

## Operation of Carbon Dioxide Road Tankers and Equipment while Loading and Unloading

### Introduction

EIGA has been notified of incidents where drivers of carbon dioxide road tankers have sustained very serious injuries, that may have endangered life, while loading and unloading carbon dioxide. In these cases it was found that the failure to follow procedures had been the main cause. Carbon dioxide has additional hazards compared to other industrial gases, such as higher pressure and potential for dry ice creation. Additional safety measures are required for safe handling of carbon dioxide, for further information refer to EIGA Doc 56, *Guidelines for handling Bulk Carbon Dioxide*.

This Safety Information is intended to raise awareness of these serious incidents and to provide basic recommendations and guidelines to prevent similar events taking place in the future.



Photo 1



Photo 2

### Summary of recent incident

In one incident, a contract driver was rendered unconscious when his head was struck by an unrestrained hose which whipped about during the transfer of carbon dioxide at a customer site. The hose disconnected and the flailing hose coupling struck the driver's safety helmet resulting in him falling to the ground unconscious. He was

rescued by customer personnel using self-contained breathing apparatus (SCBA) and was transported to a local hospital. Twenty-one tonnes of liquid carbon dioxide were released from the trailer and from the customer tank (Photo 1). A lack of operational discipline was identified as the main cause, as the restraining chains of the hose were not attached in accordance with established procedures. Further, inadequate inspection and maintenance of the hose coupling threads was an important contributor to the incident.

In another case, a driver was sampling carbon dioxide before delivering the product at the customers' site. The driver was hit by a sudden and major release of product and tragically was found dead at the scene of the accident. It is believed that the correct sampling procedure was not followed. Sampling was attempted without using an adapter and, possibly, the main valve of the filling line was already open when the driver opened the quick acting actuated bottom isolation valve (Photo 2).

In a third case, the operator was working alone to transfer liquid carbon dioxide from a rail tanker to a storage tank. It is believed that the transfer hose was disconnected by the operator after solid carbon dioxide had formed in the transfer hose. When the blockage was released the hose hit the operator causing severe injuries and he died several days later as a result.

These incidents reinforce the importance of ensuring that drivers are competent to perform product transfer activities in compliance with procedures that cover all aspects of the operation, using equipment maintained in accordance with the manufacturer's requirements.

## Risks identified

Uncontrolled release of carbon dioxide from any opening (valve, hose or a fracture or crack) can be violent and can lead to serious impact-related injuries. Injuries can be caused by, for example:

- hose failure;
- inadvertent opening of a drain valve while the system contains liquid carbon dioxide;
- failure of connections;
- failure to open valves according to specified procedures; and
- solid carbon dioxide (dry ice) plugs in pipes and hoses.

Dry ice plugs can form inside hoses and piping when liquid carbon dioxide pressure is decreased below its triple point pressure of 4.18 bar<sup>1</sup>, see Figure 1. The dry ice can be compacted into a plug which can trap gas. The pressure behind or within a plug may increase as the dry ice sublimates until the plug is forcibly ejected or the hose or pipe ruptures. A dry ice plug may be ejected from an open end of hose or pipe with enough force to cause serious injury to personnel, both from the impact of the dry ice plug and / or the sudden movement of the hose or pipe as the plug ejects.

To prevent incidents:

- Liquid carbon dioxide shall be fully purged from the hose or pipe before reducing the pressure below 4.18 bar. This can be done by supplying carbon dioxide vapour to one end of the hose or piping system to maintain the pressure above the triple point while removing the remaining liquid from the other end, see Figure 1.
- It is recommended to install a bypass line on trailer between the piping connecting the liquid and the gas phase to allow pressurisation of the liquid line with gaseous carbon dioxide.

<sup>1</sup> In this publication bar shall indicate gauge pressure unless otherwise noted i.e., (bar, abs) for absolute pressure and (bar, dif) for differential pressure

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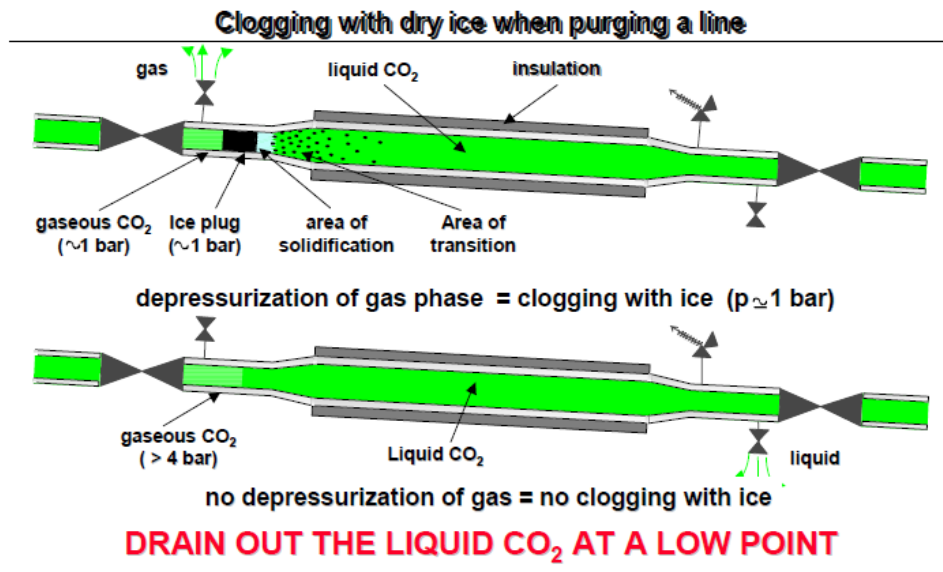


Figure 1

Taking liquid carbon dioxide samples for analysis from product stored in a vessel, trailer or container is potentially hazardous. Only safe equipment dedicated to carbon dioxide shall be used. Equipment shall be suitable for the designated operating conditions, see EIGA Doc 56.

### Recommendations for safe operations

Drivers transferring carbon dioxide shall be trained in correct procedures for connecting hoses, loading and unloading operations, purging and disconnecting hoses. Procedures shall include the following checks:

- ensure gaskets and threaded connections are suitable for continued service before connecting the hoses;
- after connecting of the hoses and before opening any valve, ensure that the hose safety cable or restraining chains are attached, if applicable;
- threaded connections are not tightened whilst under pressure;
- operating procedures and delivery sequence are followed;
- after completing the transfer, close the valves and purge the liquid only through one valve, if possible, the one at the lowest point;
- do not disconnect until purging and depressurising has been completed and checking that the hose is flexible over its whole length (i.e. no dry ice plug has been formed inside the hose), if there is any inflexibility in the hose, purge with gas or wait for the plug to sublime according to company procedures;
- remove any safety cables or restraining chains after disconnection of the hose; and
- sampling shall be in accordance with specific instructions, and drivers who are required to take samples should be trained and competent for this activity.

Equipment for loading and unloading operations shall be included in a periodic inspection and maintenance program including, for example hoses, connectors and hose coupling threads.

**Further information:**

EIGA Doc 56, *Guidelines for handling Bulk Carbon Dioxide*, [www.eiga.eu](http://www.eiga.eu).

EIGA Doc 66, *Refrigerated Carbon Dioxide Storage at User Premises*, [www.eiga.eu](http://www.eiga.eu).

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