ENVIRONMENTAL IMPACTS OF AIR SEPARATION UNITS

Doc 94/17

Revision of Doc 94/11

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL

AVENUE DES ARTS 3-5 • B – 1210 BRUSSELS
Tel: +32 2 217 70 98 • Fax: +32 2 219 85 14
E-mail: info@eiga.eu • Internet: www.eiga.eu

ENVIRONMENTAL IMPACTS OF AIR SEPARATION UNITS

Prepared by WG-5 Environment

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL
Avenue des Arts 3-5 B 1210 Brussels Tel +32 2 217 70 98 Fax +32 2 219 85 14
E-mail: info@eiga.eu Internet: www.eiga.eu

Table of Contents

<u>Amendments to 94/11</u>

Section	Change
All	Updated references to ISO 14001 - 2015 Environmental management systems
All	Updated to latest EIGA style for format and content.
3.1	Publications terminology added

Technical changes to last version are underlined.

1 Introduction

This publication details the environmental impacts of air separation units (ASU) and gives guidelines on how to reduce the impacts.

2 Scope and purpose

2.1 Scope

The publication concentrates on the environmental impacts of cryogenic ASUs. This publication does not give specific advice on health and safety issues, which shall be taken into account before undertaking any activity. On these issues the relevant EIGA documents, and or national legislation should be consulted for advice.

2.2 Purpose

This publication is intended to serve as a guide to assist in putting in place a formal environmental management system that can be certified by an accredited third party verifier. It also aims to provide a guide for operating managers for identifying and reducing the environmental impacts of these operations.

3 Definitions

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.

3.1.2.1 May and need not

Indicate that the procedure is optional.

3.1.3 Will

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

3.1.4 Can

Indicates a possibility or ability.

3.2 Technical definition

3.2.1 Environmental aspect

Elements of an organisation's activities, products or services that can interact with the environment. For example: use of energy or transportation of products.

3.2.2 Environmental impact

<u>Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's environmental aspects. (Source: ISO 14001:2015 *Environmental Management Systems*</u>

- *Requirements with guidance for use* [1] [1]). For example, the contamination of water with hazardous substances or the reduction of air emissions.

4 Air Separation Unit

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

This publication covers the environmental impacts of ASUs which are summarised in Appendix 3.

There are several EIGA publications that provide more details on general environmental issues, legislation for the gas industry and good environmental operational practices e.g. EIGA Doc 88 *Good Environmental Management Practices for the Industrial Gas Industry* [2]. A list of documents and their links to the ISO 14001 environmental management systems standard is provided in Appendix 1. Appendix 1 also shows which of these documents are relevant to ASUs.

4.2 Introduction

4.2.1 Production methods

Industrial gases are generally produced as close as technically and economically possible to the customer. This helps to minimise the impacts of transportation.

Gas (in liquid or gaseous form) can be transported by pipeline, road, rail or sea. Pipeline transportation from on or off-site gas generators avoid many of the environmental impacts, though the pipeline occupies land resources and there are compression losses.

The advent of small non-cryogenic gas generators has led to an increase in the gas generated on the customer site. This avoids the environmental impacts of transporting the gas in liquid form and vaporizing it.

4.2.2 Design, planning and control

The basic philosophy is the minimisation of environmental impacts. By considering the potential wastes which a new process could generate when engineering a plant, future problems can be avoided. This environmental analysis is a crucial element of environmental impact assessment that is strongly recommended before any decision of an industrial investment.

Eliminating or minimising waste generated in ASUs is the first rule to follow; for this reason, it is necessary to stress the importance of minimisation during the stages of plant engineering and of plant operation.

Waste should not be mixed but collected separately to aid further recycling reuse or recovery.

Safety data sheets for all chemical substances should be held on site and used to determine the best way to handle the chemical substances.

4.2.3 Environmental impact of an ASU

These units have a minimal direct impact on the environment because of the inherent nature of the processes used in ASUs.

Gases produced by ASUs have a positive impact on the environment thanks to the reduction of the environmental load when replacing a non-gas process with a process using gases. There is a very high number of successful gas applications that gives the customer an improved economical result and at the same time decreased emissions, increased recycling of material, reduced consumption of energy or water, and other environmental benefits.

