



Issue 1 July 2021

Storage of Refrigerant Cylinders in Commercial Premises

This document has been written by a subgroup of the FETA A2L Working Group as a signpost guidance document following members questions about storing A2L refrigerants (both contractors and wholesalers). The information covers a practical approach to storing all cylinders used by the refrigeration industry, including A1, A2L and A3 refrigerants together with other products such as nitrogen, oxygen, and acetylene. **It is intended to supplement a location specific risk assessment with helpful information NOT replace it.**

The Regulatory Reform (Fire Safety) Order 2005

The Regulatory Reform (Fire Safety) Order 2005 (RRFSO) requires that every non-domestic property has a Fire Risk Assessment. The objective is to prevent fires occurring and if one should occur, to minimize the risk of injury and damage to property.

Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) places a responsibility on the employer and self-employed to protect employees and the public from risks in their work activity associated with fire and explosion.

Employers must:

- Find out what dangerous substances are in their workplace and what the risks are
- Put control measures in place to either remove those risks or, where this is not possible, control them
- Put controls in place to reduce the effects of any incidents involving dangerous substances
- Prepare plans and procedures to deal with accidents, incidents and emergencies involving dangerous substances
- Make sure employees are properly informed about and trained to control or deal with the risks from the dangerous substances
- Identify and classify areas of the workplace where explosive atmospheres may occur and avoid ignition sources (from unprotected equipment, for example) in those areas

There is a duty to ensure that any operations which might result in the formation of a potentially flammable or explosive atmosphere are managed to minimize the risk of a fire or explosion.

Such risks normally can be expected during work operations involving flammable or oxidising industrial and refrigerant gases, but where involvement with these gases is only in a storage (and resale) capacity the risks are very low and can be adequately managed by choosing the correct locations and by some simple procedures.



Storage Areas – General Considerations

Whilst not directly under the scope of this document attention and consideration should be given to the following:

- Movement of cylinders to and from delivery vehicles to the storage areas
- Cylinders left in temporary locations in the warehouse during other ongoing moving operations
- Location of storage areas in relation to other forklift truck operations
- External storage areas vulnerable to other site traffic
- Cylinders should be stored and/or stacked in strict accordance with the cylinder manufacturers guidelines.

Storage Location

Outside storage is always the preferred option for bulk cylinder storage though it is accepted that commercially this is not always viable due to availability of outside space and the security of that space. It can be argued that a greater degree of risk could occur from vandalism and theft of cylinders from outside than the risk of storing them inside a properly considered space.

Probability of Leakage

Probability of leakage from refrigerant cylinders is very low to zero¹. Should leakage occur it is likely to be almost undetectable other than with a sensitive refrigerant leak detector. Cylinders, due to their construction, offer enhanced tightness levels and leakage is not expected. For A2L, A3 and other flammable gasses an explosive atmosphere is therefore not foreseen in the surrounding area from leakage should it ever occur. Consideration to ventilation and the volume of the area the cylinders are stored in would also impact dispersion of the event of leakage.

The Risks

Leakage from cylinders into the storage facility environment present the following risks depending on the fluid leaking, some refrigerants for example will have both asphyxiant and explosion risks:

- Asphyxiant
- Oxidant
- Explosive
- Toxic (unlikely but assess the products you are storing)

¹ BS EN 1127-1:2019 Clause B.3 Enhanced tightness



External Storage

Due to the high level of ventilation available, external storage is preferred for large numbers of cylinders.

Where stored externally cylinders must be kept in purpose designed metal cages or compounds, locked and fitted with the appropriate signage. Cylinders which are stored in the open air must be kept at a specified distance from boundaries, buildings, and sources of ignition. The probability of ignition of the releases is low provided that appropriate precautions are taken.

Storage must be in secure yard area with no customer/public access and the area must not be liable to flooding.

If they are stored next to the wall of the building, they should be in a cage. The wall of the building should be of minimum 30 minutes fire resistant construction:

- Behind the cage
- 2m either side of the cage and
- Have no openings to a height of 9 metres

If stored in a corner between two walls or between wing walls the walls should be at least the height of the stack but not less than 2m high.

