BEST OPERATIONS PRACTICES FOR FILLING PLANTS

Doc 236/21

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL

AVENUE DE L'ASTRONOMIE 30 • B – 1210 BRUSSELS
Tel: +32 2 217 70 98
E-mail: info@eiga.eu • Internet: www.eiga.eu

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Prepared by AHG I.22

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Avenue de L'Astronomie 30 B 1210 Brussels Tel +32 2 217 70 98
E-mail: info@eiga.eu Internet: www.eiga.eu

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1 Introduction

The EIGA Doc 02 *Job Motivation and Safe Operations in Cylinder Filling Stations* [1] focus in part 2, on the Safe Operations in the Filling Centres.

In addition to the safety aspect there are a multitude of best operating practices providing a professional level of reliability and quality around these operations.

According to the EIGA annual report of 2019, related to the Work Injury Statistics of Lost Time Injuries (LTI) and Recordable Work Injuries (RWI), more than 40 % of these events occurred at Gas Cylinder Filling Stations and Centres for Cylinders Storage and Distribution.

Year by year, there have been continued performance improvements but still a significant number of events are occurring during the operations conducted at the filling stations, leading to injure employees of the EIGA member companies.

2 Scope and purpose

2.1 Scope

This document is covering the activities performed at the Filling Stations (FS) and Centres for Cylinder Storage and Distribution (CSD),

Areas and Activities covered are as follow:

- Lay out of the filling station,
- Truck loading, unloading and forklift movements,
- Sorting and Inspection of cylinders,
- Filling of compressed gas cylinders with pure gases and gas mixtures
- Filling of liquefied gases cylinders such as carbon dioxide and nitrous oxide,
- Commissioning and truck load preparation,
- Cylinder maintenance (excluding regulatory periodic inspection).

Activities not covered by this document are:

- Process Engineering Design
- Manufacturing of gases,
- Acetylene cylinder filling,
- Design and layout of sites for filling of specialty gases.
- Cylinder retest stations (see EIGA Doc 79 *Cylinder retest stations* [2])
- Site security requirements

Note: Several requirements in this document can be used for the design, layout and handling of speciality gases filing sites.

2.2 Purpose

Purpose of this document is to provide guidelines to the EIGA member companies, of best practices for operations conducted at the Filling Stations and Centres for Cylinder Storage and Distribution.

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

4 General

4.1 Hazards

Typical hazards that can be present on a filling plant are the following

- Cylinder handling,
- Pressure,
- Temperature,
- Asphyxiant, oxidising, flammable, toxic gases.

4.2 Safety management system

4.2.1 Responsibilities

Function	Responsibility for:
Site Manager (Master of the house)	• compliance of site's operating procedures and instructions with safety and environmental laws and regulations and internal company safety standards, • ensuring that anybody entering the premises is adequately informed about the site's safety rules, • representing the interests of the company towards the employees, public authorities, associations, the public, and customers, where their area of responsibility is affected.
Plant Managers & Heads of Departments (Process owners)	• All activities at the operations, plants and facilities assigned to them. • For example: • documenting and controlling SHE risks arising from processes, • managing environmental aspects, • developing operating procedures and instructions and making them available to all concerned employees, • ensuring performance and documentation of SHE trainings for employees and encouraging all employees to engage in SHE issues, • ensuring use of PPE, • establishing and maintaining maintenance system and adequate MOC, • ensuring the use of the work permit system for all non-routine works, • preparing the annual report including target achievement, for management review.

Local SHE Manager	• advising and assisting the Company's Management Body and heads of departments in all issues concerning safety and health and environmental care, • performing SHE audits, monitoring the implementation of SHE measures and informing management accordingly, • assisting or leading incidents investigation and proposing measures to prevent any recurrence, and to report incidents to CO SHEQ[1] accordingly, • preparing the annual company, SHE reports, including target achievement, for management review.

4.2.2 Safety critical devices

Each Company sets up a documented safety critical devices management system. Safety critical devices are:

- measurement and control equipment (e.g. gauges, scales, flowmeters, …),
- process safety equipment (e.g. safety valves, emergency buttons, anti-tow-away systems, dead man switches, …),
- safety equipment (e.g. safety showers, fire extinguishers, harnesses, atmosphere monitoring system…).

The system covers the entire ownership life cycle of the equipment (from selection, planning and acquisition of the equipment, via acceptance through incoming inspection, maintenance and calibration, regulatory and documentary standards compliance, to eventual disposal).

4.2.3 Risk analysis and risk management

- Each Company identifies its operational or business processes associated with SHE risks and develops and maintains a procedure for analysing and managing these risks.

- Each Company performs and documents a job hazard analysis (job safety analysis) and risk analysis according to the procedure. These hazard identification and risk analysis cover workplace risks, process risks and risks arising from non-routine works, and provides e.g. guidance on PPE applicable.

4.2.4 Operating standards, procedures and instructions

A list of all operating standards, procedures and instructions shall be easily available to all concerned employees.

These documents are managed in accordance with the company quality management system.

While operating procedures can be descriptive documents, instructions shall be short and concise. These documents are revised when the process is changed, when a new process owner is appointed (e.g. new plant manager) and are revised as per the company quality management system.

4.2.5 Management of change

A management of change procedure (MoC) is in place in each production and filling company.

The MoC ensures that all modifications to a plant, equipment, control system, process condition, or operating procedure are evaluated for safety, health, environmental and regulatory compliance. No modification is made without authorisation from the responsible manager or delegate, including necessary approvals from specialists.

4.2.6 Health, cleanliness and housekeeping management

A risk-based health, cleanliness and housekeeping program is put in place considering the specifics of the Company's operations. It shall cover the following:

- Occupational medicine – activities aimed to prevent occupational illnesses and to provide medical support in the event of injury or illness (first aid and professional medical support).
- Prevention – the management of workplaces health risks to people, the control of local public health risks (pandemic) to our employees and contractors, and control of the health risks to neighbors.
- Health promotion – activities encouraging the health and well-being of employees
- General cleanliness and housekeeping – the management of duties involved in the running of a clean, neat and orderly workplace.

4.2.7 Emergency response management

An emergency plan is set up considering local requirements and all particularities of company's production sites, warehouses or other business location. This shall be assured by:

- Identifying potential emergency situations and assessing SHE risks associated with them;
- Establishing and maintaining a documented process (so called Emergency plan). The complexity of the plan depends on the threats and the size of the plant. All employees are familiar with the contents and application of the Emergency plan. The plan is explained to all new employees during their initial training and periodical refresh are provided.

The emergency response plan is revised immediately after an essential change at the plant which could influence the effectiveness of the plan (e.g. personnel changes, changes of the potential of danger, alterations to the building or a different use of the building). It can be reviewed annually, and may be subject to specific drills at that occasion.

For effective reporting of emergencies outside the company, an emergency telephone number is provided 24/7 (emergency call centre).

5 Typical Cylinder Plant Description

5.1 Layout of a Cylinder Plant

Cylinder movements in a Filling Station (FS) or Centres for Cylinder Storage and Distribution (CSD) can be a source of incidents as the flow of vehicles (trucks, other commercial vehicles, powered forklifts and manual (assisted) forklifts) transporting cylinders is one of most common identified risks associated to these sites.

To mitigate these risks, there are some considerations in order to optimize the lay out design of the FS and CSD, under a safety point of view

- A map of the plant should be visible and regularly updated, showing the exact location of the emergency exits and assembly points, which need to be properly signed, as well as No-Go zones (see 5.2.2.)
- It can be a good practice to conduct all the activities at the same level avoiding as much as possible the use of docks or elevated platforms;
- crossover movements between trucks, powered forklifts and manual forklifts should be avoided as much as possible, since the collision risk is significant, due the high numbers of movements of a cylinder at the plant during the complete filling process and commissioning before being delivered to customers (example of lay out with this concept is shown on the Figure 1);
- Cylinder process flow either for empty or full cylinders will be designed in order to reduce movements and taking special consideration for avoiding backward movements;
- Loading and unloading trucks should be conducted in specific areas clearly identified and marked;

- Pedestrian ways and crossing walks shall be clearly identified and marked on the ground.

