GUIDELINES FOR THE MANAGEMENT OF WASTE ACETYLENE CYLINDERS

AIGA 036/16

Revision of AIGA 036/06

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Table of Contents

Amendments to 036/06

Section	Change
Section 3.2	Publication terminology added
Section 5	References added
Section 6	Related AIGA documents moved from Appendix D to Section 6
Main text	Editorial changes in line with AIGA format

1 Introduction

This document is a revision of document 036/06, originally produced in 2006. Developments in environmental policy and practice as well as advances in methods of destruction of asbestos have prompted the additional guidance in this revised document. The main principles remain unchanged, that is the commitment to the identification of 'best industry practice' and guidance to AIGA members on its implementation.

2 Scope and purpose

2.1 Scope

This document sets out the standards for the safe treatment or disposal of acetylene cylinders and reflects the priority that AIGA gives to the protection of people and the environment.

The document determines the standards to be achieved and describes methods by which these can be achieved. Methods should only be adopted where an 'equivalence of safety' can be demonstrated.

3 Definitions and publication terminology

3.1 Definitions

None.

3.2 Publication terminology

3.2.1 Shall

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

3.2.2 Should

Indicates that a procedure is recommended.

3.2.3 May

Indicates that the procedure is optional.

3.2.4 Can

Indicates a possibility or ability.

4 Code of Practice

4.1 Background

Acetylene has been produced in commercial quantities for over one hundred years. As such it was one of the original 'industrial gases' and is still widely used throughout industry.

The majority of industrial gases can be contained in gas cylinders, either as a compressed gas or as a liquefied gas under pressure. Acetylene is a high energy gas which is unstable when compressed in its free state. To ensure safe storage, it must be dissolved under pressure in a suitable solvent. The most commonly used solvent is acetone for single cylinders and dimethyl formamide (DMF) for cylinder bundles; although more recently dimethyl formamide has been used as an alternative for some specific applications.

To ensure a uniform distribution of the acetylene and solvent throughout the cylinder it is necessary to fill the cylinder with a 'porous mass'. This 'mass' can be a complex matrix which must satisfy certain basic requirements:

- Ability to stop decomposition of the acetylene caused by 'flashbacks' in the system.
- Stable structure over a long period of time to prevent the creation of voids or cracks in the matrix e.g. by rough handling of the cylinder.
- Uniform structure which completely fills the cylinder volume.
- High porosity to ensure optimum 'fill ratios' of the cylinders.

The first three points are crucial for the safe operation of acetylene cylinders. Defects would lead to instability and, in extreme cases, explosive failure of the cylinder.

Many of the masses currently in use incorporate small amounts of chrysotile asbestos to maintain the integrity and mechanical strength of the mass. This is achieved by utilising a physical property these asbestos fibres possess i.e. the fibres have a 'ragged' surface which strongly bonds the mass. The fibres also withstand high temperatures which are essential in the function of stopping 'flash backs' from welding/cutting torches etc.

Measurements have demonstrated that no asbestos fibres are emitted during the discharge of acetylene from the cylinder.

The safety benefits of using these asbestos containing masses have been proven by more than 30 years of use. Also the quantity of asbestos in a typical acetylene cylinder is very small e.g.

- The porous mass occupies approximately 7 to 13% of the total volume of the cylinder.
- Asbestos is approximately 10% of the volume of the porous mass.
- Thus asbestos represents less than 1% of the cylinder volume.

As a result of developments in massing techniques the development of an asbestos free mass become possible in the early 1990s. These masses have the same benefits and degree of safety as the asbestos based masses.

Therefore new cylinders no longer have any asbestos content in the mass. Changes in country legislation prevent acetylene cylinders containing asbestos being placed on the market in many countries in Asia as in Europe. Existing cylinders with the porous mass containing asbestos may still be used providing they are in good condition and where this is allowed by the relevant national or international legislation.

Acetylene cylinders are high integrity high strength containers, made in accordance with relevant national and international regulations. Any asbestos is therefore in a 'closed system' and the cylinders still in service can be used to the end of their operational lives. Industry efforts should therefore be directed to the safe treatment or disposal techniques for any damaged or obsolete cylinders.

4.2 Objectives

This document reflects the principles of 'duty of care' for dealing with waste. ‘Duty of care’ requires that all reasonable steps are taken to look after any waste generated, and that illegal disposal by others is prevented. Additionally, disposal of potentially hazardous waste should be consistent with "best available techniques not entailing excessive costs", otherwise known at BATNEEC.

This document, recommending a code of practice, has been developed to reflect the experience developed by AIGA companies and adopted by Asia.

The document applies to the treatment or disposal of all designs of acetylene cylinders, even those not containing asbestos.