The production of atmospheric gases from ASUs uses one of three technologies:

- cryogenic air separation;
- adsorption in pressure swing or vacuum swing absorber (PSA/VSA) units, and

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

- diffusion in membrane units.

The three air separation processes have many common characteristics:

- they use air as a feedstock;
- they are physical processes - no chemical reactions are involved;
- compressors and/or blowers are used to drive the separation and provide products at pressure;
- the products are consistently high quality and contain no unwanted contaminants; and
- only materials originally present in the air could end up in the waste gas streams (purges and vents).

Cryogenic air separation is the most used and the oldest technology, and this publication therefore concentrates on the impacts of cryogenic air separation. Appendix 2 shows a typical air separation scheme and Appendix 3 a process mapping of the wastes and emissions.

4.3 Main environmental impacts of the process

4.3.1 Principal impacts

The principal impacts, either by amount or by potential consequences on the environment are:

- use of energy in the compression;
- use of water for cooling;
- use of oil;
- historical use of polychlorinated biphenyl (PCB) or other equivalent substances;
- emissions of volatile organic compounds (VOC): hydrochlorofluorocarbons (HCFC), chlorofluorocarbons (CFC), hydrofluorocarbons (HFC), chlorinated solvents during maintenance or accidentally from the chillers; and
- discharges of contaminated water;
- noise and vibration
- waste from maintenance.

4.3.2 Air intake

4.3.2.1 Air emissions

The only air emissions resulting from any of the air separation processes are air gases and impurities in the air returned to the air. In some instances, a small amount of natural gas or electricity, is used in cryogenic plants to provide heat for regenerating pre-purifiers. Very low-levels of air emissions result. However, accidental spills and releases of hazardous products could need to be reported to the authorities, depending on the national regulations.

In the case where back up vaporisation systems use fired heaters there are combustion emissions and these heaters may also need to have specific permits and monitoring, depending on national regulations.

4.3.2.2 Air filters

Air filters are likely to be contaminated by air borne pollutants. Used filters should be disposed of at authorised facilities.

4.3.3 Compression

4.3.3.1 Energy

Cryogenic air separation is an energy intensive process; to typically produce one cubic metre of liquid nitrogen or oxygen in a cryogenic air separation unit requires approximately 1 kWh/m3. While a non-cryogenic on-site unit requires less energy per unit it is not suitable for some applications as it does not produce liquid and it cannot match the purity of gas from cryogenic separation.

Most of this energy is used to compress the incoming air stream. This high-energy use results in an indirect environmental impact from the power production process.

Competitive pressures and environmental concerns have resulted in a continuous improvement in the energy efficiency of ASUs through process innovation, equipment design, maintenance and efficient operating practices.

In addition, increasing integration with the energy systems of the customer and improvements in power plant performance and the increase of the quantity of electricity coming from renewable sources have considerably reduced this indirect impact.

4.3.3.2 Noise - vibrations

The main sources of external noise at a gas production site are:

- compressors and other process equipment at the air separation unit;
- stationary or mobile pumps on tank trailers for the liquid gases;
- venting of tanks or trailers;
- exceptional venting of high pressure overproduction;
- noise generated in the cooling towers and
- noise is also generated by gases moving at high velocity though pipework.

The EIGA Doc 85 *Noise Management for the Industrial Gases Industry* [3] is a review of noise management and the actions which should be considered. To be able to prioritise, it is highly recommended to start with making an inventory of the sound levels from the different operations and in different areas including the site boundaries. Noise can be considered as an environmental nuisance and can often be reduced by applying simple techniques (silencers or screens for instance).

To reduce the noise at the ASU the following should be considered:

- when purchasing or designing machinery and equipment (i.e. valves), the sound levels shall be considered. The additional cost of choosing equipment with a comparable low sound level is low at this stage. Reducing the sound emission is much more expensive after plant completion. Also consider the Machinery Directive Reference? where the basic safety and health requirements are established including sound levels;
- drive vehicles and operate equipment to minimise sound generation, and
- the plant lay-out should be established considering the possibility to minimise sound generation and the sound level at the site boundary, especially adjacent to sensitive areas.

Vibrations are generated by compressors and transmitted to surroundings. Specific civil work requirements could be needed.

In general the vibration impact can be considered as very low.