Secure compounds (External Storage)

Cylinders stored in the open should be enclosed within a compound, located at least 3 metres from boundary fences, buildings, and structures. The compound should not be close to roadways or motor vehicle movements (other than for loading and unloading cylinders). The compound should be securely fenced with, for example, 1.8m high welded wire mesh on metal or concrete posts. The mesh on the cage is to be small enough to prevent any unauthorised tampering e.g., opening of cylinder valves. Gates to the compound should be secured by a good quality chain and padlock.

External storage areas must:

- Be kept free from weeds, long grass, and accumulations of readily combustible material
- Have suitable barriers which should prevent unauthorised access and impact damage and accidental damage
- Cylinders sited more than 3 metres away from plant, air conditioning intakes
- Cylinders should not be sited under power cables, including telephone cables
- Cylinders sited more than 2 metres from openings, windows, escape routes and drain openings
- If there is an unavoidable opening within 2m, the opening should be securely covered and fitted with a suitable water seal to prevent the entry of vapour.
- Cylinders must be 3 metres away from parked vehicles to protect from impact damage
- Have a floor which is level and constructed of concrete or other non-combustible, non-porous material to provide a load-bearing surface. Outdoor storage areas should be slightly graded for drainage of surface water.



Issue 1 July 2021

- Not be accessible to the general public or other unauthorised persons
- Be under strict access control regarding the entry of vehicles and mechanical handling equipment into the storage area. Only vehicles associated with transfer and handling operations should be allowed in storage areas. Transport vehicles should have their engines and auxiliary electrical equipment (radios etc) turned off when containers are being loaded or unloaded. Such vehicles should be removed when loading or unloading is completed. Other vehicles under the occupier's control may be parked within the separation distance but should be no closer than 3 m to the nearest container.
- Cylinders sited at least 10 metres away from designated smoking areas
- Have an appropriate number of fire extinguishers located in the vicinity.

Cylinder Cages (External Storage)

Cylinder cages are often needed (if cylinders are to be stored in a compound that is not secure or is frequently left open).

All of the above controls listed for external storage must be adhered to including the separation distances i.e., cages containing flammable gases must be 3 metres from the site boundary and those containing oxygen and inert gases 1 metre from the site boundary

In all cases there should be no flammable materials or ignition sources within 3m of the storage area.

Cage design should prevent tampering by using a mesh size which will prevent hands getting through. Prior to installation of a gas storage cage consideration should be shown to the location of neighbours, the nature of their business and the nearby roads, railways, and bridges.

Floor (ground) - Cage must be sited on level surface.

Internal Storage

The first consideration should be the volume of the space you are storing the cylinders in. The space should ideally be in open warehousing at ground level where adequate separation can be made between fluid types and full and empty cylinders. The ventilation rates should be based on flammability and asphyxiation and for risk assessment the contents mass of the largest single cylinder could be used for these calculations on the probability that only one cylinder might be leaking and that would be the maximum quantity that could leak.

Leakage Concentration Levels into Internal Storage Areas (assuming no ventilation)

We will use R744 for our first calculation (asphyxiation):

- 23kg cylinder A1 R744 (CO₂)



Issue 1 July 2021

- Practical limit² 0.100kg/m³ (EN 378-1:2016+A1:2020)
- Room volume to exceed the practical limit would be 230m³
- This equates a room size of approximately to 9m x 9m x 3m
- This assumes no fresh air mixing and the entire contents of the cylinder escaping

We will use R32 for our second and third calculation (flammability):

- 45kg cylinder A2L R32
- Practical limit³ 0.061kg/m³ (EN 378-1:2016+A1:2020)
- Minimum room volume to exceed the practical limit would be 737m³
- This equates a room size of approximately to 16m x 16m x 3m
- This assumes no fresh air mixing and the entire contents of the cylinder escaping

To reach 25% LFL with R32:

- 45kg cylinder A2L R32
- 25% LFL 0.307kg/m³ / 4 = 0.076kg/m³
- Room volume to exceed 25% LFL would be 592m³
- This equates a room size of approximately to 15m x 15m x 3m
- This assumes no fresh air mixing and the entire contents of the cylinder escaping

Although EN 378 has a practical limit for R32 which is approx. 1/5th of the LFL this considers stratification of a leak not homogeneous mixing. The second example gives a more realistic room volume to reach 25% LFL. We then need to consider that we would need to reach the LFL (100% LFL) and contact a viable source of ignition and the above calculations assume no fresh air mixing during the entire leakage event.