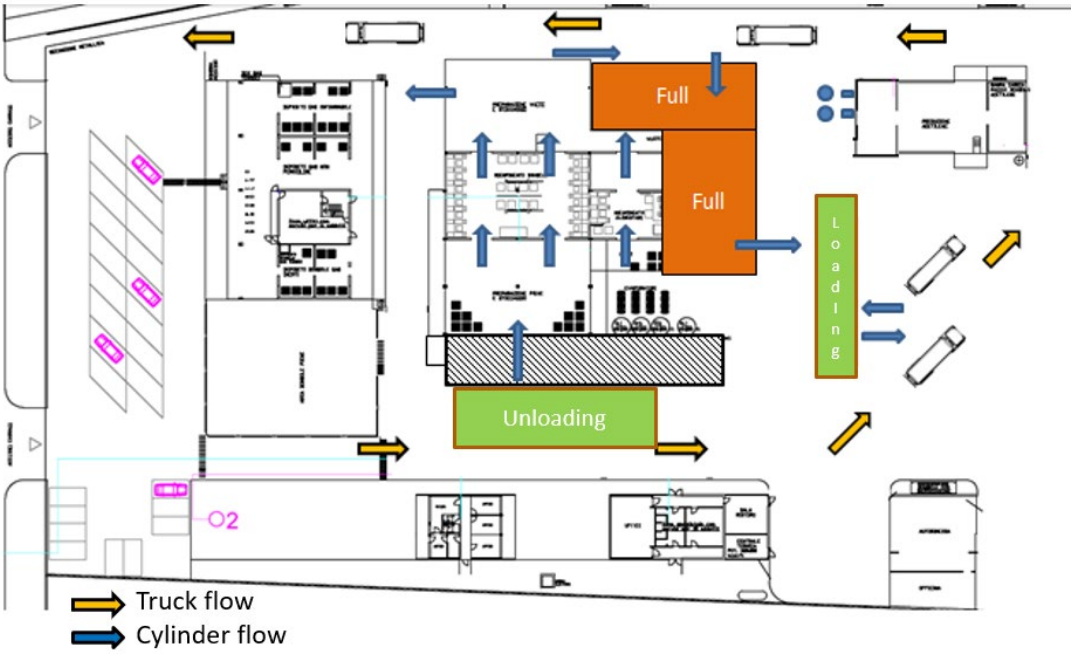


Figure 1 Example of site lay out

5.1.1 Flow of trucks, tankers and forklifts

- Driveways for trucks and tankers shall be clearly signalled with vertical traffic signs and road sign arrows on the ground;
- The traffic flow for trucks should aim at minimizing truck-reversing manoeuvres.
- Speed limit shall be clearly defined and posted for all driveways and vehicles;
- Height restrictions for traffic routes shall be clearly indicated if applicable;
- As forklifts can drive along all driveways of the FS and CSD, special precautions should be taken by forklift drivers when driven by driveways with possible traffic of trucks and tankers on the opposite direction;
- Risk analysis when deciding on the type of forklifts to be used (Figure 2) inside buildings should take into account the benefits versus the risks of the use of manual (assisted) forklifts since:
    - the available space in these areas is limited
    - the use of powered forklifts may lead to increase the risk of incidents while manoeuvring in reduced spaces
    - there may be presence of potential explosive atmospheres;
- Also, manual forklifts have additional benefits inside the buildings as they are less noisy and polluting than powered forklift (e.g. combustion motor driven forklifts).

Figure 2 Example of a manual (assisted) forklift

5.1.2 Separation and segregation of gas packages

Depending on the product portfolio handled on each FS, the separation and segregation of gas packages maybe different but a typical process with its associated storage areas can be as follow:

- Empty and unsorted cylinders,
- Empty and sorted cylinders ready to fill,
- Cylinders in quarantine (normally medical gases after being filled and analysed),
- Full cylinders (ready for picking and shipping to customers),
- Cylinders prepared for being loaded in trucks (commissioning).
- Hazard classes, for example: Flammable gases separated from e.g. oxidizing gases

5.1.3 Flow of gas packages

The lay out and flow of the gas packages between the different storage areas should be designed to prevent as much as possible:

- Long distances,
- crossover movements of vehicles and cylinders,
- Backwards movements of cylinders.

5.1.4 Flow of site personnel

- Site personnel while walking shall use the designated pedestrian ways and cross driveways using the pedestrian crossing walks;
- When available, site personnel shall use pedestrian entrances to access the buildings where forklifts may be in operation. If separate pedestrian entrances are not available, consider the installation of permanent barriers for preventing the risk of incidents;
- If barriers cannot be installed, pedestrian ways should be marked on the ground;

- Emergency exit paths should be signalled with reflective arrows on the ground, and with illuminated emergency exit signs above the emergency exit doors, to facilitate the evacuation of site personnel and visitors.

5.1.5 Private vehicles and visitors

- Private vehicles should not move on driveways designated for delivery vehicles and forklifts;
- Parking areas for private vehicles, either personnel site or visitors, should be located out of the footprint of the area defined for the operations of the FS or CSD;
- Visitors shall register at reception, will be given personal protective equipment (PPE) required on site and will be accompanied at all time by site personnel and will not leave, without permission, the pedestrian ways marked on the ground;
- Local site safety rules shall be explained to visitors during a site induction, e.g. through a leaflet, video training or by any other means.

5.2 Truck loading and unloading layouts

5.2.1 Truck loading and unloading zones

In order to reduce the forklift and truck movements during the activities of unloading and loading trucks, special attention shall be paid to the selection and location of specific areas for conducting these operations.

The unloading area should be located as close as possible from the area designated for storage of the empty and unsorted cylinders while the loading area will be located near to the cylinders prepared for being loaded.

5.2.2 Definition of “No-Go” zones for pedestrians

Loading and unloading activities have significant potential associated risks such as

- Vehicles (forklifts) in motion,
- Load falling from the forklift,
- Load falling from the truck.

In order to mitigate the consequences of potential incidents related to these risks, it is good practice to introduce the concept of “No- Go” zones.

A “No-Go” zone is an area around the vehicle loading or unloading, where the walking or the entrance of pedestrians (including the truck driver) is strictly forbidden.

On the other hand, if, for whatever reason, a pedestrian enters in the No- Go zone the forklift driver shall stop the forklift immediately.

It is good practice to warn all site personnel and visitors about the No-Go zones. These zones are typically 4 meters around the perimeter of the loading sides of the truck (Figure 3) for a standard forklift. Larger distances should be defined for larger forklifts.

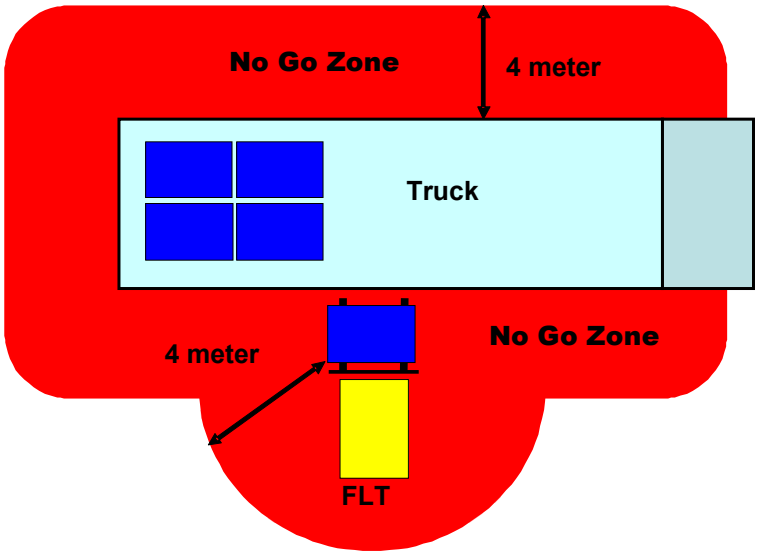


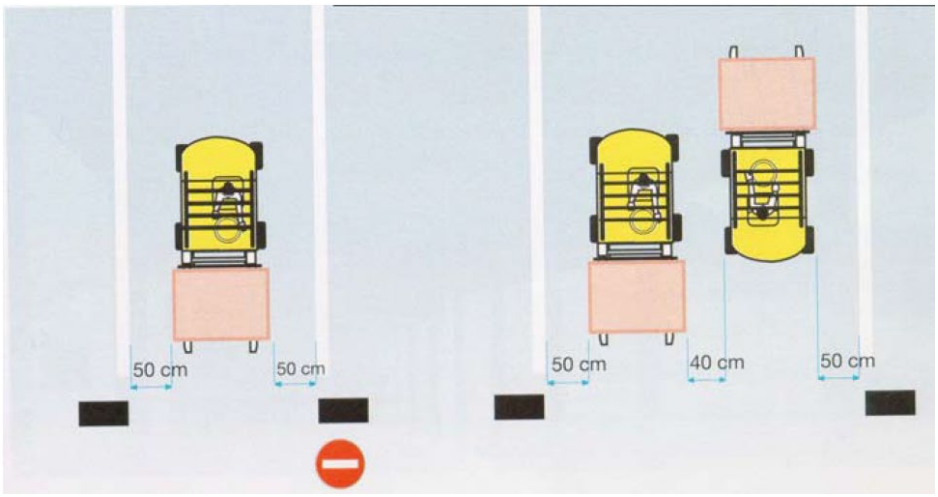
Figure 3 Typical No-Go zone

5.2.3 Forklift runways

In FS and CSD sites, the design and positioning of forklift runways is important in order to avoid collision between forklifts, pedestrian, forklift rollover, etc.

Here are some examples of good practice in runway design:

- Minimum runway width for one way or two-way forklift travel:



- Forklift runways shall be designed to avoid crossovers as much as possible (one flow runway).

5.3 Tank farm description

A tank farm should be designed considering the number and maximum dimensions of the cryogenic storage tanks to be installed, the design of road tank manoeuvring yard in front of tanks is also important.

The design of the tank farm should also take into account the location of the surrounding buildings in a way to prevent potential creation of gas clouds in semi-confined spaces, building entrances or corners.

The tank farm design shall also consider the requirements for the installation of other equipment around the tank necessary for the filling station operation, for example:

- Reciprocating pump for filling station,
- Centrifugal pump for road tanker loading,
- Air evaporator and/or water evaporator,
- Piping to filling station,
- Transportable vacuum insulated cryogenic container transfilling area,
- Road tanker loading and unloading area.

All this equipment should be installed with a layout that allows for its safe access during normal operation, for maintenance and in an emergency.

For safety reasons all piping and electrical cables in the tank farm should be installed in order not to create an obstacle around the equipment.

All exits of blow off valves of tanks, over pressure valves in liquid service shall be brought to a safe location above the ground level (e.g. +/- 30 cm above ground level to take into account the snow accumulation effect). The blow off valves of cryogenic containers (e.g. dewars) shall be directed downwards to ground level.

The yard in front of the tanks where the delivery tankers manoeuvre should be designed considering the dimensions of a standard road tanker and tractor combination plus the minimum steering radius. Like for forklifts the lorry runways should be designed in order to reduce crossover movements.