4.3.3.3 Oil

There are different points of oil discharge:

- from the compressors, due to: leaks, vapour emission, cleaning;
- from hydraulic systems, due to leaks; and
- from transformers, due to leaks.

Improvement in design and maintenance of the compressors can reduce these waste sources.:

- on no account should oil be allowed to enter the drainage system from normal operations. If some oil is mixed with water (cleaning or rain water for instance) separate the oil from the water before disposing of the water to the drainage system (see water treatment paragraph 4.3.4.1);

- install a bund (or pit) at each compressor or transformer installation to collect the oil from leaks and purges;
- do not mix different types of oil waste, keep them by type, and label appropriately;
- return the collected waste-oil to the supplier or to a specialised company, for treatment or recycling; and
- prevent inhalation of oil vapours by the operators. Generally, vapour emission is low due to proper cyclone and/or electrostatic demisters. In some cases, vapour emission can be avoided by cooling.

4.3.4 Cooling

4.3.4.1 Cooling water

Specific attention shall be given to the water discharge network, and associated liquid effluents.

For example:

- cleaning water (detergent, oil);
- cooling water and cooling tower blow-down;
- condensates;
- rain water;
- domestic water;
- water treatment chemicals and sludges from cooling tower or oily water separator, and
- emergency firefighting water.

The table below provides some ideas for best practice for activities that use significant quantities of water in ASU processes.

Activity using water	Examples of best practice solutions to minimise water usage and waste water
Make up water (Boiler)	• Avoid excessive chemical feed through control of water chemistry. • Consider using automatic blow down equipment (changing from manual to automatic can reduce boiler energy use by 2 – 5% and reduce blow down losses by up to 20%). • Consider improvements to water quality for feed water to reduce blow down rates.
Make up water (Cooling tower and systems)	• Minimize leaks through preventive maintenance (check for excessive drift and splash). • Reduce controlled losses (e.g. look at bleed losses, concentration cycles). • Maintain proper level of corrosion inhibitors to extend life of equipment. • Ensure all float valves are set within operating ranges. • Investigate fitting variable speed drive motors to cooling tower fans so that cooling system is better matched to system heat load.
Blow down (Cooling tower and process boiler)	• Run cooling tower/boiler at optimum concentration cycles to minimize chemical loss, wastewater discharges, and makeup water consumption. • Purchase water treatment chemicals in bulk or returnable containers instead of drums, where practical.

All the wastewater streams shall be clearly identified and kept separate if possible to aid treatment.

Condensed water from air is usually acidic and can contain metals leaching from piping and solder. In locations where extremely low temperature is possible, cooling towers may not be permitted due to possible black ice formation on near-by roads in winter from water moisture in the forced air of the cooling tower.

Recycled cooling water usually contains chemical treatment products used as biocides and to control corrosion. These include chlorides, phosphonates, polyacrylates, zinc, etc. Some of these chemicals are strictly regulated, because of their bio-toxicity. They can enter the drainage system when the cooling circuit is purged. The use of chromates in new systems is not recommended because of their eco toxicity. Cooling water can also contain glycol compounds to prevent freezing in case of very low outside temperature.

Cleaning water can contain solid particles and dust.

The recommendations for cooling water and cooling water chemicals are the following:

- water should be of suitable quality;
- use water treatment chemicals that do not harm the environment e.g. those that do not contain chromates or mercury;
- use the minimum quantity of treatment chemicals necessary to achieve adequate system protection and to make sure that the quality of the discharge complies with local and national regulation limit values; and
- use monitoring and measurement to optimize the water treatment regime and minimise the use of chemicals

A permit from the authorities is normally needed to regulate such discharges and this permit could cover:

- temperature of discharge: the water temperature increase is typically around 6 to 10°C;
- pH of discharge; and
- concentration of chromate and chromite or other chemicals or metals.

Consequently, water could need to be neutralised before discharge and discharges of chromate, solids and oil should be removed from water before discharging it into the sewage system. Decanting and filtration may be used to improve the water quality before discharge.

Authorities can also require specific monitoring for Legionella hazard, related to aerosols drifting outside the ASU premises. This could include periodic water sampling and Legionella analysis, risk assessment study and/or periodic cleaning of the whole water network (see EIGA Environmental Newsletter, ENL 04 *Legionella* [4]).

