CABINEX-EWT

High Pressure Carbon Dioxide Fire Extinguishing System Installation, Operation & Maintenance Manual

Please read and fully understand this installation manual, before installing and setting up this system. Keep this manual carefully.

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Introduction

Cabinex-EWT engineered high pressure carbon dioxide extinguishing system is FM Approved for the special application of open face tools, enclosed process equipment and other similar process equipment for usage in semiconductor fabrication facilities, where the maximum air exhaust rate of flow shall not exceed 1000 ft³/min (1700m³/hr).

The storage temperature of the system is 0 to 40 degrees C.
Operating temperature for Total Flooding systems is 0 to 40 degrees C and for local application systems 15 to 27 degrees C.

Installation shall be carried in accordance with this manual and the requirements of NFPA 12.

System design shall be carried out in accordance with the Cabinex-EWT design manual, COD-002.

Caution: Carbon dioxide snow may be produced by the LA nozzle when small orifice codes are used.

General Information on Carbon Dioxide

Carbon dioxide is a colorless, odorless, electrically nonconductive inert gas that is suitable for extinguishing fires in clean room equipment. Carbon dioxide is 1.5 times heavier than air, and reduces the concentration of oxygen and the vapor phase of the fuel to the point where combustion stops.

Personnel Safety

The discharge of carbon dioxide in fire extinguishing concentrations creates serious hazard to personnel, such as suffocation and reduced visibility during and after the discharge period. Consideration shall be given to the possibility of carbon dioxide drifting and settling into adjacent places outside the protected area.

In any use of carbon dioxide, consideration shall be given to the possibility that personnel could be trapped in or enter into an atmosphere made hazardous by a carbon dioxide discharge. Suitable safeguards shall be provided to ensure prompt evacuation, to prevent entry into such atmospheres, and to provide means of prompt rescue of any trapped personnel. Predischarge alarms shall be
Warning signs shall be affixed in a conspicuous location.

Audible and visual predischarge signals shall be provided.

All personnel shall be informed that the discharge of carbon dioxide directly at a person will endanger the person's safety by causing eye injury, ear injury, or even falls due to loss of balance. Contact with carbon dioxide in the form of dry ice can cause frostbite.

To prevent accidental or deliberate discharge, a lock-out valve shall be provided when persons not familiar with the system and their operation are present in the protected space. Local application systems shall be locked-out when persons are present in locations where discharge of the system will endanger them, and they will be unable to proceed to a safe location within the time delay period of the system. When protection is to be maintained during the lock-out period, a person(s) shall be assigned as a fire watch.

The following warning sign shall be located at the protected hazard.

![WARNING]

CARBON DIOXIDE GAS can cause injury or death. When alarm operates, vacate immediately.
Description of Parts

**CO2 cylinder and valve assembly**: CO2-25WT, CO2-50WT, CO2-75WT and CO2-100WT

There are 4 sizes of DOT CO2 cylinders available: 25lb, 50lb, 75lb and 100lb. All of the cylinders use the same valve assembly HFV-68H-WT.

These cylinders contain high pressure CO2 stored at 850 psi at room temperature. The cylinder must be shipped and handled with the cylinder cap fitted.

**Cylinder Boxes for securing the cylinders**: BXEWM/S-100W, BXEWM/S-100, BXEWM/S-75, BXEWM/S-50, BXEWM/S-25, BXEWM/S-50W.

Cylinder boxes are used to secure the CO2 cylinders. The cylinder boxes include the mounting brackets and all the parts required to secure the cylinders. The cylinder boxes are anchored using the anchor brackets model BSEW provided with the box.

<table>
<thead>
<tr>
<th>Cylinder Box Model:</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>BXEWM/S-100W</td>
<td>Two 100 lb cylinders</td>
</tr>
<tr>
<td>BXEWM/S-100</td>
<td>One 100 lb cylinder</td>
</tr>
<tr>
<td>BXEWM/S-75</td>
<td>One 75 lb cylinder</td>
</tr>
<tr>
<td>BXEWM/S-50</td>
<td>One 50 lb cylinder</td>
</tr>
<tr>
<td>BXEWM/S-25</td>
<td>One 25 lb cylinder</td>
</tr>
<tr>
<td>BXEWM/S-50W</td>
<td>Two 50 lb cylinders</td>
</tr>
</tbody>
</table>
Actuator Types:

There are 2 types of actuator that fit to the cylinder valves, the Main type (GHK-10WT) and the Sub type (GHK-10WT-S).

**Actuator (Main Type) : GHK-10WT**

The Main type actuator contains a gas cartridge to allow activation by an electrical signal from an FM Approved and compatible control panel. It also has a lever for manual actuation and is activated as a sub type by back pressure from the manifold via the copper tube for back pressure PPEWC-FH or alternatively by the stainless steel flexible tube for back pressure PPEWC-FT.

This actuator can be used only once, and must be replaced by a new one after use.

**Electrical Specification of Actuator**

- Circuit resistance: 2.18 +/- 0.4 Ohm
- Fire Current: 0.8 A for 2ms
- Supervisory current: 1mA max

The actuator can be monitored and fired by the FM Approved Discharge Module, EUEWM-131. The discharge module, EUEWM-131, in combination with the FM Approved Control Panel, EUEWM-128, supervises the wiring to the actuator and produces the Fire Current at 24V DC.

**Actuator (Sub Type) : GHK-10WT-S**

The Sub type actuator does not have an electrical or manual means of activation. It is activated by back pressure from the manifold via the copper tube for back pressure.
PPEWC-FH or alternatively by the stainless steel flexible tube for back pressure PPEWC-FT.

**Flexible Hose** : FHEWC-20

The flexible hose connects the cylinder valve to the manifold. It also has the connection for the copper tube for back pressure.