4.2.1 Principles

AIGA member companies who wish to use any of these treatment or disposal routes are obliged to show an 'equivalence of safety' to the containment of the cylinder in a licensed landfill. The main objective of the document is to show how such an equivalence of safety can be maintained and how the safety and environmental hazards and risks of the different treatment and disposal methods can be controlled.

Cylinders shall not be disposed of whilst they contain solvent since subsequent corrosion of the cylinder can cause the solvent to leak out. This can cause long term environmental problems. Provided that the asbestos is contained until after it has been stored in a suitably designed and licensed landfill site, it presents no pollution potential to any environmental medium. However long term liabilities associated with placing the cylinders in landfill need to be taken into account.

4.2.2 Code of practice history

The document includes various alternative methods of treatment or disposal and reflects changing legislative requirements. These methods have been included to reflect the philosophy behind the Landfill Directive in Europe (Council Directive 1999/31/EC) [1]. Landfill space is declining within the EU and so in some of the Countries in Asia. In some countries the disposal to landfill of the cylinder with the mass sealed within the cylinder is not acceptable even with the solvent removed. This is due to the legal pressure to recover recyclable materials and to treat waste before it is sent to landfill. In addition in some countries the waste remains the property of the producer even following correct disposal.

This document also reflects advances in the techniques for the destruction of asbestos. Any method that recovers the cylinder by removing or destroying the mass shall meet the criteria of the 'equivalence of safety' and all the environment, health and safety risks shall be identified and controlled.

4.3 Selection of cylinders for treatment or disposal

A flowchart of the process described in sections 4.3 to 4.5 is provided in Appendix A.

4.3.1 Reasons for treatment or disposal

There are normally four possible reasons for disposing of cylinders:

- External condition - the cylinder shell could have been subjected to fire or physical damage (see Appendix A for guidelines), and failed the inspection at time of filling, see EN 12754 [2].

- Internal condition e.g. contamination by water, carbon black, broken mass etc.

- Commercial decision - e.g. the cylinder design has been superseded by a more recent design etc.

- Periodic inspection - failed to satisfy the prevailing periodic inspection requirements e.g. expiry date of the porous mass, see EN 12863 [3].

4.3.2 Identification

Whatever the cause of rejection the cylinders selected for treatment or disposal shall be identified as such e.g. painted or better stamped with the word 'scrap' and segregated from the normal operational area.

4.3.3 Records

At this stage a record should be made of the cylinder details. This documentation shall follow the cylinder throughout the treatment or disposal process.

The record system shall be designed such that the treatment or disposal route can be audited in the future.

4.4 Removal of acetylene gas

4.4.1 Records

Check the weight of each cylinder and record the actual weight.

4.4.2 Residual pressure

Check residual pressure. This will result in two possible action routes (see Appendix A for 'flow chart').

4.4.2.1 Positive pressure indicated

Compare the pressure with the fill chart and the actual weight recorded earlier.

Reclaim the acetylene gas as far as possible (acceptable quality) to the minimum practical level of gas pressure in the cylinders, or that the acetylene recovery system can manage. This can be done, for example, by equalising the cylinder pressure to the pressure in the gasholder.

Otherwise the residual acetylene may be treated via another authorised method. Reference should be made to AIGA document 083 Disposal of gases code of practice [4]. Acetylene is considered to be a volatile organic compound (VOC) as well as its flammable properties and as such there can be restrictions on venting.

Weigh the cylinder and compare with the tare weight to ensure the cylinder is virtually empty of gas. A difference in the weight is not always an indication of the presence or absence of gas in the cylinder. Other relevant factors such as possible excess or loss of solvent, external corrosion or contamination with water need to be assessed.

The remaining gas in the cylinder should then be discharged to equalise the cylinder pressure with atmospheric pressure. The most convenient and economical method is to dilute the waste gas into the air to a harmless concentration. This shall be carried out in a responsible manner to ensure no hazardous conditions are created, legislative requirements are met and there is no risk of damage to the environment.

Cylinders which have been opened and vented can still release further residual gas if brought into a warmer area (e.g. brought inside a building having been vented in the cold), due to the saturation of acetylene in the solvent. This is a potential safety hazard against which suitable precautions should be taken as the resultant vapour will be saturated with solvent and heavier than air. For example cylinders can be connected to a vent manifold or kept in a separate area.

4.4.2.2 No pressure indicated

The absence of a positive pressure reading does not necessarily indicate the absence of excess gas due to the possibility of a blocked valve. It is therefore essential to check for a blocked valve or filter pad.

A suitable method to check this is the introduction of compressed nitrogen (or other inert gas) at a pressure below 1 bar and observing its discharge. This can be achieved for example, by the arrangement shown in Appendix B.

- Valve A is closed.
- Valve B is opened until gauge P registers 1 bar.
- Valve B is then closed. If the indicated pressure does not decay i.e. there are no leaks in the connections, then
- Valve A is opened. Rapid decay of indicated pressure indicates valve A is not blocked as the gas in the manifold flows into the cylinder.