Ozone can be used as biocide. It should be dosed carefully to prevent ozone out take on the top of the cooling tower.

4.3.5 Refrigeration unit

4.3.5.1 Volatile Organic Compounds (VOC)

HCFC, fluorinated gases and chlorinated solvents can be used as cooling liquids and as solvents. These products are volatile compounds and without proper control part of them may 'disappear' as emissions to the atmosphere.

Some halocarbons have ecological consequences, such as damage to the ozone layer. Some of them will be banned from the market, according to the Montreal protocol and EU regulations, and the suppliers will propose in some cases less hazardous substitutes. Details can be found in EIGA Doc. 106 *Environmental Issues Guide* [5] and in EIGA Doc. 192 *Fluorinated Gases Management (under revised Regulation 517/2014)* [6]

The recommendations are the following:

- refrigerant choice – work with suppliers to use refrigerants with no ozone depleting potential and/or lower Global Warming Potential, in line with the legislation;

- identify all the points on the refrigeration units where leaks can occur ; check there is no leak and eliminate any leaks found; install hermetically sealed units; collect and label all waste and used liquid solvent and return to the supplier for recycling or reuse;
- consider recovering solvent and refrigerant for recycling, and
- avoid excess use of solvent and review working practices and behaviours where solvent is used (for oxygen cleaning see EIGA Doc 33 *Cleaning of equipment for oxygen service. Guideline* [7]).

4.3.5.2 Ammonia

Ammonia can be used as refrigerant. It has no effect on the ozone layer nor on climate change. Related to its health hazard (it is classified as toxic), specific safety requirements have to be applied to prevent any leakage / spillage: for example, gas detectors in closed rooms, secondary containment under the whole installation where liquefied ammonia is present, appropriate emergency procedures and equipment.

4.3.6 Maintenance and waste

4.3.6.1 Regular maintenance

Regular maintenance is vital to keep the plant running as efficiently as possible. The change of consumables and servicing of equipment does generate some wastes, which are detailed below.

4.3.6.2 Consumables

The storage of consumables should be reviewed to minimize the quantity of substances, spare parts, etc. used and stored at the site. It is recommended to:

- have weather protection and secondary containment for storage of large volumes of oil, organic solvents or other hazardous substances;
- have absorption material available to clean spill on the floor; and
- include response to environmental events such as major leakage of oil in the emergency plan.

Safety Data Sheets shall be available for all chemical substances at the site and storage areas and vessels shall be properly labelled and the environmental recommendation shall be reviewed and followed.

4.3.6.3 Polychlorinated biphenyls (PCB)

PCBs are toxic and carcinogenic substances, and their use has been phased out in accordance with prevailing legislation, see EIGA Doc 106 *Environmental Issues Guide* [5] for more details.

If transformers and capacitors with PCB (or equivalent substances) are present, they shall 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 and so on) is controlled by national or local regulations.

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

Persons handling PCB's are required to be equipped with personal safety equipment, depending on the national regulations. These persons could require medical surveillance.

4.3.6.4 Catalysts

If catalysts are used, they usually contain biologically hazardous metal substances and shall be either recycled by returning to the supplier or disposed of by certified waste disposal companies.

4.3.6.5 Batteries and electrical cells

Most batteries and electrical cells contain hazardous compounds. According to the kind of chemicals and composition, they shall either be:

- preferably returned to supplier for recycling, or

- disposed of by certified waste disposal companies.

4.3.6.6 Metal waste

Biologically hazardous metal substances wastes (for example mercury, cadmium, lead and their compounds) are strictly regulated and shall be disposed of by certified waste disposal companies.

Scrapped metals should be segregated into ferrous and non-ferrous and recycled.

4.3.6.7 Insulation material

Non-hazardous recovered insulation material shall be returned to the supplier or disposed of by certified waste disposal companies.

Insulation material containing asbestos shall be identified and location recorded. When removing this material, precautions and control shall be taken, according to hazard of the product and the local or national regulation. Material shall be disposed of by a certified waste disposal company and handled in such a way to prevent release of asbestos fibres; this may include enclosing in a sealed bag, or wetting the material.

In the disposal of Rockwool®, the possibility of this exhibiting natural radioactivity should be considered.

Care should be taken when undertaking maintenance activities so that there is no release of perlite due to pressure changes in the cold box. See EIGA Doc. 146 *Perlite Management* [8].