**Copper Tube for Back Pressure** : PPEWC-FH

The copper tube is used for both Main type and Sub type actuators. The copper tube provides back pressure from the manifold to operate the actuator.

**Flexible Tube for Back Pressure** : PPEWC-FT

The flexible tube for back pressure, PPEWC-FT is a stainless Steel flexible hose that can be used as an alternative to the copper tube for back pressure, PPEWC-FH. It provides back pressure from the manifold to operate the actuator.

**Installation Tool for actuator** : ACEWN-AC

This is a simple tool which is used to fit the actuator (Main or Sub type) to the cylinder valve.
LA Nozzle: NZEWN-1/2L

This nozzle can be used for Local Application, or Total Flooding. The Local Application nozzle is designed to give a soft discharge to prevent splashing of liquid surface fires. The LA nozzle comes in orifice codes 1.5 through 8.0 in 0.5 increments. For liquid surface local application the operating temperature range is 60 to 80 F (16 to 27 C)

TF Nozzle: NZEWN-1/2T

This nozzle is for Total Flooding use only. The Total Flooding nozzle gives a high velocity discharge and is suitable for protecting enclosed hazards such as spaces involving flammable liquids or electrical equipment. The TF nozzle should not be directed at a liquid surface fire as splashing may occur. The TF nozzle come in orifice codes 1 through 10 in increments of 0.5 and 10 through 16 in increments if 1. The operating temperature range for total flooding is 32 to 104 F (0 to 40 C)

Lock-Out Valves:
BKH-1/2"NPT -4429/LS1-LH for 1/2 inch piping
BKH-3/4"NPT -4429/LS1-LH for 3/4 inch piping
BKH-1"NPT -4429/LS1-LH for 1 inch piping
MKHP-1.1/2"NPT-4429/LS1-LH for 1 1/2 inch piping

The models listed above are stainless steel. Ni plated steel models are also available.
BKH-1/2"NPT-1429Ni/LS1-LH
BKH-3/4"NPT-1429Ni/LS1-LH
BKH-1"NPT-1429Ni/LS1-LH
MKHP-1.1/2"NPT-1429Ni/LS1-LH
The lock out valve is a safety device that is locked closed during maintenance of the system, to prevent unwanted discharge. It is normally locked open. The lock out valve is a manually operated valve that is fitted in the discharge piping between the nozzles and the supply. It can be locked in the closed position to prevent flow of carbon dioxide to the protected area during maintenance work. It can also be locked in the open position for normal protection of the protected area and to prevent tampering.

To prevent accidental or deliberate discharge, a lock-out valve shall be provided when persons not familiar with the system and their operation are present in the protected space. Local application systems shall be locked-out when persons are present in locations where discharge of the system will endanger them, and they will be unable to proceed to a safe location within the time delay period of the system. When protection is to be maintained during the lock-out period, a person(s) shall be assigned as a fire watch.

The lock out valve contains a switch contact that can be used to provide a discharge disabled signal to the control system when the valve is closed. The valve comes with an end of line resistor (100 kilo Ohm 1/4W) for supervision of the circuit. The contact rating of the switch with resistor is 30V DC max, 0.5A max.

**Pressure Switch: CPSEWN-15**

The pressure switch is to be installed in the discharge piping when a lock-out valve is used. The pressure switch is to be located between the cylinders and the lock-out valve. Activation of the pressure switch shall cause an alarm at the releasing panel.
One lock-out valve shall prevent accidental discharge from the nozzles when locked in the closed position.

**Burst Disc Assembly: CSVEWN-15**

The burst disk assembly is used when check valves and a lock-out valve are both installed. The burst disc is to be installed between the check valves and the lock-out valve. If gas is trapped between the check valves and a closed lock-out valve an over pressure condition could result. The burst disc assembly will activate to release an over pressure condition.
Diagram Showing Location of Lock-Out Valve in a Main / Reserve System

Check Valves: 1 inch: SS-CHF16-1, 3/4 inch: SS-CHF12-1, 1/2 inch: SS-CHF8-1

The check valves are used in main / reserve systems to prevent the reserve cylinders from discharging due to manifold pressure from the discharge of the main cylinders. The direction of the check valves is critical and should always be confirmed. The direction of flow is marked with an arrow on the body of the check valve.
Fire Detection

Automatic activation of the carbon dioxide system can be achieved by using one of a number of FM Approved detection devices such as the FM Approved SX-7000 IR flame detector, in combination with a FM Approved and compatible Fire Control System. The flame detector must be FM Approved for its suitability for use in wet bench applications.

Fire Control System

Hatsuta’s FM Approved fire control system, CPX-EWT, is designed to provide automatic release of the carbon dioxide system. FM Approved flame detectors provide a fire alarm to the main panel EUEWM-128, via the SI Module EUEWM-130. The main panel provides a signal to the discharge module EUEWM-131 which provides the energy to fire the actuator and discharge the carbon dioxide system. The system also monitors the wiring integrity of the main actuator.

Installation of the discharge piping

Use piping or tubing materials and sizes as shown on the job drawing. Pipe shall be reamed and cleaned before assembly, and after the entire assembly the entire piping system shall be blown out before nozzles are installed. Stainless Steel piping TP304 or TP 316 should be used for threaded connections or TP304, TP316, TP304L, TP316L for welded connections. Black or galvanized steel pipe shall be either ASTM A53 seamless or electric welded, grade A or B; or ASTM A 106 Grade A,B, or C. 3/4 inch and smaller pipe shall be permitted to be Schedule 40. Pipe that is 1 inch through 4 inches shall be a minimum of Schedule 80.

When Stainless Steel tubing is used the thickness of the tube shall be calculated in accordance with ANSI B31.1. The internal pressure for the calculation shall be 2800 psi (19,306 kpa).

