ENVIRONMENTAL IMPACTS CYLINDER FILLING PLANTS

Doc 110/23

Revision of Doc 110/16

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

Doc 110/23

ENVIRONMENTAL IMPACTS CYLINDER FILLING PLANTS

Prepared by WG-5 Environment

Disclaimer

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

Table of Contents

1 Introduction

This publication details the environmental impacts of the management of cylinder filling operations and gives guidelines on how to reduce the impacts.

2 Scope and purpose

2.1 Scope

This publication does not give specific advice on health and safety issues, which must be taken into account before undertaking any activity. On these issues the relevant EIGA documents and / or national legislation should be consulted.

2.2 Purpose

This publication is intended to serve as a guide for the managers & personnel of Industrial Gases cylinder filling operations, to assist in putting in place a formal environmental management system that can be certified by an accredited 3rd party verifier. It also aims to provide a guide for operating managers to identify and reduce the environmental impacts of these operations.

3 Definitions

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

3.1 Publications 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 and need not

Indicate 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.

3.2 Technical definitions

3.2.1 Environmental aspect

These are elements of an organisation’s activities, products or services that can interact with the environment. For example, use of energy or road transportation of products.

3.2.2 Environmental Impact

Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects. See ISO 14001, *Environmental Management System* [1][1]. For example, the contamination of water with hazardous substances or the reduction of air emissions.

4 Cylinder filling operations–environmental impacts

4.1 General environmental aspects and impacts and links to other EIGA documents

This publication covers the environmental impact of cylinder filling operations, which are summarised in Appendix A.

There are several linked EIGA publications that provide more details on general environmental issues, legislation for the gas industry and operational good environmental practices. A list of these linked documents and their links to the ISO 14001 [1] is provided in Appendix B. Appendix B also shows which of these documents are relevant to cylinder filling plant operations.

4.2 Planning and control

The basic philosophy is the minimisation of waste, emissions and nuisances of any kind and their safe and clean disposal. Also considered is the minimisation of raw materials, energy, unused equipment and cylinders and water use. By considering the potential waste which a new process could generate, or when engineering a plant, future problems can be avoided. This analysis is a crucial element of Environmental Impact Assessment that is strongly recommended before any decision of industrial investment. Waste streams should not be mixed but collected separately to aid further recycling, reuse or recovery.

Safety data sheets (SDS) for all chemical substances should be held on site and used to determine the best way to handle them. In particular, handling of hazardous chemicals such as Polychlorinated Biphenyls (PCB), chemicals containing asbestos or lead or chromates have to be carried out by an authorised contractor. Specific detailed handling conditions and disposal methods have to be written for such hazardous chemicals. These substances will need to be disposed of as hazardous waste by a certified waste disposal company in line with local or national regulations.

The key point in planning and control of environmental impact at cylinder filling operations is to make sure that the responsibilities are clearly defined at the site for management and operators. The key areas are:

- waste management (solid and liquid waste);
- energy management;
- air emissions;
- water use and disposal.

Specifically, in the following areas:

Cylinder preparation:

- purging;
- testing and maintenance;
- cleaning;
- drying;
- painting and labelling;
- valving.

[1] References are shown by bracketed numbers and are listed in order of appearance in the reference section

Cylinder filling:

- filling;
- sampling and analysis.

Storage:

- product storage;
- underground storage.

General:

- packaging;
- vehicle washing;
- oil;
- polychlorinated biphenyl's (PCB);
- insulation material;
- silica gel;
- electrical and electronic equipment;
- ozone depleting substances and fluorinated gases – air conditioning equipment;
- abatement systems.

Employees and contractors should have site-specific briefing information covering these areas.

4.3 Waste and emissions from a cylinder filling plant

Different types of waste streams, which are to be recycled, recovered, reused or treated, should be separated according to their type and the treatment they will receive and stored safely and securely for transportation. The suppliers of the product or materials should be contacted so that they can take back any residuals. The containers should be suitable for transportation and clearly labelled in accordance with the national regulation. Any liquid should be provided with some means of secondary containment to the capacity of 110% of the largest container (or 25% of the total volume of all containers, whichever is greater).

4.4 Cylinder preparation

4.4.1 Residual gases and liquids

Cylinders that are returned to the filling plant will typically have small quantities of residual gas in them. This should be reused or recycled if technically and economically feasible and if it is not contaminated with other products. If it is not possible to reuse or recycle the residual gases, they should be disposed of correctly and in line with applicable national and international regulations. In any event, the EIGA Doc 30, *Disposal of Gases* [2] can be consulted for advice on disposal methods. Wherever possible, product should be recovered and reused.