As a general rule, do not remove insulation materials, unless strictly necessary.

4.3.6.8 Silica gel / Alumina gel / Molecular sieve

Used gel or molecular sieve should be checked for oil or other contamination. Uncontaminated absorbent can be disposed of as non-hazardous waste. Consideration should be given to return it to the supplier.

4.3.7 Storage

4.3.7.1 Waste storage

All waste which will be recovered, recycled or treated by a specialized company, or which will be disposed of at authorized facilities shall be stored and transported by authorized transporters in suitable containers clearly labelled to identify the composition of the waste. Liquid waste storage facilities should be bunded to a capacity capable of safely containing at least the 110% contents of the largest single container.

Different kinds of waste shall not be mixed but shall be separated in different containers according to their type and the treatment they will receive.

The waste storage i shall be organized so that there is no risk of mixing the containers (separations in specific area, marking, records etc).

4.3.7.2 Underground storage tanks (UST)

UST could be sources of soil and groundwater contamination through leakage and spillage. If a tank has been leaking, then immediate action shall be taken.

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

Use of underground storage tanks should be avoided on new facilities. More details can be found in the EIGA Doc. 106 [5]. Where it is necessary to have a UST, double skinned tanks should be used. The condition of USTs should be monitored regularly and a routine maintenance programme established.

4.3.7.3 Above ground storage tanks

Large volume storage tanks are frequently used for fuel while smaller volume tanks typically contain oil, antifreeze and other substances.

The presence of above ground storage tanks entails a potential risk of contamination of soil and water if the tank starts to leak, but the control of tank leakage is less complicated than for underground tanks or retention pits.

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

4.3.8 Visual

Consideration should be given to the visual appearance of the plant in relation to its location and the 'green space' inside the plant. This can be covered by National or local planning conditions.

5 References

Unless otherwise specified, the latest edition shall apply.

[1] ISO 14001:2015 *Environmental Management Systems - Requirements with guidance for use* www.iso.org

[2] EIGA Doc 88 *Good Environmental Management Practices for the Industrial Gas Industry* www.eiga.eu

[3] EIGA Doc 85 *Noise Management for the Industrial Gases Industry* www.eiga.eu

[4] EIGA Environmental Newsletter, ENL 04 *Legionella* www.eiga.eu

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

[6] EIGA Doc. 192 *Fluorinated Gases Management (under revised Regulation 517/2014)* www.eiga.eu

[7] EIGA Doc 33 *Cleaning of equipment for oxygen service. Guideline* www.eiga.eu

[8] EIGA Doc. 146 *Perlite Management* www.eiga.eu

Appendix 1—EIGA Document links to ISO 14001 (Informative)

Table 1.1 and 1.2 provide document links for the 2004 version of ISO 14001 as well as the newer 2015 version, as members may still be using both versions.

Table 1-1: EIGA Document links to ISO 14001:2004

Doc No	Title of EIGA Document	ISO 14001 (2004) Sections	Clause
107	Guidelines on Environmental Management Systems	General Requirements	4.1
		Environmental Policy	4.2
		Planning	4.3
		Objectives, Targets and Programme(s)	4.3.3
		Implementation and Operation	4.4
		Resources, Roles, Responsibility	4.4.1
		Competence, Training and Awareness	4.4.2
		Communication	4.4.3
		Documentation	4.4.4
		Control of Documents	4.4.5
		Emergency Preparedness and Response	4.4.7
		Checking	4.5
		Monitoring and Measurement	4.5.1
		Evaluation and Compliance	4.5.2
		Non-Conformity, Corrective Preventive Action	4.5.3
		Control of Records	4.5.4
		Management Review	4.6
106	Environmental Issues Guide	Environmental Aspects	4.3.1
108	Environmental Legislation applicable to Industrial Gases Operations within the EU	Legal and Other Requirements	4.3.2
30	Disposal of Gases	Operational Control	4.4.6
85	Noise Management for the Industrial Gases Industry	Operational Control	4.4.6
88	**Good Environmental Management Practices for the Industrial Gas Industry**	Operational Control	4.4.6
192	Fluorinated Gases Management	Operational Control	4.4.6
109	Environmental Impacts of Acetylene plants	Operational Control	4.4.6
84	Calculation of Air Emissions from Acetylene Plants	Operational Control	4.4.6
05	Guidelines for the Management of Waste Acetylene Cylinders	Operational Control	4.4.6
166	Guidelines on Management of Waste Gas Cylinders	Operational Control	4.4.6
94	**Environmental Impacts of Air Separation Units**	Operational Control	4.4.6

