call the EMERGENCY CONTACT that should be clearly marked on the shipping papers and labels.

**5.7 EMERGENCY REPAIRS**

Empty, clean, dry, covered receptacles (overpacks) should be available for leaking hydrobromic acid drums and for collecting spilled hydrobromic acid or contaminated absorbant materials.
5.8 EXPOSURE TO HYDROBROMIC ACID

When a person who has been exposed to hydrobromic acid vapors is sent to a hospital, information should be pinned to the person's clothing stating that he was exposed to hydrobromic acid. If possible, the MSDS should be sent with the patient.

**Acute exposure**

Eye contact: Corrosive  
Symptoms include redness, pain and blurred vision. Direct contact may result in serious corneal burns. May cause temporary or even permanent eye damage.

Skin contact: Corrosive  
Symptoms include redness, pain and edema. Direct contact may result in serious skin burns.

Skin absorption: May be absorbed through the skin in sufficient quantities to cause systemic toxicity.

Inhalation: Corrosive to mucus membranes and upper respiratory tract. Symptoms include sore throat, coughing, shortness of breath and nasal irritation. May cause delayed pulmonary edema.

Ingestion: Sore throat, abdominal pain and diarrhea. May cause severe burns to the mucous membranes of the mouth, esophagus and stomach.

**Diagnostic method:**

There is no specific test that can be utilized for the diagnosis of hydrobromic acid poisoning, however, the blood inorganic bromide determination is frequently used as a means of confirming suspected acute intoxication.

Urinary and hair levels of inorganic bromide have also been used as indicators of exposure to hydrobromic acid. Measurement of blood inorganic bromide is not suitable for cases of chronic intoxication with hydrobromic acid.
**First Aid**

Eye contact: Holding the eyelids apart, flush eyes at once with copious flowing water for at least 20 minutes. Get medical attention immediately.

Skin contact: Flood skin with water, directing a stream of water under the clothing while they are being removed. Wash skin with mild soap and plenty of water for at least 15 minutes. Treat contaminated clothing with 10% sodium bicarbonate and wash them before re-use. Get medical attention immediately.

Inhalation: Remove person to fresh air. Keep him quiet and warm. Apply artificial respiration if necessary, and get medical attention immediately.

Ingestion: If swallowed, wash mouth thoroughly with plenty of water and give water to drink. Get medical attention immediately. **Note: Never give an unconscious person anything to drink.**

**Further Medical Treatment** CHECK WITH HBr NOTE TO THE PHYSICIAN!

IN THE HOSPITAL
Respiratory failure is treated by the administration of humidified oxygen and bronchodilators, and if necessary, artificial ventilation with Positive End-Expiratory Pressure (PEEP). Loss of consciousness and convulsions are treated with anticonvulsant drugs and artificial ventilations, as required.

TREATMENT OF SKIN AND EYE EXPOSURE
Immediate rinsing with large amounts of water and a 2% solution of sodium bicarbonate. It should be remembered that both skin damage and respiratory disorders may appear many hours after the exposure.

For additional information contact the nearest Poisons Information Centre.

**Recommended Antidote**
There is no specific antidote for hydrobromic acid.
6.1 OPERATOR HEALTH MONITORING......................................................73
6.2 OPERATOR/DRIVER SAFETY TRAINING...............................................75
6.1 OPERATOR HEALTH MONITORING

Workers regularly exposed to possible hydrobromic acid vapors should be given routine medical check-ups. This applies to personnel of operations where hydrobromic acid is used, stored, filled, or unloaded. (US Code of Federal Regulations, 29 CFR 1910.120 (f)).

There are no regulations or standards indicating a medical test which would show an overexposure to hydrobromic acid.

It is recommended that complete medical records be kept for each person working in a facility where there is potential exposure to hydrobromic acid vapors.
A sample medical record is provided on the following page.
**MEDICAL RECORD FOR EMPLOYEE EXPOSED**

Name: ___________________________ Date of birth: ________________________
Address: __________________________
Occupation: ________________________ Date start employment: ____________

Previous history of following disorders:  Yes / No
(Provide details if necessary)

- Skin diseases _______________________
- Lung diseases _______________________
- Liver diseases _______________________
- Kidney diseases _______________________
- Psychiatric _________________________
- Neurologic _________________________

**MEDICAL EXAMINATIONS**

<table>
<thead>
<tr>
<th>Date</th>
<th>Test</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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**SICK LEAVE**

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Reasons</th>
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</thead>
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</tbody>
</table>
6.2 OPERATOR / DRIVER SAFETY TRAINING

The installation management should be aware of the potential dangers of hydrobromic acid. Management personnel should undergo training in hydrobromic acid specific safety inspections and safety auditing.

Workers involved with hydrobromic acid must have special safety training regarding the precautions to observe in accordance with local regulations. This applies to personnel of operations where hydrobromic acid is used, stored, filled or unloaded.

The safety training for handling hydrobromic acid has to include both theoretical classroom courses and practical hands-on and observation exercises, appropriate to the level of likely exposure of the individual worker to hydrobromic acid. Records should be kept of each person's participation in initial training and refresher courses.

