RESPONSE TO OPERATIONAL ISSUES IN ACETYLENE PLANTS

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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

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Prepared by WG-12 Acetylene

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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

1 Introduction

Acetylene has unique properties that require technical knowledge for response to operational issues.

2 Scope and purpose

2.1 Scope

This publication applies to acetylene production and filling plants and to raw materials and by-products of the production process.

2.2 Purpose

This publication provides guidance to be used for response to operational issues in acetylene plants.

3 Definitions

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

3.1 Publication terminology

3.1.1 Shall

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

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May 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

The complete list of technical definitions related to acetylene are given in EIGA Doc 123, *Code of Practice Acetylene* [1] [1].

For this publication the following definitions might be useful:

3.2.1 Calcium Carbide

Grey rock-like solid made from coke and limestone. Its chemical formula is CaC2. It exists in sizes from dust to large stones. The rate of reaction with water is governed by the size, with dust reacting most quickly.

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

3.2.2 Generator

Equipment in which acetylene is generated from the reaction of calcium carbide with water.

3.2.3 Hopper

Conical shaped container/vessel permanently installed on the generator and used to supply calcium carbide to the generator for acetylene production.

3.2.4 Carbide Lime

Suspension of calcium hydroxide in water produced when calcium carbide is added to water to generate acetylene. Carbide lime is also referred to as carbide slurry, carbide sludge generator slurry, lime slurry, lime sludge, lime hydrate, lime water, or activated lime.

4 Selection of Personal Protective Equipment (PPE)

When dealing with incidents, additional or different PPE might be required than for routine operations in acetylene plants. Guidance on selection of PPE can be found in EIGA Doc 136, *Selection of Personal Protective Equipment* [2]. Ensure that all kind of PPE is anti-static.

5 General major incident response actions

5.1 General guidelines

A major incident at an acetylene plant is rare. The response to a major incident will include shutting the plant down rapidly and safely so that any emergency responders are confronted by a safe plant. The incident may be continuing e.g. fire, but the process will not have acetylene inside.

To achieve this safety systems on the plant, include elements such as venting, purging and deluge, which can be operated by semi-automated response (pressing buttons etc.).

Table 1 describes the generic response to any major incident whilst the rest of this document discusses specific response to individual incidents.

Table 1 Major incident response actions

Step	Action
1	Isolate (shut off) the supply of the gas as soon as possible provided that this can be done safely NOTE If not possible to do this safely, let any fire continue to burn to avoid a flammable gas cloud forming
2	Evacuate personnel to a safe location
3	Activate incident response systems including: a. water deluge. b. vent the plant (high pressure) and where installed low pressure c. where available activate the nitrogen purge
4	Allow trained emergency response people to deal with the incident

All national and local authority fire and emergency regulations shall be followed.

Fire and emergency drills shall be held on a regular basis, at least once per year. The best practice is to invite the local fire services to take part in these annual drills.

Fire and emergency protection equipment shall be maintained and tested regularly in accordance with the manufacturer's instructions and local regulations.

Systems and procedures shall be in place at all plants to prevent uncontrolled acetylene gas escaping into the atmosphere and to control a fire.

5.2 Use of fire extinguishers

The selection of fire extinguishers in acetylene plants might differ from “common sense fire fighting” where water is the typical response to fire. In acetylene plants using water to fight fire can be hazardous.

There could be a number of different types of fire extinguishers in an acetylene plant and these include the following:

- Dry powder fire extinguishers are preferred.
- Water or foam-extinguishers shall not be used with carbide or solvents.
- Carbon dioxide fire extinguishers are preferred for electrical fires.

6 Calcium carbide spills

Calcium carbide is extremely reactive with moisture. If carbide comes in contact with moisture it will generate flammable acetylene gas which could be ignited and explode.

Procedures to deal with dry carbide spills and damp / wet carbide spills are shown in Table 2 and 3.