Doc No	Title of EIGA Document	ISO 14001 (2004) Sections	Clause
110	Environmental Impacts of Cylinder Filling Plants	Operational Control	4.4.6
117	Environmental Impacts of Customer Installations	Operational Control	4.4.6
111	Environmental Impacts of Carbon Dioxide and Dry Ice Production	Operational Control	4.4.6
122	Environmental Impacts of Hydrogen Plants	Operational Control	4.4.6
112	Environmental Impacts of Nitrous Oxide Plants	Operational Control	4.4.6
113	**Environmental Impacts of Transportation of Gases**	Operational control	4.4.6
137	Environmental Aspects of Decommissioning	Operational Control	4.4.6
135	Environmental auditing guide	Internal Audit	4.5.3

Table 1-2: EIGA Document links to ISO 14001:2015

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 programmes	6.2.2
		Support	7

Doc No	Title of EIGA Document	ISO 14001: 2015 SECTIONS	Clause
		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	8.1
30	Disposal of Gases		
85	Noise Management for the Industrial Gases Industry [1)]		
109	Environmental Impacts of Acetylene Plants		
84	Calculation of Air Emissions from Acetylene Plants		
05	Guidelines for the Management of Waste Acetylene Cylinders		
166	Guidelines on Management of Waste 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	Environmental Impacts of Hydrogen Plants		
112	Environmental. Impacts of Nitrous Oxide Plants		
113	**Environmental Impacts of Transportation of Gases**		

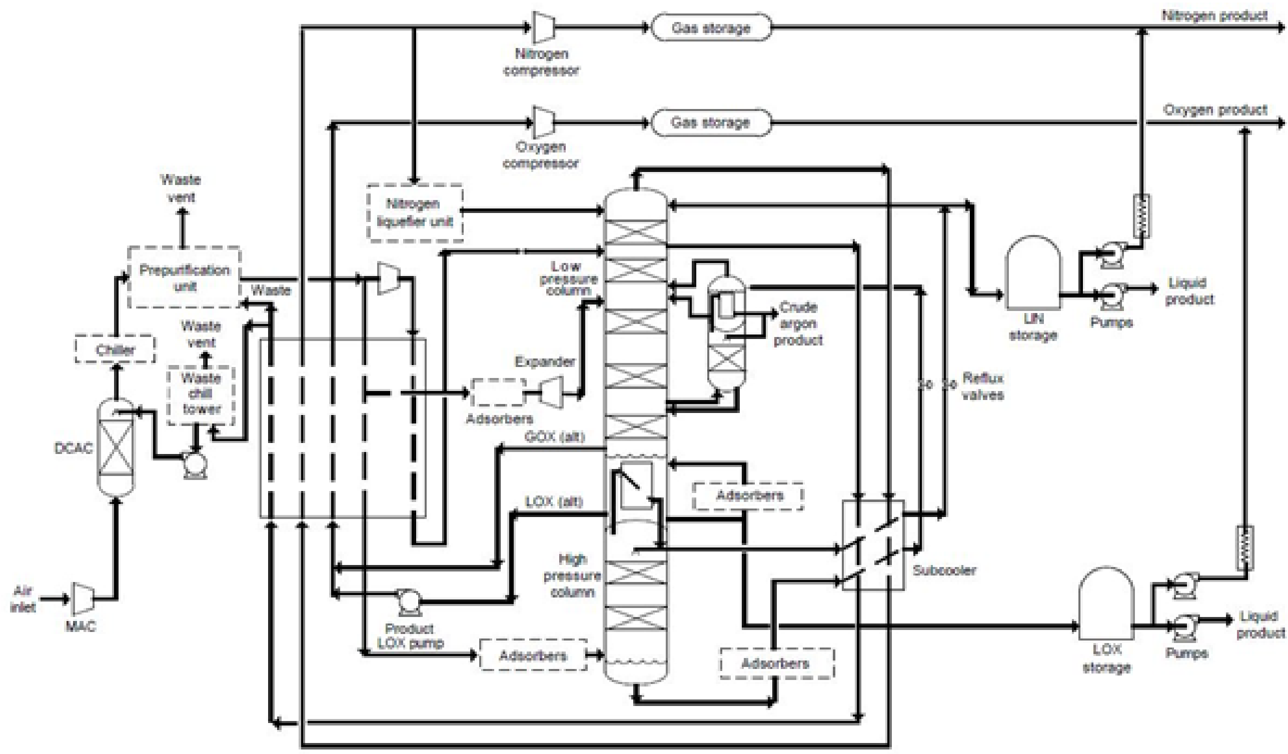
Doc No	Title of EIGA Document	ISO 14001: 2015 SECTIONS	Clause
137	Environmental Aspects of Decommissioning		
		Emergency preparedness and response	8.2
		Performance evaluation	9
		Monitoring, measurement, analysis and evaluation	9.1
		General	9.1.1
		Evaluation of compliance	9.1.2
135	Environmental Auditing Guide [1)]	Internal audit	9.2
		Management review	9.3
		Improvement	10
		General	10.1
		Nonconformity and corrective action	10.12
		Continual improvement	10.23
NOTES 1 Specific document relevant to carbon dioxide and dry ice. 2 General document useful to carbon dioxide and dry ice.			