One-way runways reduce the risk of collision between forklifts and trucks operating in the same area.

In areas where oxygen spillage can occur, the surface shall be constructed from oxygen compatible material such as concrete because asphalt will react violently with oxygen.

5.4 Product storage quantities

In a filling plant, the maximum quantities allowed to be stored are defined by National Regulations and shall comply with the SEVESO rules (see EIGA Doc 60 *Seveso Documents* [3]).

6 Plant operations

This chapter describes the operational requirements in a logical sequence of activities carried out on site. The first two sections describe the general requirements.

6.1 Forklift operations

References: move to REFERENCES

- EIGA Doc 165 *Safe Operation with Forklift Trucks* [4]
- SA 42 *Forklift truck Incidents* [5]
- SL 10 *Safe Handling of Cylinders* [6]

Today technology give us many solutions for active and passive safety forklift operation like:

- Anti-collision system between forklifts and/or forklift and pallet truck,
- Anti-collision system between forklift and pedestrian,
- Blue spot front and rear forklift,
- Siren on forklift.
- Convex mirrors in dangerous or blind corners

All these systems shall be evaluated in function of plant dimension and numbers of daily movement of cylinders and bundles etc.

Only operators with dedicated training and proper qualification can drive forklifts.

The forklift driver shall wear the safety belt when in motion.

Illustrative examples of basic safety principles are given in Annex 2.

A specific risk exists in our filling centres when using forklifts: the risk of **tow-away** of bundles that are still connected to the filling rack by a hose or pigtail.

Various solutions to prevent such a risk exist, and if no interlock or automatic device can easily be used, the most important is to provide the best visible information that the bundle is still connected to the filling rack.

Note: This can also occur with pallets, but the risk is limited as pallets are filled in racks where it is easy to see the cylinders of the pallet are connected to the filling manifold.

Another specific risk associated with the transportation of pallets or bundles with a forklift is the **poor visibility** induced by the load transported.

Example of bad visibility from the forklift driver's seat

This topic is explicitly mentioned in the chapter 8.1.5 of the EIGA Doc 165 [4].

6.1.1 Forklift pre-use checks

A daily check is recommended at the beginning of each shift by the operator in order to be sure that the forklift is safe for operation.

Pre-use check are made up by visual inspection of the forklift with a specific attention to safety equipment, for example:

- Brakes
- Tyres
- Steering wheel movement
- Lights
- Horn
- Lifting mechanism
- etc

An example of daily checklist is attached to EIGA Doc 165 [4];

6.1.2 Forklift periodic maintenance

Different types of forklifts are available (gasoline, diesel, LPG, electric or hybrid powered) and each one has a specific maintenance plan according to manufacturer's recommendation and local regulation as

minimum. Specific experience and incident analysis can be used for introducing additional maintenance steps.

6.1.3 Manual (assisted) forklift use

Manual (assisted) forklifts are available in two different version, manual or electrical in both cases this equipment is designed for moving loads in short distance in building or covered and protected area.

These have typical characteristics in the limitation of elevation and movement of loads. They are sometimes used for moving loads on the truck.

6.2 Handling of cylinders, containers, pallets and bundles and securing cylinders inside pallets

Additional information can be found in ISO 11625 *Gas cylinders- Safe Handling* [7]

“All manual handling activities should be subject to an ergonomic risk assessment. For more information and guidance on manual handling activities see EIGA Doc 229 *Guidance for Manual Handling Activities of Cylinders* [8].

6.2.1 Handling of individual cylinders (rolling, cylinder trolley, hoist, vacuum handling device)

When cylinders are moved individually in a fill plant, there can be various ways to do so:

- Simple cylinder rolling on the ground: this technique is usually used for large and medium cylinders. The distance should be limited to some (< 5) meters. Large cylinders shall be rolled one by one only. The surface that the cylinder is rolled on shall be solid and flat with no debris that can affect the activity and cause loss of control.
- Simple cylinder manual lifting: for medium and small cylinders, this handling mode can be used also for limited distances.
- Use of a trolley: on larger distances, it is recommended to use a trolley to carry one or two cylinders maximum.
- Use of a hoist or crane: this technique can be used only for limited movements (especially limiting the height to some centimetres) when the accessories of the cylinder are designed to do so. Typically, this technique is used by hooking the hoist to the cap of the cylinder, which shall be designed to ISO 11117 *Valve protection caps valve guards for industrial and medical gas cylinders-Design construction and tests* [9] and maintained or controlled to ensure a safe handling operation. For more information, see EIGA info 25 *Handling of cylinders using a crane* [10]
- Use of vacuum handling device: this technique is usually associated with some robotic devices that hook the cylinder by the body surface using suction cups.

6.2.2 Handling of transportable vacuum insulated cryogenic containers

Transportable vacuum insulated cryogenic containers are designed to contain liquefied products at cryogenic temperature. They sometimes come with a protective frame (as their shell is quite fragile) and/or wheels (for easier handling), especially when they are large (more than 100 litres) and consequently heavy.

- When they are without frame or wheels, all the precautions taken when handling loose cylinders can apply, with an additional care about the outer shell and the accessories.
- When they are equipped with wheels, they should be moved by pushing them instead of pulling them, to minimize the risk of being trapped or crushed between the container and obstacles that can appear along the path. They should also be moved only on flat surfaces in good condition.
- When they are equipped with frames (and no wheels), their handling should be made by taking the same precautions as for pallets and bundles.

6.2.3 Handling of pallets and bundles

Due to the weight of such loads (usually between 1 and 2 metric tons), these objects are often moved using powered forklifts. The following precautions shall be taken:

- The forklift driver shall ensure that the pallet/bundle is in good condition for being transported including the forklift slots.
- The forklift driver shall ensure that the individual loads of the pallets are properly strapped and secured before moving the pallets.
- The forklift driver shall ensure that the bundles are disconnected from the filling hose before moving them.
- The forklift driver shall adapt the speed according to the ground conditions (particularly paying attention to slopes and blind corners) and visibility
- Pallets and bundles often limit the visibility of the driver.
- Moving backwards should be limited to short distances.
- Vertical movement of the loads shall be performed only when the forklift is not in motion.

The load shell be lifted only some centimetres above ground level, as to avoid bumps and irregularities of the road, but also to minimize the height of the center of gravity of the loads.

6.2.4 Strapping and unstrapping in pallets

When cylinders and transportable cryogenic containers are grouped in a pallet, they shall always be secured when in motion and this is usually performed using straps.

When unstrapping the cylinders, the operator shall pay attention to the position of the cylinders inside the pallet prior to releasing the strap, as some cylinders may have moved during transportation and then may fall once unstrapped. If the pallet is equipped with a bar, whenever possible, it should be in closed position when releasing the strap. Once removed, the straps shall be safely placed on the side of the pallet to prevent any risk and damage during cylinder movements.

Once the movement of the cylinders is finished, the operator shall secure the cylinders in the pallet.

Rules shall be defined for storing and handling different size cylinders in the same pallet. These rules shall define which combinations of cylinders are acceptable, their respective position in the pallet and the number of straps to be used. For large cylinders e.g. 50 l water capacity, the use of two straps may be considered depending on the pallet design. When combining large and small cylinders, the use of two straps is highly recommended.

When finalizing the strapping, the operator shall check that no strap is out of the envelop of the pallet, as this generate risks for further loading and unloading operations

6.2.5 Check of pallets and straps

Annex 1 is giving rules for checks to be performed on pallets and straps.

6.3 Transfilling from bulk tankers into bulk storage tanks

This operation is typically the responsibility of another department (e.g. bulk distribution), but the site manager is responsible for ensuring safe operation since the activity takes place at the site.

6.3.1 General

The guidance provided in this chapter is generic because there are many different combinations of delivery areas, vessels, tankers, pumps, connectors, hoses etc. Specific risk assessments shall be completed for each area. It is expected that all personnel are trained and familiar with delivery procedures and associated equipment.

Note: Valve numbering and piping layouts differ according to the tanker design; it is therefore essential that drivers are trained to local work instructions.

6.3.2 Personal Protective Equipment (PPE)

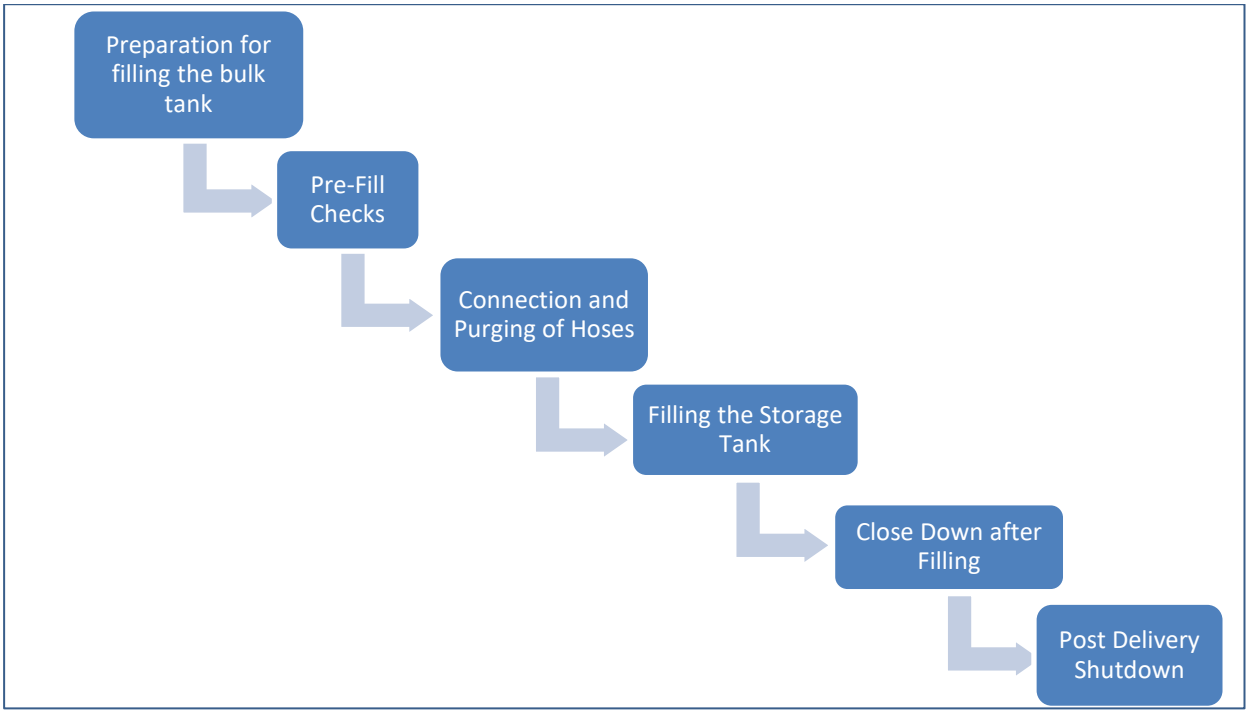
The following PPE shall be worn by the person performing the transfilling cryogenic gases