Table 2 Procedure to deal with dry carbide spills

Step	Action
1	Keep any water away and deal with it in a timely fashion.
2	Separate dry from damp carbide. Pick up the dry carbide and return it into empty drum or container.
3	Use the spilled carbide in the first available generator charge.
4	After the calcium carbide rocks have been collected, spread dust or fines thinly on an approved disposal area and hose with large quantities of water. Do not throw dust, fines and residues directly into water or carbide lime treatment pits as this can cause a fire.
5	If the PPE has become impregnated with calcium carbide, ensure that it is removed and laundered before re-use. Personnel should ensure that they have a shower immediately after the clean-up operation to remove residual calcium carbide products.

Table 3 Procedure to deal with damp / wet carbide spills

Step	Action
1	Keep any water away and deal with it in a timely fashion.
2	Separate dry from damp carbide. Pick up the damp carbide and put it into open steel drums or containers.
3	Put the open steel drums or containers with the damp carbide in a dry and well-ventilated area far away from hot spots or igniting sources. Let the damp carbide slake on its own. Stir from time to time, so that all material will be slaked.
4	When the damp carbide has reacted completely, put the residues into the lime pit.
5	If the PPE has become impregnated with calcium carbide, ensure that it is removed and laundered before re-use. Personnel should ensure that they have a shower immediately after the clean-up operation to remove residual calcium carbide products.

The following equipment is recommended for cleaning up calcium carbide spills:

- shovel (full shovel with long handle)
- metal bucket
- natural bristle broom (not nylon which could generate static electricity; full sized broom with long handle)
- steel drum without a lid.

Equipment shall be maintained at a designated location in the acetylene plant; it shall be used for the sole purpose of cleaning calcium carbide spills. Plastic or other potential spark generating equipment shall not be used.

7 Calcium carbide fires

Calcium carbide itself is not flammable but generates acetylene gas when in contact with water.

Therefore, never apply water or use foam extinguisher to a calcium carbide fire. The water will react with the calcium carbide to produce more acetylene gas, feeding the fire. It is preferable to let fires in carbide spills to burn out naturally. This consumes the escaping acetylene and avoids the formation of large unconfined gas clouds, which could result in an explosion.

The procedure to deal with carbide fires is shown in Table 4.

Table 4 Procedure to deal with carbide fires

Step	Action
1	Let fires in carbide spills to burn out naturally, do not attempt to extinguish, do not use water.
2	Evacuate personnel to a safe location.
3	Calcium carbide fires in acetylene generator skip, hopper and feed should be extinguished with the nitrogen hopper purge system fitted to the generator.
4	After the calcium carbide fire is extinguished or burned out, allow the building to ventilate.
5	Pick up the carbide and return it into empty drum or container.
6	Use the spilled carbide in the first available generator charge.

8 Hot calcium carbide drums or containers

8.1 Purging calcium carbide drums

Bulging drums shall be handled with care because they can contain acetylene gas under pressure and there is a possibility of the drum bursting during movement or opening. Table 5 shows how to deal with hot calcium carbide drums.

Table 5 Dealing with hot calcium carbide drums (not applicable to turnbins, flowbins, etc.)

Step	Action
1	The hot drum should not be moved until the reaction has ceased. Do not apply water for cooling purpose.
2	Check the whole surface of the drum has completely cooled down before proceeding.
3	Secure the drum in a fixed position so it won't move when hit.
4	Using a spark-free tool (e.g. beryllium copper), punch one hole in the top of the drum, and one near the drum base. There can be a small release of pressurised acetylene from the puncture.
	Only use a spark free tool to punch holes in the drum. Always ensure a competent second person is present and that a dry powder fire extinguisher and dry sand is available.
5	Insert the nitrogen purge line into the hole in the lid.
6	Slowly increase the nitrogen flow through the purge line. Do not increase the flow too much, as the purge line can blow out from the hole in the top of the drum.
7	Allow the flow of nitrogen to continue for several minutes. Check that the flow is coming out of the hole punched in the bottom of the drum.
8	Check if the nitrogen flowing out of the bottom hole seems hot or warm. If there is any indication that the nitrogen is warm, further purging is required.
9	Continue purging until the outflow of nitrogen is completely cool. Once cool, the drum is considered safe for normal use.
10	Because the drum was punctured to allow the purge, it is no longer air-tight, and should be used for the next generator recharge. Once the drum is opened, visually inspect the carbide for general condition. If the carbide still appears in good condition, it can be used in the generator.