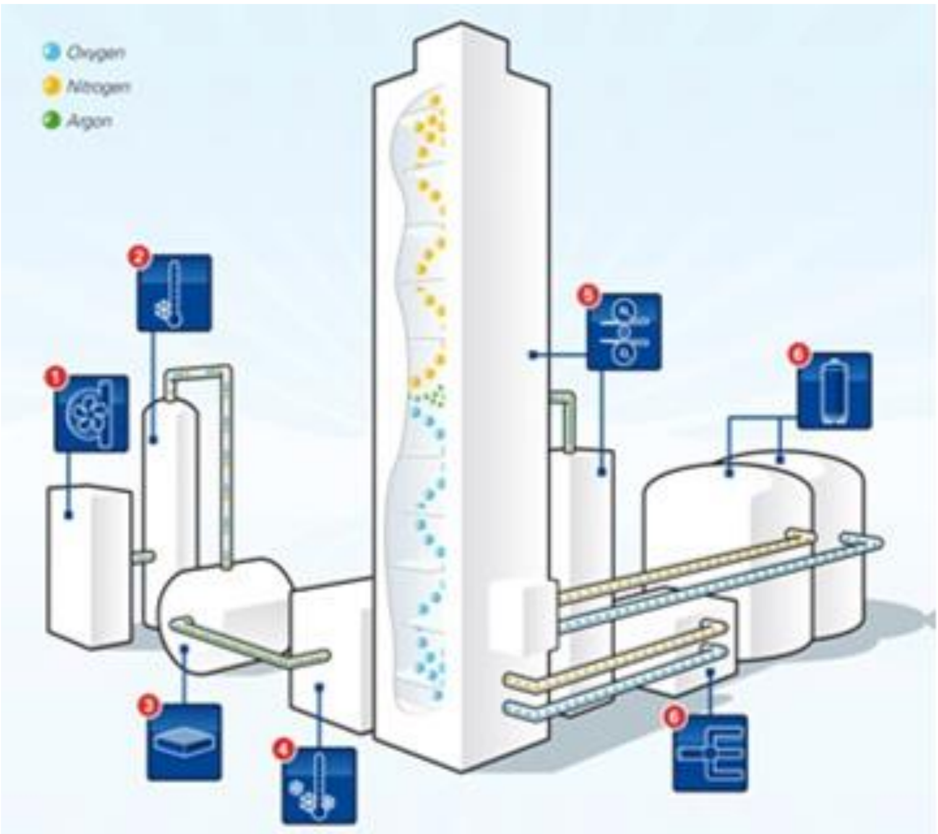
NOTE

What documents are relevant to me? For ASUs the relevant specific documents are highlighted in bold, and useful general documents in italics.

There is an EIGA Training Package TP 02 *ASU Plants Environmental Issues*.

Appendix 2: Schematics of Air Separation Plant Process





Appendix 3: ASU Environmental Impacts