- Cryogenic gloves,
- Hard hat,
- Safety glasses,
- Face shield,
- Safety footwear.

Specific gases may require dedicated or additional PPE.

6.3.3 Bulk transfilling process

The graphic illustrates the typical bulk transfilling process:



Flexible hoses for loading and unloading product can be equipped with safety cable. The necessary measures should then be foreseen to anchor these cables correctly to the tank and the trailer.

6.4 Sorting and pre-fill inspection of cylinders and bundles

For Customer Owned Cylinders, refer to EIGA Doc 182 *Pre-fill inspections of customer owned cylinders* [11]

6.4.1 Sorting (Segregating and regrouping) cylinders into pallets

The sorting of the cylinders is the first operation to be performed prior to filling, and consists of:

- Segregating the cylinders which are out of test date and/or considered as unsuitable for filling by applying the pre-fill checks defined in 6.4.2

- Regrouping in a batch the cylinders that can be filled simultaneously and having the same filling pressure.
- For pre-fill requirements for customer owned cylinders, see EIGA Doc 182 [11]

In many fill plants, especially for the large and medium-size ones, the handling of cylinders is performed using pallets.

It is recommended that sorting activities are made in dedicated areas, designed in order to minimize the risks coming from manual handling activities (e.g., when necessary, by using elevated platforms allowing to make all the activities at flat level, to ensure cylinder movement in/out of the pallet is performed at equal level)

Consequently, the sorting of the cylinders generates the need to move cylinders from one pallet to another, generating the execution of the following tasks:

- **Strapping & unstrapping cylinders**

  Cylinders in pallets coming for sorting are usually strapped and the operator in charge of sorting needs to unstrap the cylinders.

  Once the receiving pallet (homogeneous pallet) is full and ready to be sent for filling (also for the pallet regrouping the cylinders to be sent for maintenance or retest), the operator shall secure the cylinders through the strapping of the cylinders.

  All precautions described in 6.2.4 apply.

- **Handling cylinders, liquid gas containers, pallets**
  All precautions described in 6.2.1, 6.2.2 and 6.2.3 apply

6.4.2 Pre-fill inspection of cylinders, bundles and valves

Prior to filling, the cylinders shall be inspected and set apart if they cannot be considered ready for filling. Usually this is performed by the person in charge of sorting. The filler may perform an additional pre-fill check.

The pre-fill checks are defined in EN ISO 24431*Gas cylinders -for compressed and liquified gases- inspection at time of filling*) [12]

The main attention points are the following:

a) Verification of serviceable conditions (see the specific precaution for palletized cylinders, for which we need to be able to check every cylinder shell).
b) Identification of cylinders for suitability for filling (compatibility with the intended product, permitted for filling in the Country, and intended content corresponding with the identification label and colour coding, if any).
c) Identification of cylinders owners. If not, company owned, check that authorization to fill was granted.
d) For some gases (O2, CO2 and CO2 mixtures), there is a risk of internal corrosion. Therefore, some precautions are required. EIGA Doc 62 *Methods to avoid and detect internal gas cylinder corrosion* [13] gives example of precautions that can be taken.
e) Verification of neck ring and threaded boss.
f) Verification of valve integrity and suitability (including the pressure relief devices if applicable).
g) For cylinder bundles, check the integrity of the structure, including the manifold,and the presence of an ID plate for liquefied gases, in line with ADR requirements where applicable.

Only cylinders with the same filling pressure can be regrouped in a pallet in preparation for filling.

6.4.3 Check of pallets and straps

Annex 1 is giving rules for checks to be performed on pallets and straps

6.4.4 Check of residual pressure

One of the key controls prior to filling is to ensure a cylinder contains a residual pressure.

In particular for products like O2, CO2 and mixtures with significant content of CO2, for which there is a high risk of corrosion if there has been ingress of moisture or water into the cylinder (typical situation when a cylinder has remained valve open for some time in wet atmosphere). For all other gases, this potential moisture contamination is mostly a quality concern.

For this reason, the use of RPV valves (in most cases, the RPV mechanism is associated with NRV function) is progressively widely used.

When cylinders (or bundles) are equipped with RPV, the check for residual pressure is usually performed this way:

- The valve is opened slowly.
- If gas gets out, there is residual pressure, and the cylinder can be deemed OK for filling. In this case, we do not really check nor activate physically the RPV device.
- If gas does not get out, the RPV mechanism shall be neutralized (usually pushing the associated pin) to see if gas gets out.
- If gas gets out, OK
- If not, there is no residual pressure in the cylinder. The RPV mechanism has then failed in some way and the cylinder shall be set apart for check and potentially valve replacement.

When cylinders (or bundles) are not equipped with RPV, the check of residual pressure check is simpler:

- The valve is slowly and shortly open.
- If gas gets out, there is residual pressure, and the cylinder can be deemed OK for filling.
- If not, there is no residual pressure in the cylinder. There shall then be a check to determine if there is a risk of contamination (moisture or others) prior to decide the cylinder is OK for filling (mirror check, analysis, odour test, cylinder inversion…).

6.5 Filling gaseous products

6.5.1 General

This section covers the filling of high-pressure cylinders. Compressing products into cylinders is achieved, in most cases, by pumping cryogenic liquid products through vaporisers, although certain products and operations utilise gas compressors.

The control of the quantities filled (for each component) can either be performed by

- Pressure control (corrected by temperature)
- Mass control (either using weigh scale, either using mass flow controllers or meters)

The main item of equipment, used at the interface with the cylinder, is the filling rack or manifold. The product is filled into the cylinder, generally via flexible hoses or via metallic pigtails, using two basic approaches:

6.5.1.1 Filling racks or manifolds for pallet filling:

The filling hoses are grouped together so that cylinders can be connected and filled whilst remaining in their pallets. There are three main designs of this type of filling system:

- Individual hose pull down: Each hose is capable of being pulled down independently and when not in use retracts upwards.
- Multi hose pull down: All the hoses on a rack are raised and lowered together.
- Individual hose hook up: The hoses cannot be raised or lowered, and when not in use the hoses are hooked out of the way.

6.5.1.2 Filling racks or manifolds for linear filling:

Designed to fill single cylinders. They are normally constructed to accept a row of cylinders and vary in capacity. The position of the hoses on these manifolds is fixed and, when not in use, they typically hang down from the manifold.

6.5.1.3 Bundle filling pad

A variation of the above is used to fill bundles that are either filled on a dedicated manifold, designed to accept bundles, or on a conventional filling rack and manifold. On conventional rack and manifold either a couple of hoses are utilised, the rest being isolated, or a special hose is used.

6.5.2 Activities to be performed to enable filling gaseous products

6.5.2.1 Pre-use check of filling equipment

Confirm the fill equipment is in good working order.

Confirm that the fill process equipment is available: i.e. that no other operator is using part of the process or intending to do so.

6.5.2.2 Connecting (incl. use of anti-whip & cage and screen) and disconnecting

Check that the filling hoses, or pigtails are in good condition, i.e. no braiding failure, no kinks. Verify the condition of the crimped metallic connecting pieces to the manifold and the fill connector for dirt, cracks, …

Check the condition of the fixtures:

1. Check “O” rings are present, correct material for filling gas and serviceable.
2. Check that the fill connectors are clean and the thread is in good condition.
3. Check that the pins are in place for RPV cassettes. These pins should not be bent or flared.
4. Confirm that there is no debris in the fill connector.
5. Check that the fill adaptors are clean, the thread is in good condition and pins are not bent or flared.

6.5.2.3 Opening and closing cylinder valves (e.g. use of tools)

If a pneumatically or electrically operated tool is used to open a valve, it shall be designed to prevent rapid opening of the valve and in addition shall include torque limitation. This is especially important for oxidizing gases where there may be a risk of adiabatic compression due to opening the valve too fast.

If such a tool is used within a flammable or explosive classified area, then it shall be suitable for use in that area. Where tools are used for cylinder valve closure (pneumatic or electrical), or for connecting filling connectors, they should apply a limited torque as recommended by valve or connector manufacturer. (7 Nm is a typical torque value for 200 bar filling pressure, according to applicable standard ISO 10297 *Cylinder Valves -Specification and Type Testing* [14] . When Nitrogen is used as drive gas, a risk assessment shall be performed to take into account the potential risk of asphyxiation.