8.2 Purging bulk calcium carbide containers

There are several types of bulk carbide container in use. These can be non-air-tight unsealed containers or units that are air-tight. Many containers have two connections to allow purging. These

are usually containers that are sealed air-tight. One connection is to allow nitrogen to be injected into the container, while the other connection is a vent line to allow the nitrogen to escape. It is common for these points to have self-sealing couplings. Unsealed containers can only have a single purge point. This is for the nitrogen injection. The container relies on the natural leakage (or a vent hole) to allow nitrogen to escape. It is important for each site to understand the design and operation of the containers used at the site and to have a suitable nitrogen purge facility and procedure to match the container. Due to the variation in container design, the guideline for container purging in Table 6 below only covers the general principles that should be followed for safe purging.

Table 6 Purging calcium carbide containers

Step	Action
1	The hot container should not be moved until the reaction has ceased and the surface is cool. Do not apply water for cooling purpose.
2	Check the whole surface of the drum has completely cooled down before proceeding.
3	Carefully move the container to the purging area using a suitable fork lift or lift trolley.
4	Ensure that an adequate supply of nitrogen is available for purging.
5	Remove the caps (where fitted) on the container purge points and connect the nitrogen supply hose to one of the points.
6	Where necessary, fit a connector to the second point/coupling on the container so that it is open. This allows nitrogen to enter the container via the first point and leave through the second point so that there is no pressure build-up in the container, and a flow through the container can be established.
7	Start the nitrogen flow slowly and adjust it until a suitable flow is established. The purge system should have a visual flow indicator, and not only rely on a pressure gauge.
8	Purge the container with at least three total volume changes before continuing to the next step. If suitable equipment is available for the analysis of acetylene in nitrogen, check that the acetylene content is less than 0,2% by volume in nitrogen.
9	After purging is complete, retain the container for 24 hours before attempting to use. Make regular checks to ensure the container is not reheating.
10	Immediately before use, re-purge the container with three total volume changes, or re-analyse the gas in the container to confirm acetylene content in nitrogen is less than 0.2% by volume. Re-purge if necessary before use.
11	If the container has bulged it needs to be refurbished or scrapped after carbide has been released. Make contact with the owner of the containers and seek for advice for further treatment.

9 Generator incidents

9.1 Hopper fire (charging with skip)

Table 7 gives the procedure to deal with a hopper fire.

Table 7 Procedure to deal with hopper fire

Step	Action
1	Activate the emergency nitrogen purge system as quickly as possible.
2	Operate the plant emergency stop to stop the generators and all other plant.
3	Operate the generator area fire alarm.
4	Continue to provide nitrogen to the nitrogen purge system even after the fire is put out
5	After the flames are extinguished, the hopper lid may be put back on the hopper; the emergency nitrogen purge is turned off, or the nitrogen flow greatly reduced to avoid blow-out of the water seals or operation of relief valves.
6	If the fire is not extinguished by the nitrogen purge system, activate the site fire alarm and evacuate personnel.
7	Allow the generator to cool for a minimum of three hours after the fire is extinguished; Do not try to remove calcium carbide from the hopper or carbide conveyor worm chamber until all components are completely cool to the touch. Do not lower the water/sludge level in the generator body through the drain valves until all calcium carbide is removed from the carbide hopper and carbide conveyor chamber.

9.2 Internal fire (hopper or generator)

A hot hopper or generator incident can occur if the acetylene gas within the equipment undergoes a deflagration. Table 8 gives the procedure to deal with an internal hopper or generator fire.

Table 8 Procedure to deal with an internal hopper or generator fire

Step	Action
1	Stop the carbide feed by activating the generator emergency stop.
2	Stop the filling plant. NOTE Be aware that acetylene can still be generated and that there is a risk of hot/burning gas being discharged to atmosphere through the generator water seals.
3	Ensure no other sources are supplying acetylene gas to the generator.
4	Isolate the generator from the rest of the plant. Close the main isolation valve and open the generator vent line to atmosphere. Ensure that adequate water is supplied to all water seals to maintain normal levels. Open the nitrogen purge valve enough to keep the generator under positive pressure.
5	Ensure the water level in the generator and the hydraulic main/seals are at maximum operating levels.
6	Turn on the manual water valve to supply as much cooling water as possible into the generator.
7	Ensure the carbide lime slurry overflow is flowing freely.
8	Monitor the temperature and wait until it falls below 30°C. NOTE If nitrogen purging is in use (as described below) there can be false indication of cooling because the nitrogen purge provides a cooling effect. The temperature drop shall be sustained even after the nitrogen purge is stopped. If the temperature starts to rise above 30°C after stopping the nitrogen purge, then further cooling is still required.
9	After the incident, remove all the carbide in the hopper and generator.
10	Drain the generator for a full investigation and clean out.