<table>
<thead>
<tr>
<th>Stainless Steel Tubing 304 or 316</th>
<th>Tube O.D (inch)</th>
<th>Tube Wall Thickness (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>0.049 or greater</td>
<td></td>
</tr>
<tr>
<td>3/4</td>
<td>0.065 or greater</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.083 or greater</td>
<td></td>
</tr>
</tbody>
</table>
Compression type fittings shall be used with compatible tubing with a minimum pressure rating of 2800 psi.

Class 300 malleable or ductile iron fittings shall be used through 2 inches internal pipe size (IPS) and forged steel fittings for all larger sizes. Flanged joints upstream of stop valves shall be Class 600. Flanged joints downstream of stop valves or in a system with no stop valves shall be permitted to be Class 300. Stainless steel fittings shall be type 304 or 316, wrought / forged (per ASTM A 182) Class 3000, threaded or socket weld, for all sizes, 1/8 inch through 4 inches.

Piping shall be anchored to rigid structures (walls, ceilings, columns) and braced to prevent movement from nozzle back thrust.

Pipe supports shall be made of steel or stainless steel and of rigid construction. U-bolts with double nuts shall be used to secure pipe to hangers.

Maximum spacing for piping supports shall be: 5 feet (1.5m) for 1/2 inch, 6 feet (1.8m) for 3/4 inch, and 7 feet (2.1m) for 1 inch piping.

A dirt trap consisting of a tee with a capped nipple, at least 2 in (51mm) long, shall be installed at the end of each pipe run.

Installation of devices

Installation of nozzles

There are two types of nozzles, the LA Nozzle NZEWN-1/2L, and the TF Nozzle NZEWN-1/2T.

The type of nozzle, orifice code and location shall be as shown on the job drawing.

The TF Nozzle is suitable for total flooding only and the LA Nozzle is suitable for local application or total flooding. The orifice size is determined by the pressure flow calculation.

![Warning]

During installation of the nozzle, always use the specified type of nozzle and orifice size in the location designated in the design document. Otherwise, the extinguishing agent may not be able to effectively extinguish a fire.

Installation position

When the LA Nozzle is used for local application it should be positioned directly above the hazard or aimed towards the hazard. The height of the nozzle to the liquid surface shall comply with the job drawing. Aiming factors are shown below. With open type wet benches the LA nozzle should be placed directly above the working surface hazard, or at the front of the bench and aimed
at the working surface hazard. The orifice code shall comply with the job drawing.

Caution: Carbon dioxide snow may be produced by the LA nozzle when small orifice codes are used.

<table>
<thead>
<tr>
<th>Discharge Angle</th>
<th>Aiming Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 - 60</td>
<td>1/4</td>
</tr>
<tr>
<td>60 - 75</td>
<td>1/4 - 3/8</td>
</tr>
<tr>
<td>75 - 90</td>
<td>3/8 - 1/2</td>
</tr>
<tr>
<td>90 (perpendicular)</td>
<td>1/2 (center)</td>
</tr>
</tbody>
</table>

Discharge Angle: Degrees from plane of hazard surface
Aiming Factor: Fractional amount of the nozzle coverage area

Use seal tape on the threads and connect to 1/2 inch NPT fitting.

The TF nozzle produces a high pressure jet of CO2, it should be positioned away from any liquid or openings to prevent splashes and loss of CO2 from the hazard.

Maximum spacing for the TF Nozzle is 8ft (2.4m). The nozzle is to be installed on the side wall and to discharge horizontally. Nozzle orifice shall comply with the job drawing.

Install the TF nozzle with the orifice side facing the hazard area

Use seal tape on the threads and connect to 1/2 inch NPT fitting.
Installation of Lock-Out valve

The lock-out valve is a safety device to prevent unwanted discharge of carbon dioxide during maintenance. It should be installed in a location that is easily accessible, and such that the handle movement will not be obstructed. The lock-out valve may be installed vertically or horizontally and is not flow directional.

One lock-out valve shall disable discharge for the full system.

The size of the lock out should match the job drawing and the size of piping.

<table>
<thead>
<tr>
<th>Lock-out valve Model No</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>BKH-1/2&quot;NPT -4429/LS1-LH</td>
<td>for 1/2 inch piping</td>
</tr>
<tr>
<td>BKH-3/4&quot;NPT -4429/LS1-LH</td>
<td>for 3/4 inch piping</td>
</tr>
<tr>
<td>BKH-1&quot;NPT -4429/LS1-LH</td>
<td>for 1 inch piping</td>
</tr>
<tr>
<td>MKHP-1 1/2&quot;NPT-4429/LS1-LH</td>
<td>for 1 1/2 inch piping</td>
</tr>
</tbody>
</table>

The models listed above are stainless steel. Ni plated steel models are also available:

BKH-1/2"NPT-1429Ni/LS1-LH for 1/2 inch piping
BKH-3/4"NPT-1429Ni/LS1-LH for 3/4 inch piping
BKH-1"NPT-1429Ni/LS1-LH for 1 inch piping
MKHP-1 1/2"NPT-1429Ni/LS1-LH for 1 1/2 inch piping

Installation of the Pressure Switch

The pressure switch is to be installed in the discharge piping when a lock-out valve is used. The pressure switch is to be installed between the cylinders and the lock-out valve. Activation of the pressure switch shall cause an alarm at the releasing panel.
Installation of the Check Valves

The check valves are used in main / reserve systems to prevent the reserve cylinders from discharging due to manifold pressure from the discharge of the main cylinders. The direction of the check valves is critical and should always be confirmed. The direction of flow is marked with an arrow on the body of the check valve.

Diagram Showing Direction of Check Valves in a Main / Reserve System

![Diagram of check valves in a main / reserve system]

The size of the check valve should match the job drawing and the size of piping.