If the valve is suspected of being blocked or inoperative then refer to AIGA document 025 Pressure receptacles with blocked or inoperative valves [5] and AIGA document 083 Disposal of Gases Code of Practice [4] or EN 12863 [3].

Ensure that the valve design is taken into account and that appropriate precautions are taken with regard to the properties of the cylinder contents.

If there is no evidence of a blockage (valve or filter pads), or after any blockage has been dealt with, vent any residual gas.

4.4.3 <u>Removal of valve</u>

Once the cylinder has been successfully emptied of acetylene gas the cylinder valve can be removed.

WARNING*: All operations involving recovery or venting of acetylene gas shall be carried out in a suitable and defined safe area where the risk for an explosive atmosphere has been assessed and any necessary protective measures implemented. Also after the gas has been vented there will still be some "saturation gas" in the solvent. Do not let acetylene cylinders stand unattended for any excessive period of time with no valve or plug fitted, flammable vapours can be released. Acetylene/acetone vapours can be heavier than air and collect at low levels creating a fire/explosion risk. Only remove one valve at a time.*

4.5 Solvent removal

Although many solvents may be used with acetylene the two most commonly used are:

- Acetone
- Dimethylformamide (DMF).

It is strongly recommended that these solvents be reduced to the lowest practicable quantity, particularly in the case of DMF. Acetone and DMF are considered volatile organic compounds (VOC) as well as their other properties and as such there can be restrictions on venting.

Wherever possible the first step is to identify the solvent in the cylinder. This is normally indicated by the stamping on the cylinder. Reference should then be made to the Material Safety Data Sheet for the contained solvent and the corresponding risk assessment so that recommended personal protective equipment can be selected.

Remove all fusible plugs/safety devices, where these are fitted, from the cylinder and securely refit blanking plugs on the openings.

WARNING: *Solvents will only be partially removed by cylinders being left open in the 'open air' for any period of time due to poor heat transfer meaning that the cylinder contents are not held above the boiling point of the solvent*

4.5.1 Acetone

Heat the cylinder(s) uniformly to at least 150℃ for a minimum of 12 hours at atmospheric pressure. This can be achieved, for example by the use of hot air circulating ovens.

Alternatively the necessary heating can be achieved by immersing the cylinders in a water bath at 85℃ for a minimum of 12 hours, or by using heated jackets. In both cases the solvent should preferably be recovered in a condenser or, if this is not technically or economically possible, vented it to a controlled location.

The temperature can be reduced and/or the time shorted by utilising a vacuum to lower the boiling temperature of the solvent. In all cases the outside temperature shall be sufficient ensure the internal cylinder temperature is maintained above the boiling point of the solvent, and the time sufficient to remove solvent to the lowest practicable level. Care shall be taken that equipment used to create a vacuum is suitable for use with the solvent and does not initiate an ignition.

4.5.2 Dimethylformamide (DMF)

Heat the cylinder uniformly to at least 250℃ for 24 hours minimum. This can be achieved, for example, by use of hot air circulating ovens. The use of a jet pump, operated with cooled solvent, will assist the evaporation of solvent by creating a partial vacuum although this could be hazardous as the solvent will absorb any acetylene, concentrating it and possibly creating a fire/explosion risk.

WARNING: *DMF can give rise to problems including toxicity and possible plugging of process lines with white solid products, due to polymerisation.*

The temperature can be reduced and/or the time shorted by utilising a vacuum to lower the boiling temperature of the solvent. In all cases the outside temperature shall be sufficient to ensure the internal cylinder temperature is maintained above the boiling point of the solvent, and the time sufficient to remove solvent to the lowest practicable level.

If there is any doubt about the system design and operation then expert advice should be sought.

4.5.3 Reclaiming of solvents

Reclaim the extracted solvents either for future re-cycling or authorised disposal. ("Saturation gas" will also be released). Where reclamation and recycling are not possible, the following general principles for the treatment or disposal of acetone or DMF shall be followed. Solvent shall be:

- Securely contained.
- Properly and clearly labelled.
- Separated from other wastes.
- Handled with care.

- Protective clothing worn and personal protective equipment (PPE) identified in the risk assessment or SDS used.
- Transferred only to a licensed waste carrier.
- Disposed of only to a licensed waste site.

CAUTION: *The operation shall be subject to a risk assessment. In particular the equipment needed for recycling or reclamation shall be designed and operated taking into account the properties of the solvent and the possible release of any residual dissolved acetylene with the subsequent risk of ignition e.g. any storage of solvent should be blanketed with inert gas or be protected in other ways appropriate to the flammability of its contents.*

4.6 Acetylene cylinder waste management methods

4.6.1 Selection of acetylene cylinder waste management methods

Methods that are in use for the treatment or disposal of acetylene cylinders are described below. It is important to note that before final treatment or disposal it is strongly recommended that ALL cylinders contain the minimum practical level of solvent and acetylene. This can be achieved by following the steps set out in sections 4.3-4.5 of this code. A summary of the methods is provided in Appendix D.