4.4.2 Purge gases

The amount of purge gas should be kept to a minimum to avoid wastage; although these purge gases themselves are not harmful to the environment this is to avoid a waste of energy. Nevertheless, purging gases might bring a noise nuisance if no silencer is used, see Section 4.5.2. The re-use of purge gas should be considered, e.g. high purity helium re-used as balloon gas.

4.4.3 Testing and maintenance of cylinders

Gas cylinders are reusable high integrity pressure vessels that are subject to periodic re-qualification.

4.4.4 Water from cylinder testing

This testing may be hydrostatic. Steps should be taken to ensure the water use is kept to a minimum and reused or recycled. As long as the water does not contain any impurities, it may be allowed to drain into the sewage water system. For hydrocarbon products, special attention should be given to collection of the water. In accordance with national regulations a permit or consent may be necessary. Attention must be given to the water discharge network to ensure these are up to date and all discharge points are known.

4.4.5 End of life cylinders

Gas cylinders that are no longer suitable for use should be recycled for the metal content. They must be rendered unfit for use before disposal so that no pressurised cylinders are sent for waste. Some gas cylinders whose content cannot be completely eliminated, such as acetylene and some toxic gases, may be regarded as hazardous waste. See [2], EIGA Doc 05, *Guidelines for Management of Waste Acetylene Cylinders* [3] and EIGA Doc 166, *Guidelines on Management of Waste Gas Cylinders* [4].

4.4.6 Other end of life metals

Items such as valves, regulators, valve guards, dip tubes, metal pallets, etc. may have to be disposed of when worn out. They should be rendered unfit for use before disposal. These items need to be replaced on a regular basis. Steel, copper and non-ferrous metals should be separated and sent to a specialist dealer for recycling. Contaminated items should be disposed of as hazardous waste through an authorised contractor.

4.4.7 Synthetic materials

Items such as plastic guards, plastic valve caps, valve parts and polytetrafluoroethylene (PTFE) tape should be collected separately for recycling, where there is a specialised company to do this. Otherwise, they can be placed with non-hazardous general waste. Contaminated items will have to be disposed of as hazardous waste through an authorised contractor.

4.4.8 Gaskets

Some valve materials and gaskets are manufactured with hazardous materials. These should be handled as explained in the SDS for the material.

4.4.9 Cleaning

In some cases cylinders or cylinder equipment will need to be cleaned internally or externally, and/or prepared for painting. There are a number of waste streams that may arise from this process, such as wash water, residuals from shot blasting and solvents, as described in the following.

4.4.9.1 Solvents

Some solvents used for cleaning and degreasing are sources of emissions, for example, volatile organic compounds (VOC) and ozone depleting substances (ODS). Without proper control they can cause atmospheric emissions that may contribute to poor local air quality, depletion of the ozone layer or global warming. It is recommended that:

- a policy is developed and an action plan is implemented to reduce the use of such products containing VOC, ODS or greenhouse gases (GHG), for example, by introducing new products or new technology;

- excess use of solvents is avoided and work practices are regularly reviewed to minimise emissions;

- all waste and used solvent is collected and returned to the supplier for recycling or reuse and is *never* disposed of into the drains or directly to the ground. If it cannot be reused it should be disposed of by a certified waste disposal company;

- leaks and spills of solvent must be cleaned up.

More details can be found in EIGA Doc 33, *Cleaning of Equipment for Oxygen Service* [5] and EIGA Doc 106, *Environmental Issues Guide* [6].

4.4.9.2 Shot blast and dust

If cylinders need to be shot blasted, measures need to be taken to minimise and control the dust to prevent any environmental nuisance.

As a preference, metal shot should be sent for recovery. If it is not possible to recover the waste shot and dust it should be disposed of as non-hazardous waste. If the shot blast waste contains significant quantities of pollutants (for example, lead or zinc) this will need to be disposed of as hazardous waste by a certified waste disposal company in line with local or national regulations.

4.4.10 Oil and water mixtures

Oil and water mixtures have to be disposed of in accordance with applicable local or national regulations. The oil and water may need to be separated if required. Sometimes it may be possible to dispose of water-soluble emulsions by draining into a suitable sewage water drainage system, equipped with an oil separator.

4.4.11 Other cleaning agents

Acids, alkalis or other cleaning agents should be disposed of in line with local or national regulations and never directly into the drainage system. For the disposal of detergent cleaners, see Section 4.7.2.