<table>
<thead>
<tr>
<th>Check Valve Model</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-CHF8-1</td>
<td>1/2 inch</td>
</tr>
<tr>
<td>SS-CHF12-1</td>
<td>3/4 inch</td>
</tr>
<tr>
<td>SS-CHF16-1</td>
<td>1 inch</td>
</tr>
</tbody>
</table>

Installation of the Burst Disc Assembly

The burst disk assembly is installed when check valves and a lock out valve are both installed. The burst disc is to be installed between the check valves and the lock-out valve. If gas is trapped between the check valves and a closed lock-out valve an over pressure condition could result. The burst disc assembly will activate to release an over pressure condition.
Installation of the parts around the cylinder.

The cylinder cap must be fitted to the cylinder during shipping and when handling a cylinder that is not secured. Damage to the cylinder can cause discharge of carbon dioxide and violent movement of the cylinder causing personnel injury.

1. Anchor the cylinder box using the 3 anchor brackets BSEW provided. Use M-10 bolts to secure the anchor bracket to the cylinder box, and to anchor the bracket. Alternatively the base of the box can be anchored directly. First remove the box from the base by removing the bolts on the floor of the box. Remove the casters from the base. Anchor the base using M-10 bolts, 4 for single cylinder box, 6 for double cylinder box. Replace the box on the base and secure the box to the base with the bolts.

2. With the cylinder cap fitted, position the cylinder in the cylinder box, and fit the cylinder bracket. Rotate the cylinder so that the labels face the front, and secure the cylinder bracket.

3. Remove the cylinder cap only after the cylinder is secured.
4. Check the O-rings are in place in the Flexible Hose and connect the flexible hose to the cylinder valve. Connect the other end of the Flexible hose to the manifold. The required torque is 50 Nm (37 pound-force feet). The exit hole for the flexible hose is provided at the ceiling of the box.

5. Connect the actuator to the valve using the special tool, ACEWN-AC. Screw until it stops. There is no torque requirement, do not tighten with a pipe wrench or similar. The valve uses a puncture disk mechanism, so the actuator is not under pressure. No leaking should occur during installation.

6. The copper tube for back pressure, PPEWC-FH, allows the actuator to be activated by back...
pressure from the manifold. Connect the copper tube from the actuator to the Flexible tube. Required torque is 20Nm (14.8 pound-force feet)

One copper tube must be connected to each actuator (main and sub type) to ensure complete discharge of all the cylinders in the system. Failure to connect the copper tube will also result in leaking at the flexible hose during discharge.

Main type actuator assembly

Sub type actuator assembly

The stainless steel flexible tube for back pressure, PPEWC-FT, can be used in place of the copper tube.
Main Actuator Electrical Installation

Use the wiring harness provided with the main actuator to connect to the main actuator to the discharge module, EUEWM-131, of the control system. The discharge module shall be mounted inside the cylinder box. The wiring from the discharge module to the control panel shall be minimum AWG 22 shielded wire.

The main actuator, GHK-10WT, includes an emergency manual activation lever that can fully discharge the system.

The following sign shall be located near the main actuator to identify the operation of the manual activation lever.

![Diagram of activation lever]

The table below shows the number and type of actuators required

<table>
<thead>
<tr>
<th>Number of Cylinders connected to the manifold</th>
<th>Number of Main Type Actuators required GHK-10WT</th>
<th>Number of Sub type actuators required GHK-10WT-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>n&gt;5</td>
<td>2</td>
<td>n-2</td>
</tr>
<tr>
<td>Max: 10</td>
<td>2</td>
<td>8</td>
</tr>
</tbody>
</table>
Diagram showing actuator configuration with the maximum number of cylinders (10)
Checks Required after Installation

A thorough visual inspection of the installed system and hazard area is to be carried out. The piping, operational equipment, and nozzles are to be inspected for proper size and location. The locations of alarms and manual releases shall be confirmed. The configuration of the hazard shall be compared to the original hazard specification. The hazard shall be inspected for unclosable openings that could have been overlooked in the original specification.

A check of the labeling of devices for proper designations and instructions is to be carried out. Nameplate data on the storage containers shall be compared to specifications.

Nondestructive operational tests on all devices necessary for proper functioning of the system, including detection and actuation devices is to be carried out.

Piping and Nozzles

Check the nozzle orifices are clear and unobstructed
Check pipe hangers are secure.
Check the nozzle code and type is correct with the type, location, and code on the job drawing.
Check manifold connections are secure.

Leak test of the piping

Close all open ends of the piping. Pressurise to 100 psi using Nitrogen or compressed air, and leave for 10 minutes. When high pressure gas is used, use a regulator to reduce the pressure. After 10 minutes the pressure drop should be less than 5 psi. Recommended full range 0 to 160 psi (0 to 10 bar), increments 2 psi (0.2 bar).

Puff test

The puff test is to confirm that gas at relatively low pressure will pass unobstructed through the piping and nozzles.
Apply Nitrogen or compressed air at approximately 100 psi to the piping. When high pressure gas is used, use a regulator to reduce the pressure. Check that gas discharges normally at each nozzle.
Discharge Test

Local Application: A full discharge of the design quantity carbon dioxide through the system piping to ensure carbon dioxide effectively covers the hazard for the full period of time required by the design specifications, and all pressure operated devices function as intended.

Total Flooding: A full discharge of the entire design quantity of carbon dioxide through the system piping to ensure that carbon dioxide is discharged into the hazard and the concentration is achieved and maintained in the period of time required by the design specifications, and all pressure-operated devices function as intended.

With all system components connected, discharge CO2 by using the manual actuator or by activating a detector of the control system. Check that discharge sequence is correct and CO2 appears at each nozzle. When CO2 concentration of total flooding systems is to be confirmed, use an O2 meter to measure the concentration. The CO2 concentration can be calculated with the following formula:

\[ \%CO_2 = \left( \frac{21-%O_2}{21} \right) \times 100 \]

After the discharge test the main actuators must be replaced as they are one shot devices. (Even when the main actuator is manually actuated the it must be replaced)
Replace or re-charge the carbon dioxide cylinders after the discharge test.