Ventilation (Internal Storage)

Air mixing and ventilation are a key mitigation to asphyxiant or flammable clouds forming in the event of leakage. The above calculations only account for the physical space available for the leakage to disperse and mix in and have assumed total leakage of the cylinders exemplified. Many warehouses will exceed these dimensions but where they do not and there is a theoretical risk of the contents of one leaking cylinder exceeding the practical limits other measures might have to be considered, these could be:

- Increased natural ventilation
- Permanent forced ventilation
- Forced ventilation activated by gas detection

Commercial premises, especially warehousing is rarely airtight but unless air changes can be formally calculated then the correct approach would be to assume worst case. Most

² Practical Limit – Concentration used for simplified calculation to determine the maximum acceptable amount of refrigerant in an occupied space

³ Practical Limit – Concentration used for simplified calculation to determine the maximum acceptable amount of refrigerant in an occupied space

⁴ For flammables, the practical limit is approx. 1/5th of the LFL



Issue 1 July 2021

warehousing would expect to have between 5 and 15 air changes per hour. If the ventilation rates can be proved as sufficient then mechanical ventilation might not be required.

Gas Detection (Internal Storage)

Gas detection used to raise an alarm and/or activate forced ventilation should consider the range of fluids stored as more than one type of gas detector might have to be fitted. The gas detector manufacturer will advise the number of detectors required to cover the gas storage facility and consideration should be given to their location (typically low level) and the protection of the detectors against mechanical damage.

Separation

All cylinders should be separated in the storage area according to their Hazard Classifications. Separation distances should be at least 1 metre for non-flammables and 3 m for flammables. Careful consideration should be given to separating flammables and oxidants. They should be stacked in accordance with the cylinder supplier's guidelines. Emergency exit routes from the building through the warehouse should not be routed through cylinder separation corridors.

Documentation on Site

The storage location should have relevant material safety data sheets available for all the substances stored. This compendium of information should be readily available in case of an emergency to hand over to the incident commander to assist them in dealing with the risks that might occur and might not only be fire risks.

Signage

Outside storage compounds and warehouses storing gas cylinders should be clearly marked with the appropriate signage to advise emergency responders to the risks and to approach them correctly. Advice should be taken for the signage to cover your storage requirements but below are examples typically used on both internal and external storage areas:



Other useful references

- [Chemical warehousing: The storage of packaged dangerous substances - HSG71 \(hse.gov.uk\)](https://www.hse.gov.uk)
- BCGA CP44 The storage of gas cylinders 2016 [Home - British Compressed Gases Association \(BCGA\)](https://www.bcgas.co.uk)
- BS EN 1127-1:2019 Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology <https://shop.bsigroup.com/>

FETA acknowledges the work of the subgroup of the FETA A2L Refrigerants Working Group in the preparation of this document.

REVIEW DATE JULY 2022

© Federation of Environmental Trade Associations Ltd 2021

All rights reserved. Apart from any fair dealing for the purposes of private study or research allowed under applicable copyright legislation, no part of the publication may be reproduced, stored in a retrieval system, or transmitted in any form by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the Federation of Environmental Trade Associations, 2 Waltham Court, Milley Lane, Hare Hatch, Reading, Berkshire RG10 9TH.

FETA uses its best efforts to promulgate Standards and Guidelines for the benefit of the public in the light of available information and accepted industry practices but do not intend such Standards and Guidelines to represent the only methods or procedures appropriate for the situation discussed. FETA does not guarantee, certify, or assure the safety or performance of any products, components, or systems tested, installed, or operated in accordance with FETA's Standards or Guidelines or that any tests conducted under its Standards or Guidelines will be non-hazardous or free from risk.

FETA, and the individual contributors, disclaims all liability to any person for anything or for the consequences of anything done or omitted to be done wholly or partly in reliance upon the whole or any part of the contents of this booklet.