Some references are made to patents on the processes discussed. It is strongly advised that the patent status of any process be checked before designing and implementing a particular solution.

Local, national and international regulations shall be followed. In particular, regulations for waste treatment or disposal need to be identified and understood. Specific permits are required for installations where exposure to asbestos fibres is likely.

Cylinders sent for treatment or disposal shall follow the regulations for shipments of waste. This involves pre notification to and agreement with the authorities in the region or country of destination for treatment or disposal. This also follows the proximity principle as may be set down in the country or region law that waste should be disposed of as close as possible to the point of generation, to minimise the environmental effects and risks of transport.

In countries or regions where the facilities exist, the recyclable cylinder shell can be recovered, followed by safe containment of the mass in a licensed landfill.

The objective of this document is to to maintain an 'equivalence of safety' to the safe containment of the cylinder and mass in a licensed landfill, whilst recognising that there are environmental benefits to recovering the recyclable cylinder shell and avoiding landfill and possible associated liabilities.

The Landfill Directive (1999/31) [1] reduces the acceptability of landfill as a solution. As part of the implementation of this Directive there is an EU decision establishing criteria and procedures for the acceptance of waste at Landfill pursuant to article 16 and annex II of the Landfill Directive [6].

In accordance with the acceptance criteria, there is a requirement that waste is treated before sending to landfill. For acetylene cylinders with asbestos mass this involves as a minimum removal of the solvent in accordance with section 4.5 of this document. In some countries the cylinder shell also needs to be removed for recycling before landfill of the mass is acceptable.

The proximity principle that waste should be treated and disposed of as close as possible to the point of production and safety considerations need to be balanced with the desirability of recovering the cylinder shell.

When the mass is to be removed from the cylinder this requires very stringent control for the removal process to ensure that workers are not exposed to unacceptable levels of asbestos fibres and so that no asbestos fibres will be released into the environment.

The philosophy of this document is that any asbestos used in the construction is contained within the cylinder shell as part of the treatment or disposal process unless an equivalence of health and safety can be demonstrated by an alternative treatment or disposal process. Removal of the mass by untrained personnel can lead to safety or environmental hazards.

4.6.2 Selection of waste contactors

Waste contractors shall be selected to comply with the waste 'duty of care'. Technical considerations that shall be checked include:

- Competence and training of the contractor,
- Contractor shall have valid licences or permits for the activity
- Financial viability of the contractor.

The waste producer may still retain liability for the waste if the contractor is not financially sound or becomes financially insolvent.

4.6.3 Treatment or disposal

Acetylene cylinders scrapped in the way described are regarded as hazardous waste. Due regard shall be given to taking all reasonable steps to look after any waste you have and prevent its illegal treatment or disposal by others. This is commonly known as 'duty of care'. This applies when disposing of scrap acetylene cylinders. National legislation within individual countries can require specific actions on the part of persons disposing of such cylinders which shall be complied with. In general, the following are to be taken as minimum requirements:

a) Correct labelling and description of the waste (i.e. cylinders and residual contents).

b) Transfer only to an authorised person who is capable of dealing with the waste correctly (i.e. licensed). Permission from the competent authority can be required prior to treatment or disposal. In this case normal good practice will require the following details:

- What the waste is and how much there is.
- The time and date the waste was transferred to the treatment or disposal facility.
- Where the transfer took place.
- The names and addresses of both parties.
- If either or both parties, as a waste carrier, has a registration certificate, the certificate number and the name of the authority that issued it.
- If either or both of the parties have a waste licence, the licence number and the name of the authority that issued it.

c) Treatment or disposal only to an authorised site capable of accepting the waste (licensed).

d) Periodic review of waste treatment or disposal contractor operations.

e) Production and retention of records of disposal.

Compliance with relevant national legislation should be regarded as the minimum acceptable standard.

4.6.4 Records

In most countries the record keeping for the treatment or disposal of hazardous waste is clearly stipulated. However, the following points shall always be included to ensure that the treatment or disposal process can be reliably audited:

- Cylinder details.
- Transport contractor and licence details.
- Treatment or disposal site and approval/licence details.
- Treatment or disposal date.
- Records of the reviews of transport and treatment or disposal contractor operation regarding scrap acetylene cylinders.
- Records of disposal of the different wastes generated by the process (mass, cylinder, solvent etc).

4.6.5 Landfill of cylinder plus mass

4.6.5.1 Rendering cylinder unfit for further use

After following the steps outlined above, i.e. removing the acetylene and solvent to the lowest practical level, it is essential that precautions are then taken to ensure that these cylinders are not returned to service in the future.