Control Equipment

Confirm the equipment is FM Approved and is as specified on the job drawing. Check the continuity of wiring of all detectors, manual releases, notification appliances and form the control panel’s discharge unit to the actuator.

The main actuator is a one shot device, and must be replaced after firing. When testing the control equipment, disconnect the wiring to the main actuator, and confirm the actuator voltage (24V DC) is produced by the discharge module, EUEWM-131, using a DC voltmeter.
Activate all detectors and manual release devices and confirm correct operation.

**Maintenance**

To prevent unwanted discharge of CO2 during maintenance of the system, the lock-out valve shall be locked in the closed position. This will cause a discharge disabled signal to be produced at the control panel and the fault sounder to sound. When protection is to be maintained during the lock-out period, a person(s) shall be assigned as a fire watch.

On completion of maintenance the lock-out valve must be returned and locked in the open position.

The complete fire extinguishing system must be inspected and tested periodically (every 6 months) by competent personnel. The cylinders must be weighed semi-annually in accordance with NFPA 12. If a container at any time, shows a loss in net content of more than 10 percent, it must be refilled or replaced. The gross weight full is marked on the cylinder label.

<table>
<thead>
<tr>
<th>Model</th>
<th>Refill if less than</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2-25WT</td>
<td>Weight full – 2.5lb</td>
</tr>
<tr>
<td>CO2-50WT</td>
<td>Weight full – 5lb</td>
</tr>
<tr>
<td>CO2-75WT</td>
<td>Weight full – 7.5lb</td>
</tr>
<tr>
<td>CO2-100WT</td>
<td>Weight full – 10lb</td>
</tr>
</tbody>
</table>

The inspections shall identify any problems due to wear and tear, damage, tampering, and changes to the protected hazard that would adversely affect the performance of the fire suppression system.

The hazard should be checked against the original layout drawing during the inspection to ensure there have been no alterations or additions.

Initiating, Notification and Control equipment are to be tested in accordance with NFPA 72 chapter 10.
Procedure for System reconditioning after discharge.

After a discharge the system must be completely serviced by fully trained and qualified personnel.

Reset the control panel.
If there is a reserve supply, transfer the main-reserve switch mechanism to the reserve supply.
Remove the spent cylinders and main actuators.
Replace the main actuators. Model: GHK-10WT
Replace or re-fill the cylinders.

<table>
<thead>
<tr>
<th>Cylinder assembly model</th>
<th>Weight of carbon dioxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2-25WT</td>
<td>25 lb</td>
</tr>
<tr>
<td>CO2-50WT</td>
<td>50 lb</td>
</tr>
<tr>
<td>CO2-75WT</td>
<td>75 lb</td>
</tr>
<tr>
<td>CO2-100WT</td>
<td>100 lb</td>
</tr>
</tbody>
</table>

Inspect all components in the system: nozzles, detectors, notification appliances, manual releases, piping and piping supports for damage. Replace all parts that have been damaged or exposed to flames or extreme heat from the fire.

Reinstall the cylinders and parts around the cylinder in accordance with the appropriate section of this manual.
Refill instructions for CO2 cylinders:
CO2-25WT CO2-50WT CO2-75WT and CO2-100WT

The cylinder valve uses a rupture disk mechanism, the following parts must be replaced before the cylinder can be re-filled:
- Piston (Part No. CXT-0132)
- Spring (Part No. CXT-01306)
- Packing (Part No. CXT-01305)
- Puncture disk (Part No. CXT-01304)

Failure to renew these 4 items will result in leakage from the cylinder valve.

After replacing the above items, reassemble the valve and tighten the nut to 180 Newton meters.

The cylinder can be filled through the discharge/ refill port. Screw size is W26 x 14

<table>
<thead>
<tr>
<th>Model</th>
<th>Nominal CO2 fill</th>
<th>Minimum CO2 fill</th>
<th>Max CO2 fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2-25WT</td>
<td>25 lb</td>
<td>24.56 lb</td>
<td>25.77 lb</td>
</tr>
<tr>
<td>CO2-50WT</td>
<td>50 lb</td>
<td>49.4 lb</td>
<td>51.1 lb</td>
</tr>
<tr>
<td>CO2-75WT</td>
<td>75 lb</td>
<td>74.4 lb</td>
<td>76.1 lb</td>
</tr>
<tr>
<td>CO2-100WT</td>
<td>100 lb</td>
<td>99.2 lb</td>
<td>101.7 lb</td>
</tr>
</tbody>
</table>
Carbon Dioxide Safety Manual

General

Carbon dioxide is a colorless, odorless, electrically nonconductive inert gas that is suitable for extinguishing fires in clean room equipment. Carbon dioxide is 1.5 times heavier than air, and reduces the concentration of oxygen and the vapor phase of the fuel to the point where combustion stops.

Personnel Safety

The discharge of carbon dioxide in fire extinguishing concentrations creates serious hazard to personnel, such as suffocation and reduced visibility during and after the discharge period. Consideration shall be given to the possibility of carbon dioxide drifting and settling into adjacent places outside the protected area.

In any use of carbon dioxide, consideration shall be given to the possibility that personnel could be trapped in or enter into an atmosphere made hazardous by a carbon dioxide discharge. Suitable safeguards shall be provided to ensure prompt evacuation, to prevent entry into such atmospheres, and to provide means of prompt rescue of any trapped personnel. Predischarge alarms shall be provided.

Warning signs shall be affixed in a conspicuous location.

Audible and visual predischarge signals shall be provided.