The theoretical classroom training should be at least three days. Some of the subjects to be covered should be:
- The main types of hazards
- Packaging details
- Labelling and marking to indicate hazards
- Precautions during loading and unloading
- Environmental protection
- First-aid
- Fire-fighting
- Selection and use of personal protection equipment
- Respiratory protection
- Emergency procedures

Refresher training courses should be taken regularly, at least every two or three years, and should include new technical and substance-related developments. The refresher course should be for at least one full day.
APPENDIX

A. TYPICAL QUALITY SPECIFICATIONS ..............................................79
B. REFERENCES ..............................................................................82
## APPENDIX A:

### Hydrobromic acid  48%

**Typical Quality Specifications**

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear, colorless to yellow liquid</td>
</tr>
<tr>
<td>Density 20/20°C</td>
<td>1.48 min.</td>
</tr>
<tr>
<td>HBr Content %</td>
<td>48 min.</td>
</tr>
<tr>
<td>Chlorides Cl- %</td>
<td>0.04 max.</td>
</tr>
<tr>
<td>Iron ppm</td>
<td>2 max.</td>
</tr>
<tr>
<td>Heavy Metal ppm</td>
<td>3 max.</td>
</tr>
<tr>
<td>Arsenic As ppm</td>
<td>0.5 max.</td>
</tr>
<tr>
<td>Non-Volatiles %</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Free Bromine %</td>
<td>0.005 max.</td>
</tr>
<tr>
<td>Sulfates ppm</td>
<td>10 max.</td>
</tr>
</tbody>
</table>
### Hydrobromic acid 52% – 53%

**Typical Quality Specifications**

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear, colorless to yellow liquid</td>
</tr>
<tr>
<td>Density 20/20°C</td>
<td>1.53 min.</td>
</tr>
<tr>
<td>HBr Content %</td>
<td>52 - 53</td>
</tr>
<tr>
<td>Chlorides Cl- %</td>
<td>0.012 max.</td>
</tr>
<tr>
<td>Iron ppm</td>
<td>2 max.</td>
</tr>
<tr>
<td>Heavy Metal ppm</td>
<td>3 max.</td>
</tr>
<tr>
<td>Arsenic As ppm</td>
<td>0.5 max.</td>
</tr>
<tr>
<td>Non-Volatiles %</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Free Bromine (ppm)</td>
<td>10 max.</td>
</tr>
<tr>
<td>Sulfates ppm</td>
<td>10 max.</td>
</tr>
</tbody>
</table>
### Hydrobromic acid 62%

#### Typical Quality Specifications

<table>
<thead>
<tr>
<th>Property</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear, light yellow fuming liquid</td>
</tr>
<tr>
<td>Density 20/20°C</td>
<td>1.705 min.</td>
</tr>
<tr>
<td>HBr Content %</td>
<td>62 min.</td>
</tr>
<tr>
<td>Chlorides Cl- %</td>
<td>0.03 max.</td>
</tr>
<tr>
<td>Iron ppm</td>
<td>5 max.</td>
</tr>
<tr>
<td>Heavy Metal ppm</td>
<td>5 max.</td>
</tr>
<tr>
<td>Arsenic As ppm</td>
<td>0.5 max.</td>
</tr>
<tr>
<td>Non-Volatiles %</td>
<td>0.01 max.</td>
</tr>
<tr>
<td>Free Bromine %</td>
<td>0.05 max.</td>
</tr>
<tr>
<td>Sulfates ppm</td>
<td>10 max.</td>
</tr>
</tbody>
</table>
APPENDIX B:

REFERENCES

1. Dead Sea Bromine Group
   Hydrobromic acid PRODUCT DATA SHEET
   (www.dsbg.com)

2. Dead Sea Bromine Group
   MATERIAL SAFETY DATA SHEET for hydrobromic acid
   (www.dsbg.com)

3. UNITED NATIONS TRANSPORT OF DANGEROUS GOODS (ORANGE BOOK)

4. INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG) CODE, 2000
   (www.imo.org)

5. EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE
   OF DANGEROUS GOODS BY ROAD (ADR), 1 July 2001 (Restructured)
   (www.unece.org/trans/danger/danger.htm)
   (Also, corresponding document for carriage of dangerous goods by rail - RID)

6. US CODE OF FEDERAL REGULATIONS (Issued annually)
   TITLE 29 - Occupational Safety and Health Administration (OSHA), 2001
   TITLE 40 - Environmental Protection Agency (EPA), 2001
   TITLE 49 - Department of Transportation (DOT), 2001
   (www.access.gpo.gov/nara/cfr/index.html)

7. International Air Transportation Association
   (www.iata.org)

8. AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENISTS (ACGIH)
   THRESHOLD LIMIT VALUES, 2001
   (www.acgih.org)
9. Health and Safety Executive, Merseyside, England
   OCCUPATIONAL EXPOSURE LIMITS, 1999
   Guidance Note EH 40/99

10. US CHEMICAL HAZARDS RESPONSE INFORMATION SYSTEM (CHRIS)
    HAZARDOUS CHEMICAL DATA, U.S. COAST GUARD,
    DEPARTMENT OF TRANSPORTATION (DOT), November 1992

11. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
    Hazardous Chemical Data, NFPA 49
    (www.nfpa.org)

12. US DEPARTMENT OF TRANSPORTATION
    EMERGENCY RESPONSE GUIDE BOOK, 2000 Edition
    (hazmat.dot.gov/gydebook.htm)

13. National Institute for Occupational Safety and Health (NIOSH)
    POCKET GUIDE TO CHEMICAL HAZARDS, Publication 97 - 140, June 1997
    (www.cdc.gov)

14. Z. E. Jolles, 1966
    BROMINE AND ITS COMPOUNDS

Note: The internet websites are given for reference only, as their contents are continually changing.
NORTH AMERICA

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The Dead Sea Bromine Group (DSBG) draws on the vast resources of the Dead Sea (Israel) to promote quality of life on five continents. Supplying over 33% of global demand for bromine and bromine compounds, DSBG works together with 5,000 customers, striving for continuing excellence. Over 95% of DSBG’s sales are to the international market.

DSBG increases food yields through a broad range of agricultural products, enhances healthcare with pharmaceutical intermediates, enforces safety standards in the home and workplace with state-of-the-art flame retardants and improves the quality of water via leading water treatment products.