This is necessary because a responsible person has decided to scrap the cylinder because he considers it unfit for further use. It is possible that less responsible persons may wish to benefit by attempting to re-use such cylinders.

4.6.5.2 Cylinder neck

The most effective way to prevent a scrapped cylinder being re-used is to permanently damage the internal neck thread. This can be achieved during the plugging of the neck e.g.

- An oversize plug can be hammered into the neck and then seal welded.
- A plug can be welded into the neck in such a way as to destroy the threads during welding.

Note that welding can cause an ignition if some acetylene/acetone is present.

Any practical method may be used which achieves the twin aims of thread destruction and sealing the cylinder neck e.g.

- Severely damaging the neck and seal the neck with suitable concrete.
- ‘Thread locking’ a plug into the cylinder and shearing off the plug drive so that it is flush with the top.

4.6.5.3 Cylinder marking

Existing cylinder marking shall be obliterated in accordance with prevailing standard. Also the cylinder shall be stamp marked saying it is scrapped. This is to further ensure that the cylinder cannot be returned to service.

It is considered that cylinders treated in this way present no risk to the environment, and no health and safety risk to people.

4.6.6 Landfill of mass after removal from cylinder

4.6.6.1 Dry removal of mass

The acetylene and solvent in the cylinder shall first be removed following steps described in sections 4.3 - 4.5 of this code of practice.

The cylinder is then cut open so that the mass can be removed by mechanical means. This shall be carried out under carefully controlled conditions in a purpose built facility. The mass is then double bagged, suitably labelled or identified and removed to a licensed waste treatment or disposal facility in accordance with the 'duty of care' principles outlined in sections 4.6.3 and 4.6.4 above.

The facility shall be designed to ensure that all asbestos fibres are contained and that at no time are operating personnel exposed to these fibres, according to established occupational health standards. This can be achieved by remotely operated cutting equipment in a sealed 'air locked' room. This will maintain an equivalence of safety to the containment and burial of cylinder plus mass.

4.6.6.2 Wet removal of the mass

The acetylene and solvent in the cylinder shall first be removed following steps described in sections 4.3-4.5 of this document.

The solvent shall first be removed to prevent contamination of the water used in the mass removal process. Acetone forms an azeotropic mixture with the water which makes it difficult to treat this water.

A water jet is used to remove the mass from the cylinder in an area designed to contain the resulting slurry, which shall be disposed of as hazardous waste in accordance with the duty of care principles outlined in 4.6.3 and 4.6.4 above. No emissions of asbestos fibres into surface water or sewers are permitted so the fibres must be collected before discharging to water.

4.6.6.3 Cutting the cylinder without solvent removal

The acetylene in the cylinder shall be removed following steps described in sections 4.3 of this document. Normally the solvent is also removed as this is the best way to prevent contamination by the solvent and safety/ handling problems.

Removal of the mass without removing the solvent is only acceptable if an equivalence of safety and environmental protection can be shown. i.e. this is only acceptable when there is adequate control of the mass which is saturated with solvent.

All acetylene cylinders are treated by a full automatic process in a closed container which is protected by vacuum (~ 0.5 bar). The cylinder is picked up and cut into two pieces. The mass is separated from the steel cylinder inside the closed container and the acetylene cylinders are not pre-heated. This is only acceptable when there is adequate control of the mass which is saturated with solvent. The solvent shall be recovered or vented when the mass is pressed out. Sending mass to landfill that is contaminated with solvent is prohibited as it does not meet the landfill Directive waste acceptance criteria on leachability of waste.

The mass is pressed out and collected in a bag. The bag is closed automatically and transported to the disposal site or for further usage.

The steel cylinder is cleaned by means of washing with a special fluid to ensure no fibres remain on the steel itself.

4.6.7 Treatment by dissolving the mass with hydrogen fluoride (HF)

The acetylene and solvent in the cylinder shall first be removed following steps described in sections 4.3-4.5 of this document. The cylinders are internally treated with hydrogen fluoride in a purpose built facility.

This dissolves the asbestos mass and means that the cylinder shell can be completely recovered. This process is subject to a patent by Solvay S.A. but is not presently in use.

4.6.8 Disposal in high temperature conventional furnace

The acetylene and solvent in the cylinder shall first be removed following steps described in sections 4.3-4.5 of this document.

The cylinders can then be added in a controlled manner to a blast furnace or be treated in a plasma furnace. Provided the temperature exceeds 1200 ^{o}C this process results in the complete destruction of the asbestos fibres. The furnace shall have the correct licenses and controls for disposing of cylinders in this way. Some parts of the blast furnace disposal process are subject to a patent from Linde AG.

4.6.9 Dissolving the mass by chemical reaction in an autoclave

The acetylene and solvent in the cylinder shall first be removed following steps described in sections 4.3-4.5 of this code of practice. The mass shall then be removed from the cylinder following the method set out in 4.6.2.1

The process described below is the so called “TRE-SE-NE-RIE” process, which is subject to a patent by WTB SA/NV.