All personnel shall be informed that the discharge of carbon dioxide directly at a person will endanger the person's safety by causing eye injury, ear injury, or even falls due to loss of balance. Contact with carbon dioxide in the form of dry ice can cause frostbite.

To prevent accidental or deliberate discharge, a lock-out valve shall be provided when persons not familiar with the system and their operation are present in the protected space. Local application systems shall be locked-out when persons are present in locations where discharge of the system will endanger them, and they will be unable to proceed to a safe location within the time delay period of the system. When protection is to be maintained during the lock-out period, a person(s) shall be assigned as a fire watch.
Warning Signs
The following warning sign shall be located at the protected hazard.

![WARNING]

CARBON DIOXIDE GAS can cause injury or death.
When alarm operates, vacate immediately.

The following sign shall be located at each manual release station.

![WARNING]

CARBON DIOXIDE GAS can cause injury or death. 
Actuation of this device causes carbon dioxide to discharge. Before actuating, be sure personnel are clear of the area.

The following sign shall be located at the entrance to Carbon Dioxide Storage Rooms.

![WARNING]

CARBON DIOXIDE GAS can cause injury or death. 
Ventilate the area before entering. A high carbon dioxide gas concentration can occur in this area and can cause suffocation.
MATERIAL SAFETY DATA SHEET

MSDS STK No.001 (11 pages in total)

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: Liquid Carbon Dioxide
Company: MATSUYAMA OXYGEN, Co Ltd.
Address: 2877, Nishihabu-cho, Matsuyama-city, Ehime, Japan
Department in Quality Control Division
TEL: 81-89-972-0170
FAX: 81-89-974-1850
Emergency contact: (Name)
(Address)
(TEL and FAX)
Made on February 21, 2005
Revised on April 20, 2011

2. SUMMARY OF HAZARD/HARMS INFORMATION

Most important hazards/harms information
Harmful effects on human health:
* Inhalation of high concentrations of carbon dioxide may cause unconsciousness, and coma and death.
* Liquefied carbon dioxide released into the atmosphere forms a low temperature gas and snowy dry ice. Skin exposure to this may cause frostbite and eye exposure to this may cause loss of eyesight.

Environmental effect:
* Liquefied carbon dioxide has no environmental effect in the normal state, although it is known as global warming gas.

Physicochemical hazardousness:
* Liquefied carbon dioxide causes hazards as "high pressure gas" and "extremely low temperature substance".
* No chemical hazards have been known.

Specific hazards/harms information:
* If liquefied carbon dioxide is released quickly, static electricity is generated from the formation of the snow-like dry ice and due to rust, dust, moisture, etc. in the piping,
and ignition may be possible if there are combustible compounds.

* If a hermetically sealed container such as a bottle or PET bottle is packed with the snow-like dry ice that is created by discharging liquefied carbon dioxide into the atmosphere or with industrially manufactured dry ice, the container may rupture or explode as the dry ice became sublimated into a gas, increasing hundreds of times in volume.

GHS classification
- Physical and chemical hazards: High pressure gas, liquefied gas
- Health-related hazards: None
- Environment-related hazards: None

*None: Outside the classification target or no classification

GHS label elements
- Pictogram:

![Pictogram]

Attention signal word: Warning

Hazard /hazards information: Pressurized gas; danger of explosion
- When cylinder is heated

Precautions: Shield from sunlight, and store in a well ventilated place.

3. COMPOSITION AND INFORMATION ON CONSTITUENTS

Single or compound product: Single component

Chemical name (generic name): Carbon dioxide

Chemical formula: \( \text{CO}_2 \)

Purity: \( \geq 99.5 \text{ vol.}\% \)

CAS Number: 124-38-9

Molecular weight: 44.01

Chemical Substance Control Law (1)-169

ICSC Number: 0021
4. EMERGENCY AND FIRST AID PROCEDURES

Inhalation:
* Move victim immediately into fresh air and keep them rested and warm.

Skin contact:
* For minor frostbite, local rubbing is sufficient. In the case of severe frostbite, however, warm the affected skin in lukewarm water without rubbing and cover the injured part loosely with gauze or bandage and seek medical attention immediately.

If splashed into the eyes:
* Flush the exposed eyes with clean water and seek medical attention immediately.

If swallowed:
* None

Protection of rescue workers:
* Ventilate the area and have them wear respiratory protective equipment such as a supplied-air respirator, if needed.

5. MEASURES IN THE EVENT OF FIRE

Extinguishing agent:
* Carbon dioxide is noncombustible and is also extinguishing agent.

Extinguishing agents that should not be used:
* None

Typical harmful danger in the event of fire:
* If the cylinder is exposed to flames, the internal pressure will rise, the safety device will operate, and CO2 gas will gush from the cylinder.
* When the rise in the cylinder pressure is sudden, there is a possibility that the cylinder may explode.

Extinguishing method:
* Quickly move cylinders to safe place if they are movable.
* Sprinkle water over the cylinders as a measure to prevent the pressure in the cylinders from rising.
* In the case of immovable low temperature cylinders, containers, and tanks, open the gas blow valves and liquid blow valves to release the gas and liquid. Take the necessary measures to keep people away from near the release outlet to avoid inhalation of the discharged high concentration carbon dioxide.

Protection of firefighters:
* Have them wear a supplied-air respirator, if needed.
6. MEASURES IN THE EVENT OF LEAKAGE

Precautions for the human body:
* Quickly evacuate people from the leak site and neighboring areas and prohibit unauthorized entry to the site. Ventilate the area well to avoid gas inhalation.

Protective equipment and emergency measures:
* Carbon dioxide which is heavier than air is likely to collect in lower-lying places and to build high concentrations there. There will be a danger of suffocation when this highly concentrated gas is inhaled, so in situations where it is impossible to repair leak locations, wear protective equipment such as a supplied-air respirator.