6.5.2.4 Removing labels (can be done during sorting)

Damaged or illegible labels shall be replaced, preferably during sorting activity. If labels are being replaced at filling, as they are easier to remove from warm cylinders, it is recommended to wait till the end of fill once leak check is completed and after closure and disconnection of pressure source.

Tools used for removing labels should be fit for purpose and protective gloves shall be worn to avoid cuts.

6.5.3 Control of quantity of gas introduced - Filling charts

In case the quantities filled are controlled by pressure, it is necessary to use a temperature sensor to follow the recommended fill pressure and temperature filling charts to provide the correct pressure to customers (e.g. 200 or 300 bar at 15°C). Filling charts should be developed and made available to the operator for manual filling or should be entered in a PLC when filling automatically.

For mixture filling, specific precautions shall be taken when one of the components of the mixture may liquefy or condensate during the filling process (e.g CO_2, N_2O).

6.5.4 Mobile filling racks

Especially for small cylinders, it can be convenient to use mobile racks, which consist in a complete filling rack, with connections to cylinders, mounted on wheels, and which can be connector through a simple connection point to the filling point, exactly like for the bundles.

This setup allows avoiding occupying the filling rack for all the cylinder connection/disconnection tasks, which represent a significant proportion of the process time compared to the filling time, usually short for small cylinders filling. It also allows a certain flexibility as it can be connected to a single filling hose, as for the bundles.

6.5.5 Lifting of small and medium size cylinders

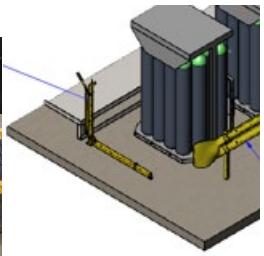
When filling small or medium size cylinders, the filling station should be adapted, either by using a supporting structure to bring the cylinders at height or by installing a system which can lift the cylinder or pallet to the required height (at elbow level for sake of ergonomics).

6.5.6 Anti-tow away protection

In order to prevent cylinders or pallets from being removed whilst cylinders are connected, it is recommended to install an anti-towaway system.

Different solutions exist, and in line with EIGA Doc 63 *Prevention of Tow-Away Incidents* [15] a level of efficiency is given dependant on the independency of human intervention (the highest level of security is when the system is interlocked with the filling system, either mechanically or electrically)

Example for packs: a bar to which the filling hose is connected, and which is dropping down in front of the fork pockets of the pack when the hose is connected to the pack for filling



6.5.7 Filling cylinders or bundles with gaseous product

Filling of cylinders or bundles is performed as described under 6.5.4. The normal cycle for filling is venting of residual product to a safe area, pulling vacuum and filling to the required quantity for each component. Depending on the type of product and purity required, this cycle might need to be repeated several times.

During filling all cylinders in a pallet or bundle shall be checked to ensure they are warm, by means of hand touching, or by means of a temperature sensor, or an infrared thermometer. Warm means at least 10°C above ambient temperature indicating the cylinder is being filled.

During the filling process, measures shall be taken to prevent any risk of partial and/or temporary liquefaction of the gas introduced. (Typical case of manufacturing of high CO2 content mixtures).

New cylinders, or cylinders which come back from periodic inspection, even when fitted with RPV, may need to undergo a specific “first-fill” procedure to achieve product final quality.

All cylinders filled simultaneously shall be filled at a same final filling pressure, limited according to the lowest test pressure of these cylinders

A fill record shall be maintained either manually or electronically.

Full cylinders shall be identified by using e.g. tamper evident plugs, seals or shrink wrap cover or any other mean to assure the customer that the cylinder is full.

6.5.8 Top filling of products

Top filling of pure gases and gas mixtures means that venting of residual product and pulling of vacuum can be omitted and filling can proceed.

Top filling is allowed if residual pressure valves (RPV) are installed. This is conditional upon confirmation of residual pressure in the cylinder.

Some gases may not be top filled for safety and/or legislative reasons, for instance:

- Medical, food grade, pyrophoric and toxic, diving gases, etc.

It is recommended to separate products with RPV and products having standard valves.

Before starting the top filling, all valves of cylinder and/or bundles shall be opened to equalise the pressure. Particular attention is required for mixtures as cylinders in the pallet have different residual pressures and a waiting time is required to equalise cylinder temperatures.

For mixtures, the filling system shall be able to recalculate the needed quantity of each component, depending on the residual pressure on top of which the filling will be performed. The feasibility of this topping up has also to be checked for certain components that can be available at a limited pressure (e.g. CO2, often limited, as a source, to 60/70 bar).

Refer to fill charts for correct top filling of packages with RPV.

6.5.9 Product analysis activity

Analysis of a product shall be determined by the application of legal requirements, or product specification.

A procedure, which identifies the frequency and criteria for analysis of all products filled, should be in place.

Whilst a cylinder from a batch is being analysed the other cylinders shall not be released until the analysis is confirmed. Quarantine can apply to certain products (e.g. medical gases). Analysis data shall be recorded and kept according the application, of legal requirements or product requirements.

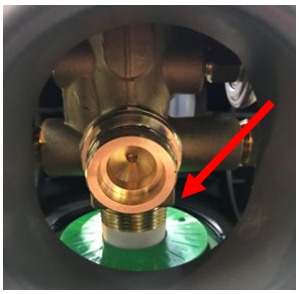
6.5.10 Leak testing

Before filling, when all cylinders are connected, a leak check can be carried out by putting limited pressure (less than 5 bar) or pulling vacuum (preferable) into the filling lines to the cylinders, with all cylinder valves closed.

A second leak check can be carried out during filling, ideally above 25 barg to identify leaks early in the process.

If a leak is detected during filling process, do not attempt to tighten any connection under pressure. The system should be depressurized prior to any intervention. Risks are even more critical in case of oxygen filling.

After filling, when all cylinder valves are being closed and filling system has been depressurised, a final leak check should be carried out at the connection between cylinder and valve, around the valve gland and outlet connection to identify any leaks.



6.6 Filling process of liquefied gases

Different types of liquefied gases have different types of filling procedures.

The quantity to be filled shall respect the “Fill Ratio” charts, as defined in ADR.

Instructions for safe operations during filling of liquefied gas cylinders:

- Liquefied gases are filled in liquid state under pressure in the cylinders. It is hazardous to overfill cylinders as they can consequently burst. Each cylinder shall have a legible tare weight indication (total weight = tare weight + weight of filled liquefied gas).
- Bundles shall have the tare weight clearly and durably marked including the weight of the frame and all cylinders, and fittings.
- Cylinders which are not top filled shall be emptied prior to tare weight check. In case of a difference between tare weight and actual weight the cylinder shall be inspected.
- The quantity of liquefied gas filled into every single cylinder or bundle can only be measured by weight (using weighing scale or mass flow meter) and not by pressure.
- Weighing scales used to fill liquefied gas cylinders shall be certified by a third party.
- Weighing scales shall be pre-usechecked using test weights (at least once per day)
- Most liquefied gas cylinders are fitted with valves with built-in bursting discs. Make sure you know how to identify those valves and what to do in case a bursting disc blows out.
- When not connected to the filling rack, cylinders shall secured and cylinder valves protected

6.7 Filling process of cryogenic containers

General

Liquids can be held in a variety of containers, such as for example open dewars, closed insulated tanks or road tankers. This section covers the filling of containers of less than 1,000 liters, not fixed on a vehicle.

Instructions for safe operations during filling and handling of cryogenic containers:

- Perform the pre-fill checks operations including: external damages, cleanliness, labelling, integrity of the vacuum jacket, integrity of the safety pressure relief devices.
- Ensure that filling and handling of cryogenic containers is performed in well ventilated areas, preferably outdoor, and under cover.
- If filling is performed indoor, monitoring of the oxygen enrichment or deficiency should be performed. Permanent room sensors (preferred) , or alternatively portable oxygen analyzers can be used for that purpose.
- Follow the filling procedures, including the correct use of equipment like couplings or hoses.
- Use only containers designed and identified for the specific cryogenic liquid which is to be filled
- Wear specific protective equipment including goggles or face shield, cryogenic gloves and arms and legs covering clothes, on top of the required standard personal protective equipment like safety shoes.Never release cryogenic liquids in confined

areas to avoid fire hazard created by high concentration of oxygen, or to avoid risk of asphyxiation created by high concentration of inert gases.
- Do not enter a vapour cloud, as on top of the inherent gas danger, breathing the very cold gases which arise from vaporizing cryogenic liquids, can cause serious damage to the lungs.
- In the case of oxygen filling, the operator's clothes could become saturated with the gas and could catch fire very easily. Fabrics should be ventilated or changed if possible, after the fill operation. In any case, do not approach immediately any source of ignition like smoking areas. Refer to EIGA Doc 128 *Design and Operation of Vehicles used in Medical Oxygen Homecare Deliveries* [16] for further information about this risk.

6.8 Preparation of truck loads

For plants which are using pallets to transport the cylinders, the cylinders to be delivered (either to customers or to another plant or depot) with a truck will be prepared, prior to their loading regrouping them according to rules which depend on the local organization of the supply chain.

As this step requires moving cylinders from one storage location (often in pallets) to a receiving pallet, all precautions described in 6.2.1 to 6.2.5 concerning handling and securing apply.