4.4.12 Drying

Cylinders may be baked or further purged to dry them before filling. These systems need to be designed to optimise the use of energy and minimise the waste of purge gases.

4.4.13 Painting and labelling

4.4.13.1 Paint and thinners

Some paints and thinners can be sources of VOC. It is recommended that excess use of paint is avoided and work practices regularly reviewed. Consideration should be given to using paints that are less harmful, both to the environment and the health of employees (for example, water based or lead free). Where possible, paint should be supplied in returnable containers.

Waste paint (solid or liquid) is treated as hazardous waste and shall be disposed of in accordance with national regulations by certified waste disposal companies.

When using powder painting, filter systems must be used to minimise the effect on workers.

Also surplus powder may be recycled, e.g. to paint the base of cylinders where colour is irrelevant.

4.4.13.2 Labels

These may be disposed of along with the non-hazardous waste.

4.4.14 Valving

Valves and other consumables that need replacing should be disposed of as scrap metal, see Section 4.4.6.

4.5 Cylinder filling

4.5.1 Filling process

4.5.1.1 Product

Product should be reused or recycled if technically and economically feasible. For the correct disposal of product, see Section 4.4.1.

4.5.1.2 Disposal systems

Many disposal systems (for example, scrubber systems) use acids or alkalis to clean or to absorb the waste gases. These solutions should be disposed of as hazardous waste by certified waste disposal contractors in line with national regulations. It is important to monitor disposal systems and keep them well maintained so that they remain effective at preventing harmful or nuisance (for example, odour) emissions.

Scrubber systems often contain absorbent or packing material. This should be reused or recycled if technically and economically feasible and if it is not contaminated with other products. Waste absorbent material must be correctly packaged to prevent degassing or other hazards. Otherwise it is treated as hazardous waste and should be disposed of in accordance with national regulations by certified waste disposal companies.

4.5.2 Noise

The venting of product in normal or abnormal operations may give rise to environmental nuisance. This can often be eliminated by simple techniques such as use of a silencer or screen, or by eliminating the need to vent the product. Regular noise surveys are recommended to ensure compliance with applicable legislation.

The main sources of noise on a cylinder filling plant are:

- venting of residual gases;
- delivery vehicles and fork lift trucks (FLTs);
- manual or mechanical handling of the cylinders; and
- activation of a safety relief device.
- reciprocating pumps

The EIGA Doc 85, *Noise Management* [7] gives a comprehensive review of noise management and the actions that should be considered.

4.5.3 Sampling and analysis

4.5.3.1 Batteries and electric cells

Most of these contain hazardous compounds. According to the type and composition, these should be either:

- returned to the supplier for recycling; or
- disposed of by certified waste disposal companies.

4.5.3.2 Cartridges and consumables

Any cartridges or consumables should be treated in the same way as scrubber absorbent or packing, see Section 4.5.1.2.

4.5.3.3 Laboratory chemicals and gases

Excess use of chemicals should be avoided and work practices regularly reviewed. For the treatment of waste gases, see Section 4.5.1.1. Waste from the laboratory may not be the same as from production

and separate treatment may be necessary. Particular attention must be given to speciality and analytical gases.

Waste and used chemicals, and their packaging, should be collected and returned to the supplier for recycling or reuse, and *never* be disposed of into the drains. If they cannot be reused, these products shall be sent to a certified waste disposal company for disposal.

4.5.3.4 Mercury and heavy metals

Some measurement and calibration apparatus contains biotoxic metals (for example mercury, lead, cadmium and their compounds). These shall be disposed of by certified waste disposal companies and should be kept in designated containment during storage and hand-over to the disposal company.

4.6 Storage

4.6.1 Product storage

The product storage system should be designed to minimise product losses. Any losses should be handled as described in Section 4.4.1.

4.6.2 Tanks and drums

Any tanks or drums that have contained product should be treated in the same way as cylinders i.e. returned for reuse, recycled or properly disposed of. If they have been contaminated by hazardous waste, they shall be disposed of through an authorised contractor.