Environmental precautions:
* There will be no environmental effect in the normal state.

Secondary disaster prevention measures:
* Before entering a location that is lower than the leakage spot (such as a basement, pit etc.) make sure that the site is safe by measuring the atmospheric level of carbon dioxide.

7. PRECAUTIONS FOR HANDLING AND STORAGE

Precautions for handling

Technical measures:
* Take measures to prevent cylinders filled with carbon dioxide from being subjected to impact and valve forms being damaged by cylinders falling over or dropping. Do not handle cylinders roughly.
* Load and unload extremely low temperature cylinders using a truck equipped with an elevation system or a crane, lift, etc. being especially careful not to subject cylinders to impact.

Local ventilation/General ventilation:
* Carbon dioxide collects easily in low places because it is heavier than air.
* Avoid using carbon dioxide in poorly ventilated locations.

Precautions:
* The cylinder pressure increases with increasing the temperature of the CO₂, and CO₂ will gush out from the cylinder due to the operation of the rupture disk type safety valve.
* If CO₂ gushes from the cylinder indoors due to the operation of the safety valve, prevent gas from remaining by opening doors and windows.
Precautions for safe handling:

* If a cylinder valve is damaged, gas will gush out dangerously. Be certain to place protective caps on cylinders valves whenever the cylinders are being transported.

Precautions for storage:

Appropriate storage conditions:

* Store cylinders and containers, etc. in a well-ventilated, well-drained and level place.
* Fix the cylinders with chains or fences to prevent impact due to falling over or dropping.
* Place protective caps on cylinder valves except when the gas is being used.
* Do not expose cylinders to direct sunlight, keep the temperature below 40 degrees Celsius, and store them in a well-ventilated place.
* Do not place objects around the cylinders that will become obstructions in a disaster.

Moreover, do not place cylinders near to salts and other corrosive chemicals.

Safe cylinder packing materials:

* Cylinders stipulation by the High Pressure Safety Law

8. EXPOSURE PREVENTION AND PROTECTIVE MEASURES

Facility measures:

* Indoor workplaces should be equipped with ventilation fans or other machines so that carbon dioxide gas will not collect there.
* Before entering large facilities for the purpose of inspection or other work, make sure that the location is safe by measuring the atmospheric level of oxygen together with the concentration carbon dioxide.

Threshold limit values:

* ACGIH (The American Conference of Governmental Industrial Hygienists)
  TWA: 5,000 ppm
  STEL: 30,000 ppm
* NIOSH (The U.S. National Institute for Occupational Safety and Health).
  IDLH: 40,000 ppm

TWA (Time Weighted Average):

This is time-weighted average concentration for a conventional 8-hour workday and a 40-hour workweek.

STEL (Short Term Exposure Limit):

This is the concentration to which workers can be exposed continuously for a
short period of time without suffering from irritation, chronic or irreversible, tissue damage, or narcosis of sufficient degree to increase the likelihood of accidental injury. A STEL is generally defined as a 15-minute period.

IDLH (Immediately Dangerous to Life and Health):
This is the threshold limit valve proposed by NIOSH and OHSA in the event of accidental exposure. It is the concentration below which an individual could escape within 30 minutes without experiencing any escape-impairing or irreversible health effects.

When this concentration is exceeded, a complete respiratory protective device is needed.

Measurement Method:
- Aspiration detection tube, non-dispersed infrared analyzer, etc.

Protective equipment:
- Respiratory protective equipment: Supplied-air respirator, oxygen respirator, air supply mask
- Hand protective equipment: Leather gloves
- Eye protective equipment: Full-face, protective glasses
- Skin and body protective equipment: Protective clothes

9. PHYSICAL AND CHEMICAL PROPERTIES
Appearance (Physical state, shape, color, odor):
- Gas: Colorless and odorless. Reaction with water leads to exhibition of weak acidity and a pungent odor.
- Liquid: Colorless and transparent
- Solid: Semitransparent, milky white

Smell: Odorless
pH: 3.7 (25°C, 0.1013MPa, saturated water)
Melting point/freezing point: -56.6°C (triple point, 0.518MPa (abs))
Boiling point, initial boiling point and boiling range:

-78.5°C (sublimation point)
Flash point: None (noncombustible):
Combustion and explosion range:
- Upper limit: None (noncombustible)
- Lower limit: None (noncombustible)
Vapor pressure: 1.967MPa (abs) (-20°C)
3.485MPa (abs) (0°C)
5.733 MPa (abs) (20°C)

Vapor density: 1.977 kg/m³ (0°C, 0.1013 MPa abs)
Liquid density: 1.030 kg/L (−20°C, 1.967 MPa abs)
Solid density: 1.566 kg/L (−80°C)

Solubility in water:
1.713 L CO₂/L H₂O (0°C, 0.1013 MPa)
1.194 L CO₂/L H₂O (10°C, 0.1013 MPa)
0.878 L CO₂/L H₂O (20°C, 0.1013 MPa)

n-octanol/water partition coefficient:
log Pow 0.83

Other data:
* Critical temperature: 31.1°C,
* Critical pressure: 7.382 MPa abs, 75.28 kg/cm²

10. STABILITY AND REACTIVITY
Stability and hazardous reactivity: Inactive gas which is stable
Conditions to be avoided: Carbon dioxide in the presence of water shows acidity and corrodes steel materials.
Corrosion increases further with the presence of oxygen or under high pressure.
Hazardous/harmful decomposition products:
No decomposition under normal conditions (use and storage)

11. INFORMATION ON HARMs
The following influences are exerted on the human body by the carbon dioxide concentration in air

<table>
<thead>
<tr>
<th>Carbon dioxide concentration (%)</th>
<th>Effects on the human body (at normal oxygen concentrations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04%</td>
<td>Normal air</td>
</tr>
<tr>
<td>0.5% (TLV-TWA)</td>
<td>Long-term safety limit</td>
</tr>
<tr>
<td>1.5%</td>
<td>Tolerable for long hours without adverse effect on workability and basic physiological function, but may affect calcium and phosphorus metabolism</td>
</tr>
<tr>
<td>2.0%</td>
<td>Deep breathing appears; and an amount of a breath increases by 30%</td>
</tr>
<tr>
<td>3.0% (TLV- STEL)</td>
<td>Workability reduces, and physiological function changes are caused as variations in body weight, blood pressure and heart rate.</td>
</tr>
<tr>
<td>4.0%</td>
<td>Deeper breathing is caused; respirations increase with slight gasping</td>
</tr>
</tbody>
</table>
for breath; and there is considerable discomfort.