The regrouping rules can vary depending on the transport type:

- Primary transportation (inter-sites) usually leads to the preparation of homogeneous complete pallets
- Secondary transportation (e.g. to customers) usually lead to the preparation of non-homogeneous pallets, as the composition of one pallet is usually driven by the products present in the delivery note(s) of one or multiple customers. In this case, the pallets are not necessary "full", and can contain cylinders of variable size and type, so the strapping rules defined in 6.2.4 have to be strictly followed

6.9 Truck loading operations

Refer to the EIGA 52 Doc *Load Securing of Class 2 Receptacles* [17].

6.10 Storage of cylinders

6.10.1 General considerations

In most cases, the preferred way for storing cylinders and bundles is within a storage zone at ground level, for easy access by handling equipment like forklifts of trolleys.

In certain cases, a multi-story storage can be envisaged, when surface constraints on the site justify such choice, but in this case, the following precautions need to be strictly enforced:

- Selection of robust structures with a careful periodic check and maintenance plan
- Training and qualification of operators accessing this storage zone
- Use of adequate forklifts
- Need to keep floor in excellent condition, with very limited slopes

If this type of multi-story storage is partially or fully automated, specific rules prohibiting the access during normal operations and restricting it to qualified personnel during maintenance or trouble-shooting need to be issued.

6.10.2 Classification and segregation

Full cylinders and empty cylinders should be stored in clearly identified different zones to minimize the risk of errors

Storing cylinders protected from the direct sunlight and from rain and snow is a good practice.

Some local rules can impose it, especially for full cylinders

In warm climatic zones, one should consider protecting cylinders of high pressure liquefied gases (e.g. CO2), as well as Acetylene cylinders from the sun

Some rules, locally defined, apply concerning distances to be respected between different gas families (e.g. flammable vs oxidizing)

Specific rules apply for toxic (and other high risk) gases.

6.10.3 Sizing of storage zones

The sizing of storage zones depends on the organization of the supply chain through the average number of days of stock that is set (may depend on gas families) by the organization of the plant.

The sizing also depends on the accessibility that is required for cylinders of a gas family or a given product. Requiring an easy access to any cylinder (or pallet, when stored in pallets) (FIFO approach) or restricting it only to the last ones that have been stored (LIFO approach) will lead to different surface required for a same number of cylinders. The type of access required (forklift, manual trolley, or fully manual for individual cylinder motion) also impacts this surface determination, as the accessibility of the handling device has to be considered.

The order of magnitude of the surface needed to store on the ground cylinders in pallets accessible by a forklift varies between 0,2 and 0,3 m2 per cylinder, depending if LIFO or FIFO approach is selected.

6.10.4 Nesting and securing of cylinders in storage zones

When the cylinders are not in the process of being moved individually, form one place to another (e.g. From one pallet to another), they should be secured to prevent them from falling.

Various solutions exist, depending on the way they are stored

- If stored in pallets, cylinders should be strapped (see 6.2.4)
- If stored in racks, a chain should be installed to avoid any potential fall with domino effect. The attachment points of the chain should be multiple to cope with the fact the number of the cylinders in the rack can be variable.
- If stored in racks, a simple system consisting in nesting cylinders 4x4 (square metallic structure, placed over the shoulder of the cylinders) with overlap can also be efficient.
- If stored in racks, the size of the rack should be limited as much as practical.

6.10.5 Counting and scanning of cylinders

The setup of the storing zone should also take into account the practical way the tasks associated to cylinder counting (inventory) or scanning (if any) are performed. More space is required if these tasks are performed manually by an operator. Any automation of these tasks (through means like cameras, drones, RFID devices etc…) may allow reducing the storage zones as far as all other constraints described in 6.10.2 are considered.

6.11 Cylinder Maintenance (valve & accessories replacement and painting)

6.11.1 Tests to perform prior (de)valving (e.g. valve whisper test)

Cylinders to be devalved shall be emptied and depressurised before being put into a devalving machine. A test shall be performed to ensure the cylinder is empty before devalving by performing a valve whisper test.

Refer to EN ISO 25760 *Gas cylinders - Operational procedures for the safe removal of valves from gas cylinders* [18]

6.11.2 Handling

The number of freestanding cylinders at the workstation shall be limited to what the operator can handle. Refer 6.2 for details on handling of cylinders.

6.11.3 Precautionary measures with flammable and oxidizing gas packages

Cylinders in flammable, toxic or oxidizing service shall be emptied and depressurised in controlled conditions then purged to prevent an ignition or harmful release to the atmosphere.

6.11.4 Cleaning of cylinder and cylinder thread

Cylinders to be externally cleaned by abrasive means shall be emptied and made safe before work is carried out on them. Cleaning can be done by shot blasting or wire brushing under controlled conditions and waste products from cylinder cleaning shall be disposed of in accordance with applicable local regulations.

Cylinder neck threads shall be cleaned and inspected for wear or damage. Cylinders with badly damaged or worn threads shall be taken out of circulation and scrapped.

6.11.5 Brushing prior painting

Cylinders for painting can be cleaned by manual wire brushing or in an enclosed wire brushing machine which captures the dirt and paint removed. If manual wire brushing is done the worker shall wear suitable face mask to prevent breathing in the dust or paint removed from the cylinder.

7 Automation

Developing automation in a cylinder plant (filling, maintenance, storage) is usually aiming at reducing the arduousness of some manual tasks for operators, as well as enhancing higher efficiency and reliabilty of the automated tasks.

In most cases, the automation involves programmable devices (e.g. PLCs) which are piloting some robotic tools (robots, conveyors, gantries...) which are not necessarily programmed to interact physically in real time with operators nearby (except for so-called »cobots«) and may then create new risks associated to that situation.

The use of automatic devices and/or robotic devices shall comply with the applicable local legislation, like Machinery Directive, *Directive 2006/42/EC* [19] of the European Parliament and of the Council

7.1 Working in automated areas (man versus robot)

Automated facilities are then often designed to remove the workers from the work area; thus, safeguarding them against the hazards of the factory environment. Automated plants have lots of moving parts, equipment and or self-propelled robots, hence there is a need to separate the workers from the machines whilst in operation.

Physical barriers and gates shall be used to prevent contact between working machines and the workers (except in the case of “cobots” mentioned above, which are specifically designed to share their work environment with workers in a safe manner). Automated operations should stop automatically when control system errors occur, or a worker enters a restricted zone.

Maintenance on automated systems shall be tightly controlled with permits to work and lock out – tag out applied to isolate the energy supplies.

7.2 New technologies for automation introduce new risks

On top of the risks during operation of automated devices, there are some risks associated to the trouble shooting and maintenance of automated devices. As mentioned in above 7.1, any intervention of operators for trouble shooting or maintenance should be managed with the adequate methodology

7.2.1 Manual mode vs Automatic mode

Many automated systems have a manual mode that can be activated for troubleshooting of performing non preprogrammed actions, while using the robotic system to perform the tasks needed. In that case, the system must be designed in such a way to:

- Integrate a robust right access management system to allow only qualified operators or supervisors to enter the manual mode (through password management system or equivalent)
- Keep all safety loops active in the manual mode to prevent any mistaken actions that can appear more easily, as being undertaken remotely.

7.2.2 Maintenance on the robotic devices

Any maintenance needing a physical action on automatic devices requires the deactivation of these devices, using LOTO procedures.

8 People matters

8.1 Training and qualification

Refer to EIGA Doc 23 *Safety Training of Employees* [20] for complementary information.

Each employee‘s level of knowledge extends beyond just knowing daily tasks. It means employees shall understand the overall job and environment they work in deeply enough, to allow each employee to think on his or her feet and identify abnormal conditions and potential hazards.

The responsibility for achieving the appropriate level of knowledge depends on both, management and employees.

The following training types shall be adapted /integrated in accordance with local regulation.

8.1.1 Training types:

Companies shall manage three different types of safety training:

- Training of new employees: this type of training is also aimed at an existing employee who is being transferred to a new job.
- Periodic refresher training on safety rules and practices for experienced employees.
- Extraordinary training
- Training of temporary workers

8.1.2 Training of new employees

Accident statistics show that newly hired and inexperienced employees are more prone to accidents than others. Data that focuses not on age but on length of service gives similar results and confirms that the frequency rate of work accidents decreases with length of service. However, statistics fail to explain why so many accidents occur with new employees.

A newly hired or transferred individual should learn about the specific details of their job, the hazards of the materials they will be handling and the tools at their disposal. Lack of experience and training increases their vulnerability to all the hazards they are exposed to.

An employee can also be affected by the unfamiliar work environment of a new job which includes both the physical factors such as noise and heat, as well as the new relationships they have to establish with their colleagues and supervisors.

The arrival of new employees is a unique opportunity for management to help them understand the work environment and safety culture and ensure rapid and safe integration. This responsibility shall be

accepted by management. A structured safety training programme helps to create an environment of trust which is beneficial to the safety awareness of all new employees.

Safety training for new employees and employees transferred to a new job includes:

- Induction safety training
- Full safety training

8.1.3 Induction safety training

shall be performed before an employee starts to undertake any kind of activities related to their job. Induction safety training comprises, for example, the topics of:

- emergency preparedness,
- basic safety information,
- personal protective equipment.

For induction training, EIGA Doc 23.01 *Safety Training Leaflet for new employees* [21] should be used. This publication is designed to be used by the employee's immediate manager to serve as a training plan, record and a feedback document.

Completion of the Safety Training Leaflet for new employees is not a substitute for full safety training. The Safety Training Leaflet is divided into sections but neither these sections nor the order of the items in a section constitutes a priority list.

8.1.4 Full safety training

shall cover all relevant topics related to the activities performed and can be delivered in a classroom and/or at the work place, as well as in other formats.

Regarding the training program and intensity, the full safety training can last a few hours, a few days or even a few months. During this time the employee shall not be allowed to work unsupervised.