4.6.2.1 Maintenance

Table 1 shows the waste streams produced during the routine maintenance of storage facilities

Table 1—Waste classification and disposal

Typical waste	Causes of waste generation	Possible ways to reduce amount of generated waste	How to dispose of waste
Product	Residuals in cylinders Losses during filling Losses from storage Speciality gases (calibration and purge gases)	Reuse or recycle product Design to reduce losses Proper maintenance of scrubbing equipment	EIGA Doc 30, Disposal of Gases [2]
Waste water	Detergent from vehicle washing Oil from equipment	Do not mix oil and detergent Improved maintenance	Discharge to sewage system under local approval
Scrap metal	Cylinders, valves guards, dip tubes, metal pallets, drums	Maintain to extend the lifetime	
Chemicals	Spent scrubber solution Lab chemicals Cleaning and de-greasing	Avoid excess use Review of procedures	Send for recycling or disposal by certified contractor
Packaging	Boxes and cylinder pallets	Reuse on plant	Send to recycling, reuse
Solvents	Cleaning and degreasing, paint thinners	Avoid excess use Review of procedures	Disposal by certified contractor
Dust and shot blast	Cylinder preparation	Control use	Disposal by certified contractor
Oil	Vacuum pumps Mechanical equipment	Improved maintenance	Send for recycling or fuel use or disposal by certified contractor
Noise	Product venting Vehicles	Improved system design	
Odour	Product	Maintenance of disposal systems	EIGA Doc 30, Disposal Of Gases [2]
Silica gel	Dessicant		

Typical waste	Causes of waste generation	Possible ways to reduce amount of generated waste	How to dispose of waste
Paint	Maintenance of cylinders and equipment	Avoid excess use Use lead free or water based	Disposal by certified contractor
Plastic	Packaging (shrink wrap, bags) PTFE tape		Send for re cycling or disposal by certified contractor
Labels			
Batteries/electric cells		Use non-toxic alternatives	Disposal by certified contractor
Cartridges/ consumables		Use more efficient cartridges Run equipment efficiently	Disposal by certified contractor
Insulation material	Maintenance and modifications		Return to the supplier or landfill disposal by certified contractor. Special precautions needed for disposal of asbestos
Adsorbent material/scrubber packing	Ageing	Use more efficient adsorbents Run equipment efficiently	Return to supplier for recycling or reuse or disposal by certified contractor

4.6.2.2 Cooling media

Several kinds of cooling media may be in use. In the case of coolants that are liquid at normal pressures (for example, ethylene glycol) care must be taken during operation and maintenance to prevent any spillages or discharges into water.

For other refrigerants like HFC and Ammonia, leaks should be prevented by careful maintenance. For CFC (if any), HCFC (R-22), or HFC (F gas) maintenance needs to be done by authorised contractors, see EIGA Doc 192, *Fluorinated Gases Management* [8].

4.6.2.3 Underground storage

Underground storage tanks (UST) could be sources of soil and groundwater contamination through leakage and spillage. The condition of USTs should be monitored regularly and a routine maintenance programme established. If a tank has been leaking then immediate action should be taken.

Any unused tanks should be removed or cleaned, emptied and filled with sand [6].

4.6.2.4 Above ground storage tanks

Above ground storage tanks also risk contamination of soil and water if the tank starts to leak. However, the control of tank leakage is less complicated than for underground tanks. Even a dripping valve could easily contaminate several cubic meters of soil. Spill plates should be used.

Large storage tanks are frequently used for fuel while smaller ones could contain oil, antifreeze and other substances. The importance of avoiding spills and correct labelling of tanks is similar regardless of tank size [6].

4.6.2.5 All tanks

All tanks must be fit for purpose to the appropriate national or international standard. Correct maintenance and painting gives a positive visible image of the gas industry.

When filling a tank, the operator/driver shall attend the filling at all times. By installing overfill alarms, the risk of a major spill could be further reduced. Minor spills could occur when filling or emptying the tank and proper precautions, such as using spill plates over drains, should be taken to avoid any environmental damage caused by this.

4.7 General

4.7.1 Packaging

Wooden crates and cardboard boxes should be reused or recycled. If this is not possible, they should be disposed of as non-hazardous waste and sent for incineration with energy recovery. Suppliers should be encouraged to eliminate unnecessary packaging or reuse it.

4.7.2 Vehicle washing

Detergent from vehicle washing should be directed to the sewer, but precautions should be taken to prevent oil and debris entering drains (for example, the provision of an interceptor). In accordance with national regulations, a permit or consent may be necessary. It is important that water containing detergent is not directed to any oil/water separating system. This is because it will prevent the correct functioning of such a system.

4.7.3 Oil

Oil binders and oily cloths should be recycled or disposed of as hazardous waste by a certified contractor. There are different points of discharge:

- oil from vacuum pumps due to leaks, vapour emission, cleaning;
- oil from other machinery and vehicles (for example, FLTs);
- oil from transformers.