9.3 Blocked carbide lime drain system

The carbide lime drainage system can become blocked, which prevents carbide lime from being removed from the generator. The procedure to deal with a blocked carbide lime drain is given in Table 9.

Table 9 Procedure to deal with blocked carbide lime drain

Step	Action
1	Back flush the drain with cold water.
2	Use a flexible rod to clear sediment from the drain outlet. NOTE A full chemical splash proof suit shall be worn for this operation
3	Manually operate the agitator (if fitted) in both directions to try to release the blockage.

9.4 Fire in the carbide lime slurry overflow

It is possible for small fires to occur in the lime slurry overflow system. Table 10 gives the procedure to deal with these fires.

Table 10 Procedure to deal with a fire in the lime slurry overflow

Step	Action
1	Extinguished the fire with a dry powder fire extinguisher.
2	After the fire is extinguished, a thorough investigation shall be undertaken to establish and rectify the basic problems.

9.5 Blocked carbide feed drop chute

A blockage in the carbide drop chute (which feeds carbide into the generator) is potentially hazardous. Table 11 shows the steps to deal with a blocked carbide drop chute.

Table 11 Initial procedure to deal with blocked carbide drop chute

Step	Action
1	Stop the carbide feed by activating the generator stop.
2	Allow the compressors to continue running to take the after-generation from the generator and to allow the gasholder to fall to minimise the gas contents of the generator, then stop the filling plant.
3	Ensure no other sources are supplying acetylene gas to the generator (i.e. blow-down manifolds, manifold vents, regenerating dryers, acetylene trailers, etc.).
4	Activate the generator nitrogen purge system and open the generator or gasholder vent to atmosphere.
5	Advise the supervisor of the situation so they can decide what action shall be taken, and if the blockage is a major incident.
	It is essential that no air is introduced in to the generator as this can cause an explosion. In the absence of nitrogen purging, do not open any valves to atmosphere (this includes the outlet gas/air valve and safety relief valves).
6	Close all valves to the purifiers and compressors.
7	Ensure the water level in the generator and the hydraulic main are maintained at high operating levels.
8	Turn on the manual water valve to maintain as much cooling water as possible in to the generator body. Where a generator is fitted with a carbide feed shower system, turn this water supply off.
9	Wait for the generator to become completely cold before any attempt is made to unblock the carbide feed or chute.

When the generator is completely cool, the blockage shall be removed. This requires a procedure to be prepared and risk assessed before taking any action. The procedure shall be implemented under a permit to work control (see EIGA Doc 40, *Work permit systems* [3]). The permit to work shall take into account actions as shown in Table 12.

Table 12 Permit to work actions

Step	Action
1	Keep the generator filled with water to a high level during the entire process.
2	Before opening any access point on the carbide feed system, ensure that the system has been thoroughly purged with nitrogen, and that adequate nitrogen is supplied to keep air out.
3	Manually remove all remaining carbide in the carbide feed system in line with the instructions provided by the generator manufacturer or the generator operating instructions.
4	If after opening any of the access covers hot areas are discovered, allow the nitrogen purge to continue until the area has cooled completely.
5	Remove the helix or feed device to enable the down chute to be visually inspected.
6	Remove any further unreacted carbide found. Store all carbide removed in covered steel drums or covered boxes.
	There is a risk of a flammable atmosphere being present and a flash fire occurring. Use gas monitoring equipment to check for flammable acetylene concentrations, and asphyxiation risk due to oxygen deficiency as a result of nitrogen purging.
7	If possible and suitable for the generator type, raise the water level in the generator body as high as possible to wet the blockage from underneath. If possible, use water to thoroughly wet the blockage from above. This process can dissolve and/or soften any blockage slowly.
	The presence of any live carbide in the blockage will result in generation of acetylene and creation of heat, which requires cooling with large amounts of water. Use gas monitoring equipment to check for acetylene generation.
8	It could be necessary to remove lime build-up mechanically. Always use spark free tools. Hard wooden implements can also be used.
9	When the blockage is finally clear, shut the system down completely for a full generator clean and incident investigation.