8.1.5 Periodic Refresher Training

Personnel shall be retrained (or where specified, their competency levels shall be reassessed) as follows:

- At the frequencies specified in the training program.
- If significant change occurs in the operation or work environment.
- If lack of understanding of the topic is demonstrated.
- • When a significant revision to the training material is issued.
- • When regulatory or company's requirements change.
- When the employee was involved in an incident or near miss, indicating a lack of knowledge and/or awareness

If employee understanding of a topic is judged to be unsatisfactory according to a reassessment, then complete retraining shall be undertaken.

8.1.6 Exceptional adhoc training

Exceptional adhoc training shall be performed when an incident or near miss occurs in a similar type of operation elsewhere and relevant lessons have been derived or dedicated campaigns are carried out.

8.1.7 Training of temporary workers

Due to different circumstances such as, vacation periods, campaigns of seasonal products etc, the hiring of temporary workers is not infrequent at the Filling Plants.

These employees shall go through same training process as the permanent workers at the Filling Plant, including

- Induction safety training
  - Emergency preparedness
  - Basic safety information
  - Personal protective equipment
- Full safety training for those activities which the temporary worker is going to conduct during his/her contract.
- Qualification

Depending on the duration of the contract it is suggested, as long as it is possible, to train and qualify these employees in those activities with less associated hazards and risks and less training requirements.

8.2 Qualification

Activities conducted at Fill Plants are very different depending on the process developed, pre-filling inspections, filling, cylinder maintenance, etc and/or gases handled, oxidizers, inerts, liquefied, etc., therefore, the level of training and knowledge of each employee may be different.

In order to guarantee the knowledge and skills of the employees, during the execution of the tasks assigned to them, is suggested the implementation of a system to qualify the employees at the Fill Plants.

The qualification system might be compound with all or part of the following items :

- Definition of the different processes, activities and tasks conducted at the Fill Plant
- Specific Safety and Operational trainings for each process and activity
- Demonstration of theoritical knowledge through written tests for each process/activity
- Practical training, addressed by experienced employees, on the process and activity under evaluation
- Job Observation, by the qualifier or approver, of the employee during the execution of the tasks related to the process and activity that is going to be qualified for.
- Qualification sheet by employee (paper or electronic), containing the process and activities the employee has been qualified for,date of qualification and the signatures of the persons involved in the qualification process, employee, trainer,approver etc. (example of a paper sheet on attached figure 4).

QUALIFICATION OF PERSONNEL OF THE PLANT

PLANT: _____

Employee Name: _____

Job Description	Activity	Date of Qualification	Employee Signature	Trainer Signature	Responsible Signature
Filling operator	Filling of Flammable gases				
Cylinder Maintenance operator	Valving / De-valving of cylinders				

Figure 4. Example of Employee Qualification Sheet

8.3 Operational discipline

Operational discipline is the deeply rooted dedication and commitment by every member of organisation to carry out each task the right way every time.

Operational discipline is a responsibility of all employees, regardless the position, title, location or type of work. We all have to be willing to always do the right thing and to ensure others always do the right thing. We are professionals.

Every task of the business processes is important and has to be done properly. Thus, everybody should understand his tasks and also the ones of the colleagues.

Each time, all the time …..in the right way.

What is the right way? Professionally, according to instructions.

What is «all the time»? It simply means «always» whether or not someone is looking.

Operational discipline is built on:

Quality of work documentation:

- Clear and updated procedures and Instructions
- Work Permit

Values being willing to do the right thing:

- Integrity and good will
- Formality
- Training (level of knowladge)

Ensuring that others always do the right thing:

- Employees back up one other
- Supervision

Operational discipline leads to the operational excellence and has huge impact on quality.

Safety observations by plant manager and supervisors: safety walk and talk can be useful to identify if it is followed.

'12 Life saving rules: if not respected, you don't work in this company anymore'.

Some of these rules could be used for recommendations:

e.g. PPE: high visibility jacket, safety glasses,....leave this to Local site safety rules.

8.4 Contractor management

Each Company's Management Body shall adequately outline the control to be applied on outsourced business processes that affect Company's SHE management. The responsible person for the contractors' management shall be adequately empowered to control the contractors and to engage relevant supervisors as required by law. These processes shall be defined within the company's SHE management system.

In particular, if the contractor is performing activities with high, SHE risks, it shall be ensured that:

- contract managers and SHE representatives are named and known to both contractual parties and
- that the contractor is informed of and committed to the Company's general SHE rules as well as any specific SHE rules for the activities to be performed.

Contractor Management has three main components – Contractor Selection, Management and Review.

Contractor management means that supervision of the work is carried out e.g. by facility management or designated person.

For some jobs, it may be necessary to provide specific training such as Safety Work Permit systems, energy isolation and confined space entry.

Contractors shall ensure that their own employees are competent to perform the work and are provided with all necessary plans, tools and equipment.

In addition to general craft and EH&S training, the contractor supervisor shall ensure that all contractors understand the scope of work, associated safety requirements and the boundaries of their work. The JSA or risk assessment shall be reviewed when applicable, as well as any permits to work.

Where workplace risk assessments or JSAs are required, they shall be done by the contractor as required by their own standards and as required by the company where work is being carried out. See appendix 3 for an example of a JSA.

8.5 Safety Work Permit requirements

Refer to EIGA Doc 40 *Work Permit Systems* [22] and EIGA Doc 23.23 *Work Permit* [23] for complementary information.

A Safety Work Permit is an integral part of a safe system of work. The issuance of a Safety Work Permit does not, by itself, make work safe. A Safety Work Permit system supplements normal hazard control method.

It shall ensure that the foreseeable risks to people, processes, assets, or the environment have been identified, and that precautions against injury or damage are implemented, acknowledged and documented. It provides for a consistent application and documentation of the personnel involved in the work activities and relevant methods and techniques used to mitigate the risk.

Each facility shall develop a site-specific list of work which requires a work permit.

It shall be ensured that a work permit form contains as a minimum the elements of the list present in the EIGA Doc 40 [22].

9 References

Unless otherwise specified, the latest edition shall apply.

[1] EIGA Doc 02 *Job Motivation and Safe Operations in Cylinder Filling Stations*

[2] EIGA Doc 79 *Cylinder retest stations*

[3] EIGA Doc 60 *Seveso Documents*

[4] EIGA Doc 165 *Safe Operation with Forklift* Trucks

[5] EIGA SA 42 *Forklift truck Incidents*

[6] EIGA SL 10: *Safe Handling of Cylinders*

[7] EN ISO 11625 *Gas cylinders- Safe Handling*

[8] EIGA Doc 229 *Guidance for Manual Handling Activities of Cylinders*

[9] ISO 11117 *Valve protection caps valve guards for industrial and medical gas cylinders-Design construction and tests*

[10] EIGA Info 25 *Handling of Cylinders Using a Crane*

[11] EIGA Doc 182 *Pre-fill Inspection of Customer Owned Cylinders*

[12] EN ISO 24431 *Gas cylinders -for compressed and liquified gases- inspection at time of filling*

[13] EIGA Doc 62 *Methods to Avoid and Detect Internal Gas Cylinder Corrosion*

[14] EN ISO 10297 *Cylinder Valves -Specification and Type Testing*

[15] EIGA Doc 63 *Prevention of Tow-Away Incidents*

[16] EIGA Doc 128 *Design and Operation of Vehicles used in Medical Oxygen Homecare Deliveries*

[17] EIGA Doc 52 *Load Securing of Class 2 Receptacles*

[18] EN ISO 25760 *Gas cylinders - Operational procedures for the safe removal of valves from gas cylinders*

[19] Machinery Directive, *Directive 2006/42/EC*

[20] EIGA Doc 23 *Safety Training of Employees*

[21] EIGA Doc 23.01 *Training Checklist for New Employees*

[22] EIGA Doc 40 *Work Permit Systems*

[23] EIGA Doc 23.23 *Work Permit*

[24] EIGA TB 13 *Safe Design and Use of Cylinder Pallets*

ANNEX 1: Check of pallets and straps

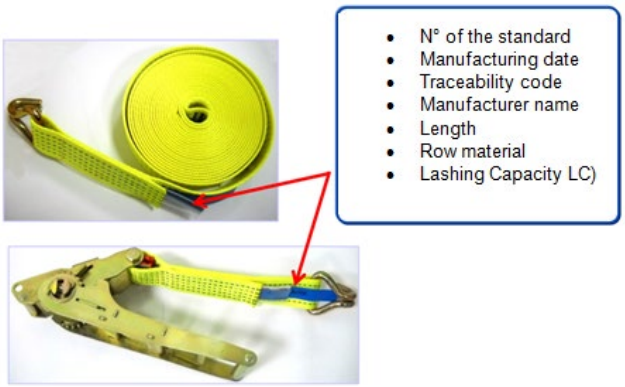
Pallets

The recommendations exposed in the EIGA TB 13 *Safe Design and Use of Cylinder Pallets* [24] are to be considered.

Straps

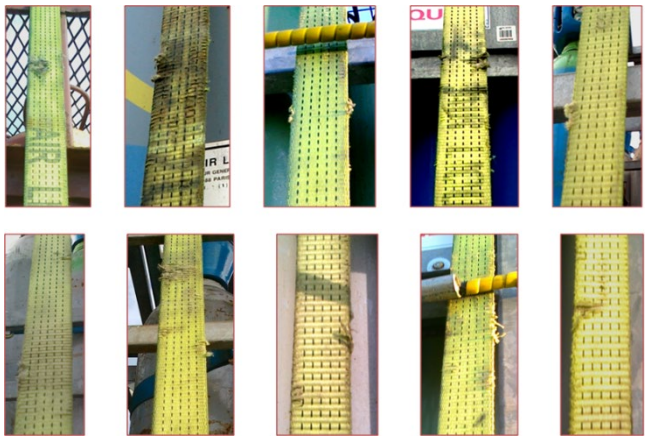
The straps used to secure the cylinders into the pallets and to secure the loads onto the trucks (when used) shall comply with the requirements of EN 12195-2. For load securing on trucks, see Doc EIGA 52 [17] .