Improving maintenance of the vacuum pumps (and also a better design) can reduce waste from these sources. Recommendations for control and disposal are the following:

- precautions must be taken to prevent oil from entering drainage systems, watercourses and soil;
- oil must never be mixed with other substances, for example water, soil, solvents. Different types of oil must always be collected separately in barrels or drums and be delivered for recycling;
- a bund (or pit) on each compressor or transformer installation should be installed to collect the potential leaks and purges. The size of the bund should be equal to 110% of the largest equipment of the installation;
- oil barrels or drums should be stored in a bunded area, or on a bunded pallet or catch pot, and wherever possible protected against rainfall. The size of the bund should be equal to 110% of the largest container.

4.7.4 Polychlorinated biphenyls

PCBs are toxic and carcinogenic substances, and their use has been phased out in accordance with prevailing legislation [6].

If transformers and capacitors with PCB (or equivalent substances) are present, they should be labelled accordingly and a programme agreed for their removal. Disposal of this product and any material that is contaminated by PCB (for example, rags, absorbent material) should be controlled by national or local regulations.

PCB or PCB contaminated materials have to be collected into suitable sealed containers, labelled, and then recovered and treated by certified waste disposal companies.

4.7.5 Insulation and asbestos containing materials

This should not be removed unless necessary. Non-hazardous insulation material should be returned to the supplier or disposed of by a certified waste disposal company.

Material containing asbestos shall be identified. When removing this, special precautions and controls are required as specified by national regulations. This will normally involve the use of a specialist

contractor. Material shall be disposed of by a certified waste disposal company and handled in such a way as to prevent the release of asbestos fibres. This may include 'double' bags, or wetting the material.

The disposal of material or equipment containing asbestos has to be tracked in detail.

4.7.6 Silica gel

This is often used as a desiccant and should be sent to a specialist company for regeneration and reuse.

4.7.7 Electronic equipment

This should be returned to the supplier for reuse or recycling where possible. If the equipment contains toxic materials, it should be disposed of as hazardous waste through an authorised contractor.

4.7.8 Emergency plan and response

The gas company employees and contractors must be aware of the site emergency plans, and be trained and competent in the requirements. The emergency plan should contain the following:

- actions in the event of environmental events such as major leakage of chemicals or oil;
- the location of absorption material to clean up spills on the floor/ground;
- actions in the event of fire and/or explosion;
- actions to contain contaminated fire water run off;
- action in the event of dispersal of hazardous materials for example, asbestos;
- action in the event of toxic or flammable gas releases;
- action in the event of severe weather, flooding and other natural causes.

The emergency plan should be regularly tested with drills, simulations etc..

5 References

Unless otherwise specified, the latest edition shall apply.

[1] ISO 14001 *Environmental Management System* www.iso.org

[2] EIGA Doc 30, *Disposal of Gases* www.eiga.eu

[3] EIGA Doc 05, *Guidelines for Management of Waste Acetylene Cylinders* www.eiga.eu

[4] EIGA Doc 166, *Guidelines on Management of Waste Gas Cylinders* www.eiga.eu

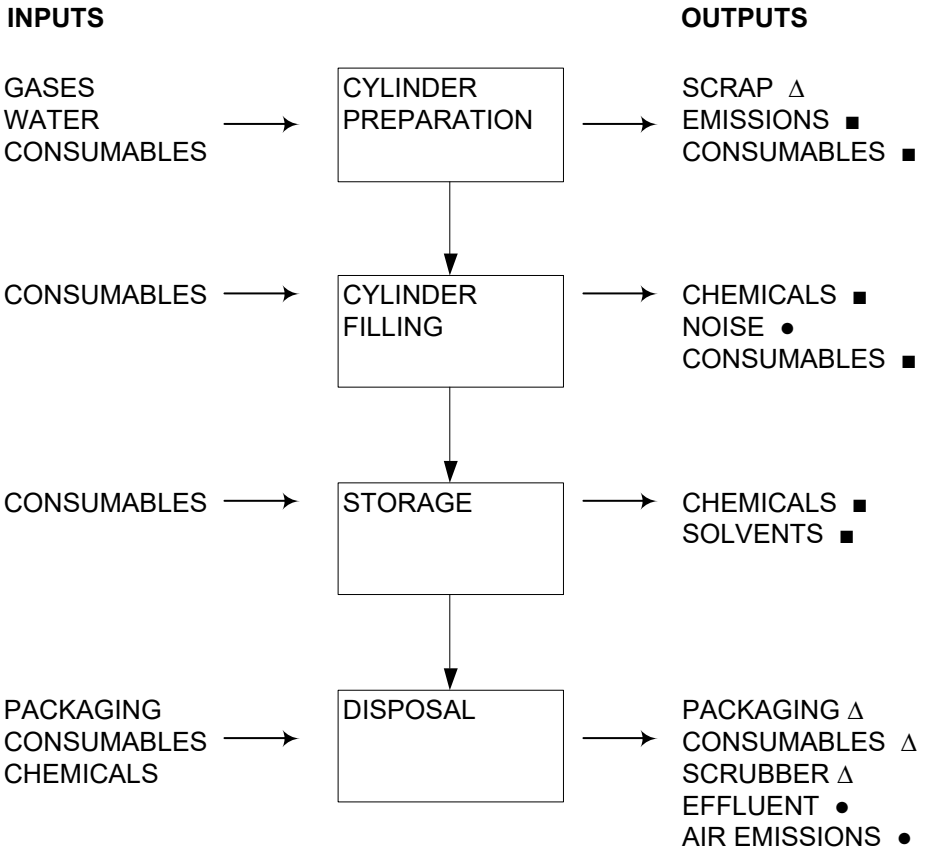
[5] EIGA Doc 33, *Cleaning of Equipment for Oxygen Service* www.eiga.eu