5.0%  Severe dyspnea is caused with heavy gasping for breath. Most victims can barely tolerate the conditions, nausea may occur; and 30-minute exposure causes symptoms of carbon dioxide poisoning.

7-9%  Tolerance limit; very severe gasping for breath is caused; and victims become unconscious in about 15 minutes.

10-11% Regulation hypofunction is caused, and about 10-minutes exposure causes unconsciousness.

15-20% More severe symptoms are caused, but 1-hour exposure is not fatal.

25-30% Symptoms including hypopnea, reduced blood pressure, coma, reflex function loss, and paralysis are caused; being fatal in a few hours.

12. INFORMATION ON ENVIRONMENTAL EFFECT

Carbon dioxide is a main ingredient of the air and is an indispensable gas for animals and plants. On the other hand, it has been reported to be a main causative agent of global warming and various carbon dioxide reduction measures have been studied and evaluated both domestically and overseas.

13. PRECAUTIONS FOR DISPOSAL

Processing of used cylinders:

* Close the cylinder valve surely after use, display the fact that it has been closed, and distinguish the cylinder from filled cylinders.

* Return used cylinders containing some remaining gas to the manufacturer.

* When the gas is blown out, release the gas little by little, taking care of the ventilation.

* Do not use empty cylinders for other purposes, such as substitutes for anvils or rollers.

Return used cylinders

* The user must not dispose of cylinders without permission, since cylinders should be returned by the owner according to the regulations.

* When the owner disposes of a cylinder, they should remove the valve and treat the remainder as scrap.

14. PRECAUTIONS FOR TRANSPORTATION

UN classification Class 2-2 (Noncombustible non-toxic high pressure gas)
UN No. 1013(Compression)/2187(Refrigerated liquid)

UN transportation name: Carbon gas

Labels and method of loading onto vehicles:
* Display warning labels stating “High Pressure Gas” on the vehicle in easily viewable places.
* Keep the temperature of cylinders filled with carbon dioxide at below 40 degrees Celsius at all times.
* Load vertical type extremely low temperature cylinders by standing them up, and do not load these cylinders by laying them down even if they are empty. Load other seamless cylinders by standing them up or laying them down.
* Do not place any cylinders on the driver’s seat.

Handling of cylinders:
* Take measures to prevent cylinders filled with carbon dioxide from being subjected to impact and valves from being damaged by cylinders falling over or dropping. Do not handle the cylinders roughly.
* Load and unload extremely low temperature cylinders using a track equipped with an elevation system or a crane, lift etc. being especially careful not to subject cylinders to impact.
* If a cylinder valve is damaged, gas will gush out dangerously. Be certain to place protective caps on cylinder valves whenever the cylinders are being transported.

15. APPLICABLE LAWS AND ORDINANCES IN JAPAN
* Labor Standard Law: Work limit to hazardous/harmful works (duties of producing or using compressed gas or liquefied gas). Work limit for young people under 18 years of age to work on hazardous/harmful duties.
* Industrial Safety and Health Law:
  Ordinance on Prevention of Anoxia, Ordinance on Health Standards in the Office.
* High Pressure Gas Safety Law:
  General high pressure safety regulations, cylinder safety regulations, etc.
* Vessels Safety Law: Notification of danger, Attached table 1 (High pressure gas)
* Aviation Law: Notification, Attached table 1 (High pressure gas)
* Road Traffic Law, Road Law: Prohibition or limitation of traffic.
Traffic limitation of vehicles

* Fire Service Law: Distances related to high pressure gas facilities
* Food Sanitation Law: Food additives
* Pharmaceutical Affairs Law:
  Carbon dioxide in the Japanese Pharmacopoeia
* Agricultural Chemicals Regulations Law:
  Fumigants
* Laws relating to the Prevention of Global Warming:
  Greenhouse effect gases

16. OTHER INFORMATION

References:

* ACGIH (The American Conference of Governmental Industrial Hygienists (2001 issue).
* Quinn E.L. and Jones C.L.: CARBON DIOXIDE, Reinhold Publishing Corporation, 1936, USA.
* Masuda, S.: Recent Electrostatic Engineering, issued by The High Pressure Gas Safety Institute of Japan. “Carbon dioxide”
* Disaster prevention Indicator No. 120 ‘Carbon Dioxide’ by Environment and Safety Promotion Committee, The Chemical Society of Japan.

This Material Safety Data Sheet was produced based on the Notification No. 60 of the Ministry of Labor (the current Ministry of Health, Labor and Welfare), dated July 1, 1992, and revised based on the Japanese Industrial Standards JIS Z7250:2005. See relevant laws and regulations, relevant publications, liquefied carbon dioxide handling textbooks, etc., for further details.

Note: Handling of the information herein:

This MSDS was compiled based on documents, information and data available to date, but does not guarantee the perfection and correctness of information in the described data and evaluation. Please note that the precautions are provided for normal handling. In the case of special handling, use this MSDS after completing safety measures appropriate for the new uses and methods.