If a ratchet tensioner is used, the elements indicated on the label (located on the long side and the short end of the strap) are to be considered. The elements that appear on the labels are shown in the following figure:



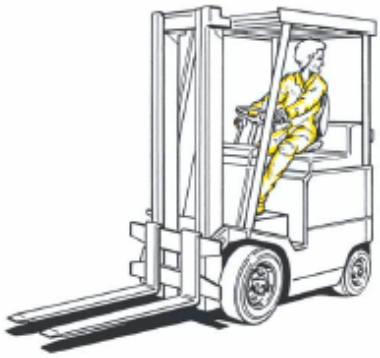
Strap condition:

The straps should be in good condition. If major seams are damaged, or if the weaving is rough, shredded or frayed, the strap should be replaced.



ANNEX 2: Basic safety rules for forklift operations

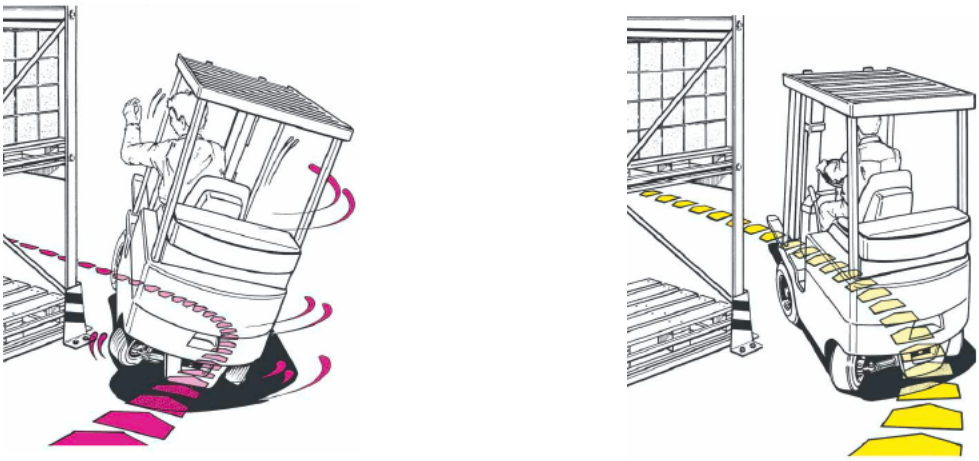
There are a number of significant hazards associated with FLT operations here below we report some good practice for forklift driver.



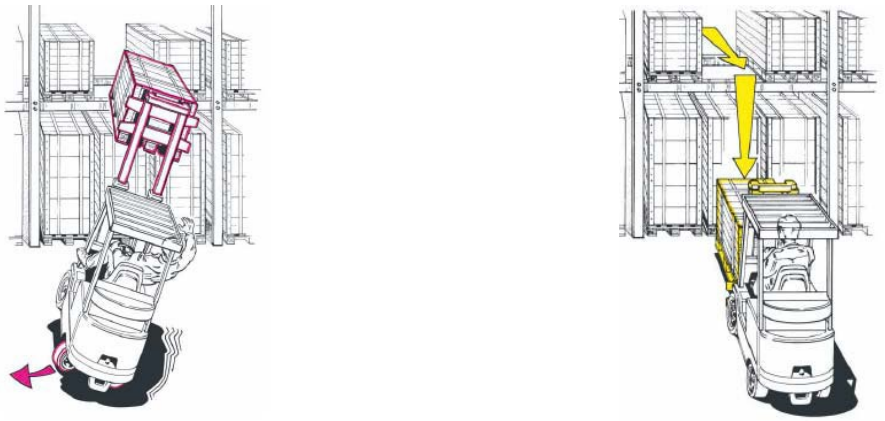
Forklift shall be operated from driver set

Load shall be kept close to the forklift mast and tilted backwards

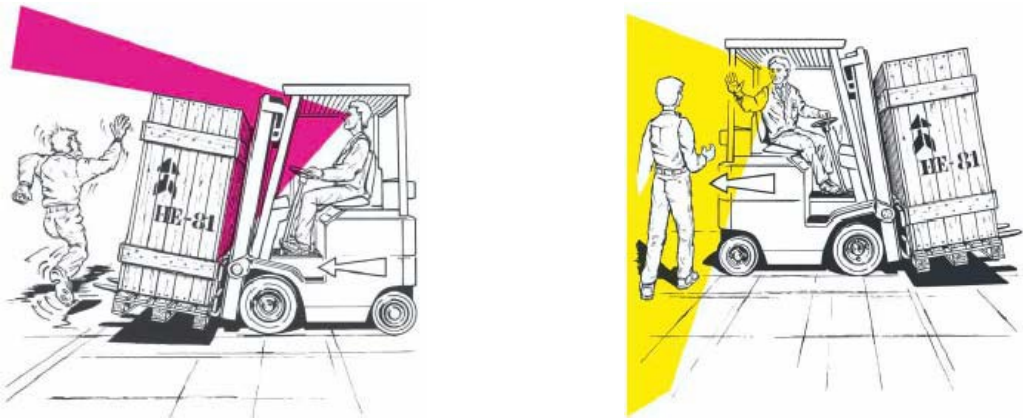
In case of poor visibility proceed slowly



Drive round curves at low speed, Accelerate with caution



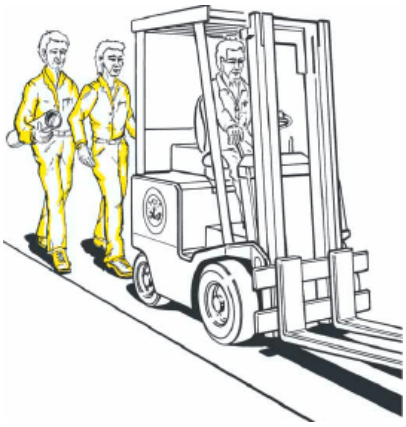
Before moving lower, the load or fork



Proceed only in conditions of complete visibility

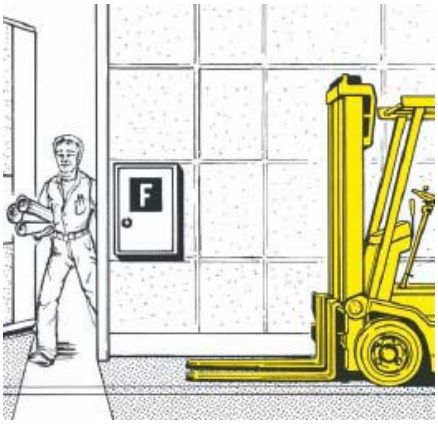
Before forward check backward

Check that nobody is near the raised load

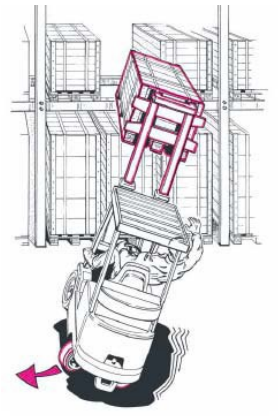


Do not transport people on forklift

The lifting of people is allowed only with suitable equipment provided in the user manual of forklift



Park forklift in the proper way, fork low and not in front of door or emergency exit



In case of forklift overturning, do not leave the forklift but:
Remain sit
hold onto the steering wheel well
push your feet on forklift floor
tilt the side opposite to that of overturning

ANNEX 3: Example of JSA

REQUIRED PROTECTIVE EQUIPMENT: Bump Cap Or Hard Hat, Steel Toe Shoes, Gloves, Safety Glasses With Side Shields

STEP(S)	POTENTIAL HAZARD(S)	RECOMMENDED SAFE PROCEDURES
Remove ladder from service truck	Slipping, falling, tripping, bumping head, pinch points, overexertion, tie down straps.	Wear required safety equipment, watch your step, keep area under stored ladders clean, use proper lifting technique, watch for loose ends on tie down straps.
Inspect ladder	Pinch points, overxertion	Wear gloves, use proper lifting technique.
Carry to work area	Overexertion, tripping, falling, pinch points, controlling the ladder in wind-snow-ice and work area,	Proper lifting technique, move slowly, use caution, know your limits, use extra help if needed.
Inspect work area	Tripping, falling	Recognize hazards
Set up the ladder	Slipping, overexertion,pinch points, electrical hazards, clearance around other piping, uneven ground,	Review ladder safety training video tcn0023
Extend ladder	Pinch points, overexertion, rope burn, overhead lines,	Proper lifting technique wear gloves, use an extra person if needed, inspect area
Use the ladder	Falling, climbing, slipping, exceeding capacity of ladder,	Use proper ladder technique. Inspect ladder capacity
Retract the ladder	Pinch points, overexertion, rope burns	Use proper ladder technique, use extra help if needed. Wear gloves
Store the ladder	Overexertion, slipping, tripping, pinch points, overhead lines	Use proper lifting technique, use extra help if needed
Secure the ladder	Overexertion, slipping, falling, pinch points, bumping head,	Watch your step, have a clean area under ladder storage area, use ratchet straps to tie the ladder down, do not use rubber straps, wear gloves

ANNEX 4: Example of MOC procedure