[6] EIGA Doc 106, *Environmental Issues Guide* www.eiga.eu

[7] EIGA Doc 85, *Noise Management* www.eiga.eu

[8] EIGA 192, *Fluorinated Gases Management* www.eiga.eu

Appendix A—Environmental impact cylinder filling operations (Informative)



Appendix B—EIGA Document links to ISO 14001
(Informative)

Doc No	Title of EIGA Document	ISO 14001:2015 SECTIONS	Clause
107	Guidelines on Environmental Management Systems [1)]	Context of the organization	4
		Understanding the organization and its context	4.1
		Understanding the needs and expectations of interested parties	4.2
		Determining the scope of the environmental management	4.3
		Environmental management system	4.4
		Leadership	5
		Leadership and commitment	5.1
		Policy	5.2
		Organization roles, responsibilities and authorities	5.3
		Planning	6
		Actions to address risks and opportunities	6.1
		General	6.1.1
106	Environmental Issues Guide [1)]	Environmental aspects	6.1.2
108	Environmental Legislation Applicable to Industrial Gases Operations within the EU [1)]	Legal requirements and voluntary obligations	6.1.3
		Environmental objectives and planning to achieve them	6.2
		Environmental objectives	6.2.1
		Environmental improvement programs	6.2.2
		Support	7
		Resources	7.1
		Competence	7.2
		Awareness	7.3
		Communication	7.4
		General	7.4.1
		Internal communication	7..4.2
		External communication and reporting	7.4.3
		Documented information	7.5
		General	7.5.1
		Creating and updating	7.5.2
		Control of documented information	7.5.3
88	Good Environmental Management Practices for the Industrial Gas Industry [1) and 2)]	Operation	8
30	Disposal of Gases		
85	Noise Management for The Industrial Gases Industry [1)]		
109	Environmental Impacts of Acetylene Plants		

Doc No	Title of EIGA Document	ISO 14001:2015 SECTIONS	Clause
84	Calculation of Air Emissions from Acetylene Plants		
05	Guidelines for the Management of Waste Acetylene Cylinders		
166	Guidelines on Management of Gas Cylinders		
94	Environmental Impacts of Air Separation Units		
110	Environmental Impacts of Cylinder Filling Plants	Operational planning and control	8.1
117	Environmental Impacts of Customer Installations		
101	The Carbon Dioxide Industry and the Environment		
106	Environmental Issues Guide		
111	Environmental Impacts of Carbon Dioxide and Dry Ice Production [2)]		
122	Environ. Impacts of Hydrogen Plants		
112	Environ. Impacts of Nitrous Oxide Plants		
113	Environmental Impacts of Transportation of Gases		
137	Environmental Aspects of Decommissioning		
		Value chain planning and control	8.2
		Emergency preparedness and response	8.3
		Performance evaluation	9
		Monitoring, measurement, analysis and evaluation	9.1
		General	9.1.1
		Evaluation of compliance	9.1.2
135	Environmental Auditing Guide [1)]	Internal audit	9.2
		Management review	9.3
		Improvement	10
		Nonconformity and corrective action	10.1
		Continual improvement	10.2

NOTES

1 Specific document relevant to CO_2 and dry ice.

2 General document useful to CO_2 and dry ice.