The principle of the process is chemical reaction with sodium hydroxide (NaOH) at 100^{o}C for 35 minutes. This causes the breaking of the bond structure and complete dissolution of the fibres.

NaOH is added to water in an autoclave and heated to 160^{o}C. Addition of NaOH is automatically controlled by pH measurement. Bags of waste are loaded into an autoclave without sorting. NaOH solution is transferred and the reaction allowed proceeding. Liquid solid separation is achieved by centrifuge. Liquids go back into the system. Solids are drained and used according to their nature. Waste is rinsed and pH balanced where necessary.

The solid waste contains no fibres. Where no uses can be found for this it can be treated as ordinary building rubble and disposed of accordingly. No vapours are produced.

Solid waste is the residue from the process. NaOH is the prime raw material and there are no liquid effluents. This process adopts a chemical reaction with no obvious solvent usage.

This process is at a concept stage and not currently in use.

4.6.10 Disposal in high temperature induction furnace

The acetylene and solvent in the cylinder shall be removed following steps described in sections 4.3-4.5 of this document.

Provided the correct precautions are taken the heating in the furnace can be used to remove the solvent and residual acetylene.

The cylinders can then be added in a controlled manner to an induction furnace, the cylinder and mass are melted in the furnace. Provided the temperature exceeds 1200 °C this process results in the complete transformation and destruction of the asbestos fibres. The furnace shall have the correct licenses and permissions.

4.6.11 Polymer encapsulation

The acetylene and solvent in the cylinder shall be removed following steps described in sections 4.3-4.5 of this document.

The asbestos mass is then removed using method 4.6.6.1. A specific chemical is mixed with asbestos to encapsulate the fibres and form a non hazardous residue.

This process is at a concept stage and not currently in commercial operation.

5 References

[1] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.

[2] EN 12754 Transportable gas cylinders. Cylinders for dissolved acetylene. Inspection at time of filling.

[3] EN 12863 Transportable gas cylinders. Periodic inspection and maintenance of dissolved acetylene cylinders.

[4] AIGA 083 Disposal of gases code of practice.

[5] AIGA 025 Pressure Containers with blocked or inoperative valves.

[6] 2003/33/EC: Council Decision of 19 December 2002 establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC.

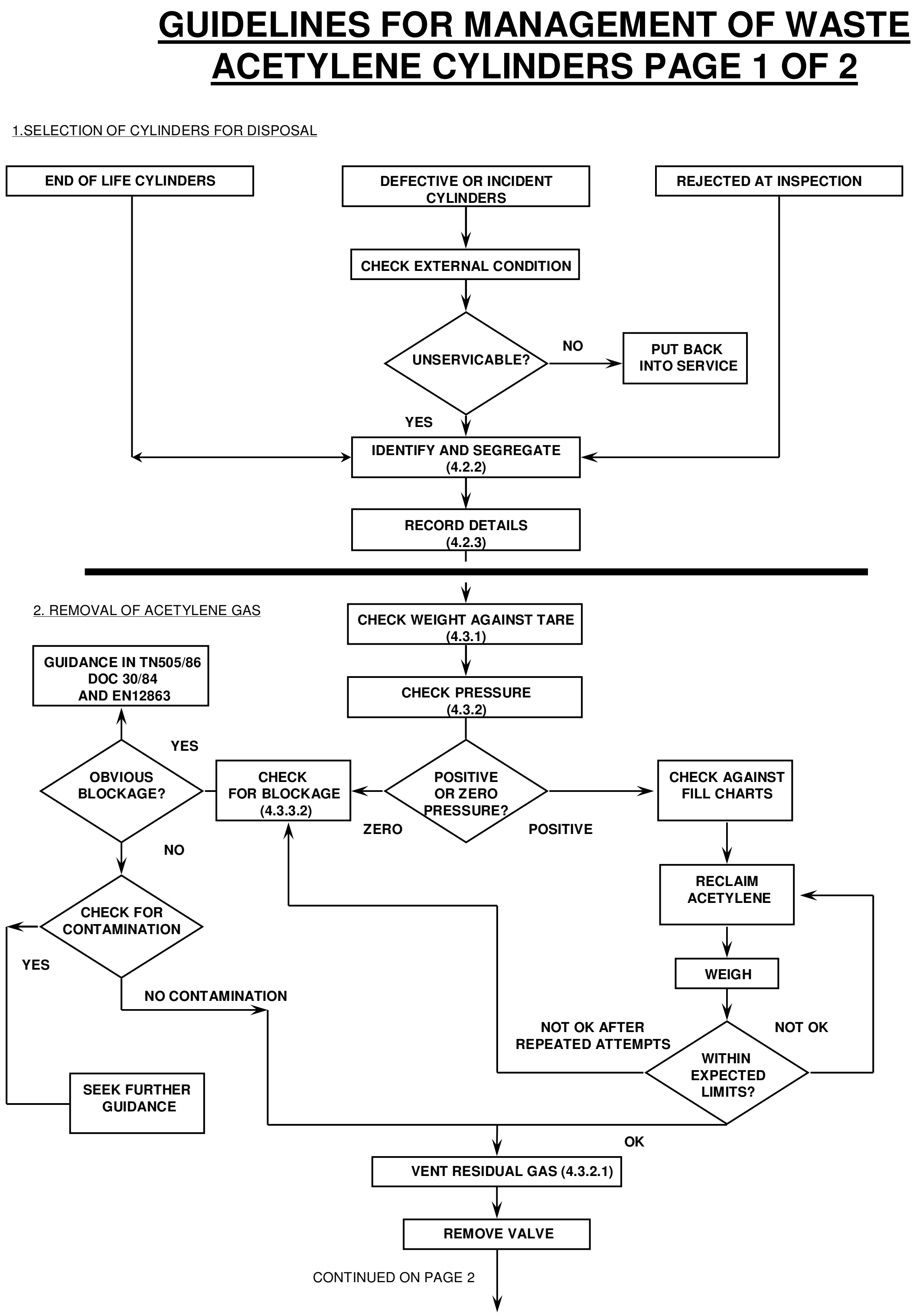
6 Other Related Publications

AIGA 037 Permissible charge/filling conditions for acetylene cylinders

EIGA Doc.109 Environmental impacts of acetylene plants

AIGA 022 Acetylene Code of Practice

Appendix A: Flowchart



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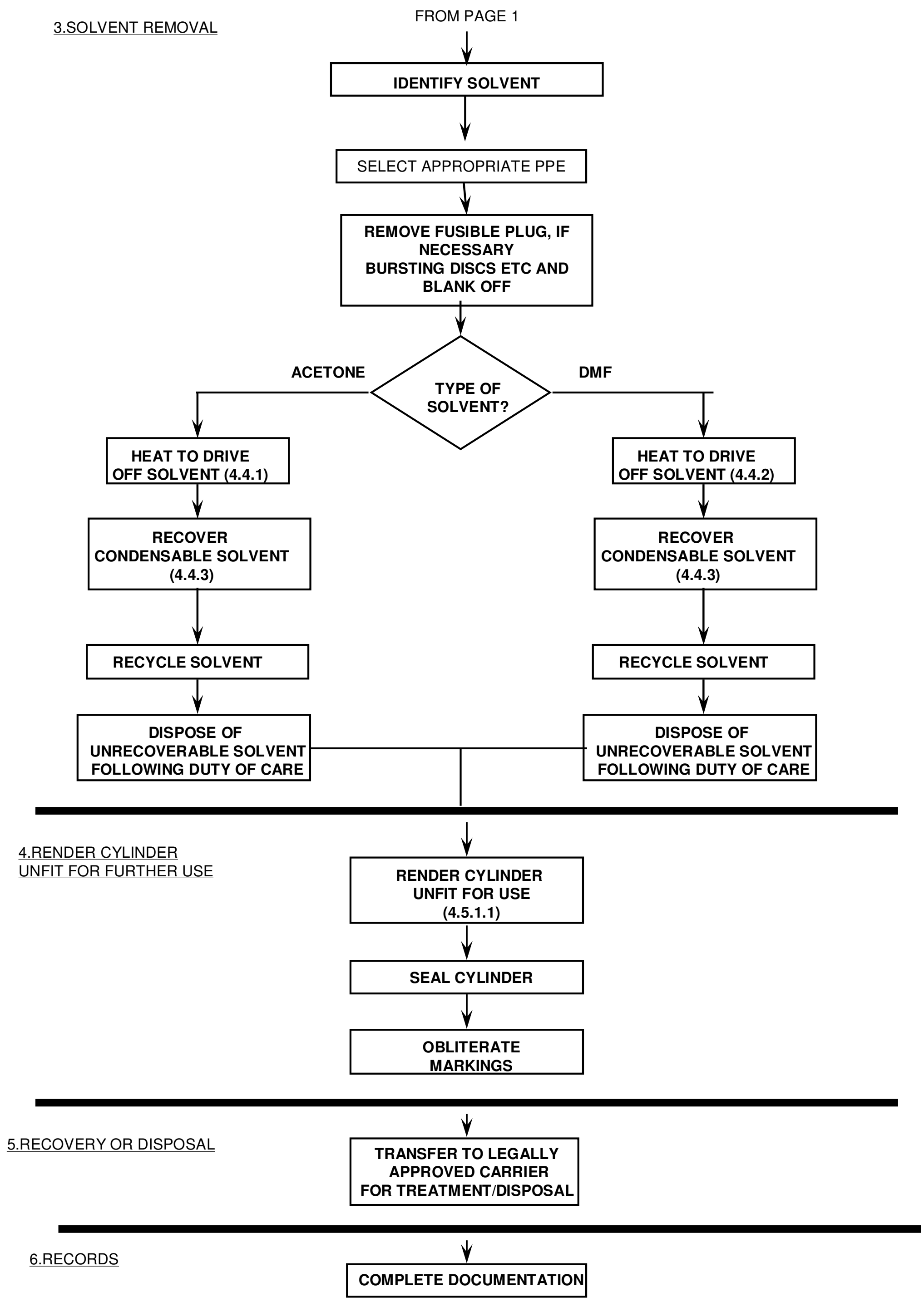
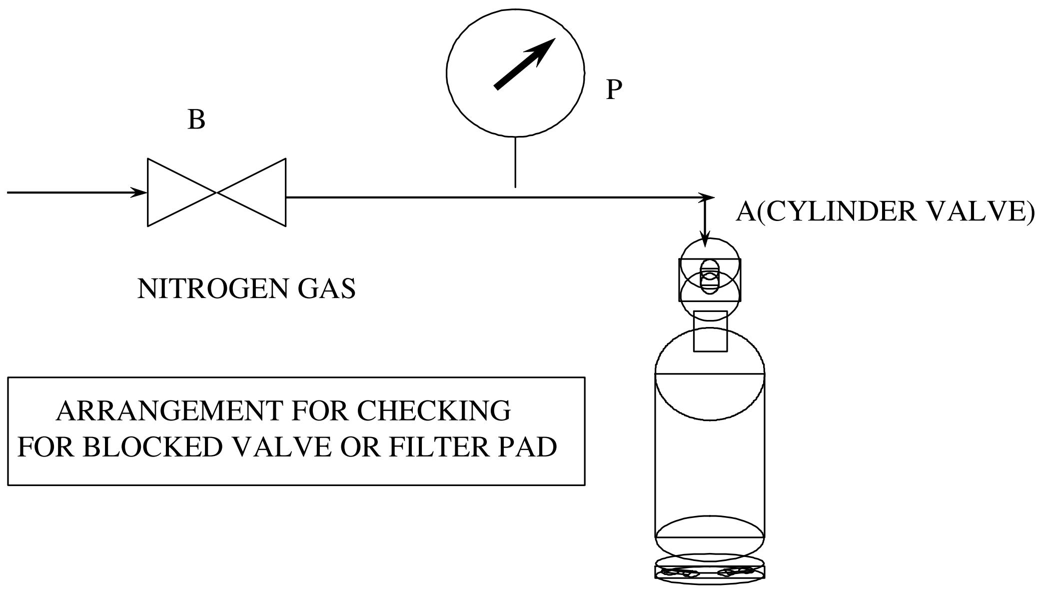


Appendix B: Dealing with blocked valves



Appendix C: Advantages and disadvantages of each process

NOTE : Cylinders shall be treated in accordance with 4.3 – 4.5 of this document.

	Method	Advantages	Disadvantages
1	Landfill cylinder plus mass	No asbestos exposure Proven Method Low cost	No recovery Potential Landfill Liabilities Leachate Pressure on landfill space/ public perception
2	Landfill dry mass	Recovery of steel Proven Method Low cost	Control of workplace asbestos Potential Landfill Liabilities Landfill Leachate
3	Landfill wet mass	Recovery of steel Proven Method Low cost	Control of asbestos in water Water pollution if solvent not removed Control of workplace asbestos Transport of waste Landfill Leachate Potential Landfill Liabilities
4	Cutting Cylinder without removing solvent	Cost saving by missing out solvent removal step Reuse/recovery of cylinder	Control of solvent
5	Hydrogen Fluoride Process (dissolve mass)	Pilot only Reuse/recovery of cylinder No transport of waste necessary End products are harmless	High Cost Acid Handling during process Disposal of waste No facilities Not currently used in practice
6	Plasma Furnace	Proven Method Complete vitrification	High Cost Control of workplace asbestos required Current capacity Explosion risk if solvent not removed
7	High temperature conventional Furnace	Proven Method Energy is recovered from the waste	High Cost High temperature required to destroy fibres Control of workplace asbestos required Acceptability to companies owning furnaces Approval authorities/public Explosion risk if solvent not removed
8	Sodium hydroxide	Medium cost Reuse/recovery of cylinder No transport of waste necessary End products are harmless	Method not proven on cylinders Control of workplace asbestos required Alkali Handling during process Permit required for gas site

	Method	Advantages	Disadvantages
9	High temperature Induction Furnace	Proven Method on pilot scale Energy is recovered from the waste No waste end product – 'slag is recycled Solvent need not be removed	High Cost High temperature required to destroy fibres Control of workplace asbestos required Approval authorities/public
10	Polymer encapsulation	Reuse/recovery of cylinder End products are harmless	High cost