9.6 Hoist failure

If the hoist fails whilst the skip or container is being lifted, do not perform any actions not covered by procedures in an attempt to charge the hopper, as these can introduce additional risk of a hopper fire. The different steps to deal with a carbide hoist failure are listed in Table 13.

Table 13 Procedure the deal with a carbide hoist failure (whilst charging)

Step	Action
1	Stop all generators by pressing the generator stop button.
2	Operate the hopper nitrogen purge for the affected generator.
3	Leave the building and prevent any persons approaching the generator.
4	Wait for the generator to cool down and acetylene generation to stop.
5	Do not restart production until the hoist is either repaired or replaced with an approved unit.

10 Carbide lime emergencies

Because carbide lime is highly alkaline, specific environmental regulations can exist in some locations. Ensure all applicable local and national regulations are consulted for compliance with handling, storage, transporting, disposal and reporting requirements. The procedure to deal with a carbide lime spill is given in Table 14.

Table 14 Procedure to deal with a carbide lime spill

Step	Action
1	Prevent spill from entering drains by using sandbags, absorbent pillows or a boom.
2	Absorb the liquid waste in sand or other absorbent material, or sweep up solid material, and store in containers for disposal (preferably by returning it to the carbide lime treatment plant).
3	Hose down all contaminated concrete surfaces with an excess of water, preferably draining the water back in to the lime treatment plant.
4	Where contracted assistance is required to clean up the spill, ensure that any lime disposal done by contractors is in line with local hazardous material and environmental regulations.

11 Purifier/scrubber emergencies

Table 15 shows how to deal with a purifier/scrubber fire

Table 15 Procedure to deal with a purifier/scrubber fire

Step	Action
1	If a fire occurs at any of the drain or sample valves, close the valve.
2	If the fire makes it impossible to close the valves, stop the plant and raise the emergency alarm.

12 Compressor emergencies

Acetylene compressor fires can occur at any of the following points where acetylene, lubricating oil or condensate is released:

- leaking glands, pressure relief valves
- any vent or condensate drainage point
- bursting discs
- leaking high pressure joints.

To deal with an acetylene compressor fire, see Table 16.

Table 16 Procedure to deal with an acetylene compressor fire

Step	Action
1	Immediately stop the compressor.
2	Closing suction and discharge valves; ff the fire is at the compressor separator, aftercooler or any drainage point, attempt to stop the fire by closing the drain valve if safe to do so.
3	Stopping the generator(s) (such as by activating the plant emergency stop).
4	Let the fire burn out in a controlled manner.
5	If needed, keep equipment, pipes and vessels cool with water sprays; if the compressor fire can affect acetylene cylinders, start the main plant deluge system.
6	the compressor shall not be restarted until it is thoroughly cleaned and checked, and the cause of the fire investigated and understood, with suitable corrective actions taken.

13 High pressure drier incidents

Drain valve fires are usually caused by the operator manually draining water by opening the drain valve too fast and the escaped acetylene can ignite. In the case of a high-pressure drier fire, see Table 17.

Table 17 Procedure to deal with a high-pressure drier fire

Step	Action
1	If a fire occurs at any of the drain or sample valves, close the valve.
2	If the fire makes it impossible to close the valves, stop the acetylene supply to the dryer and allow the fire to burn out.
3	If needed, keep equipment, pipes and vessels cool with water sprays; if the compressor fire can affect acetylene cylinders, start the main plant deluge system.

14 Cylinder filling incidents

14.1 Acetylene decomposition in acetylene cylinders

"Hot" cylinders in an acetylene plant are a unique and serious hazard. A hot cylinder is one where an internal decomposition is occurring or is suspected of having internal decomposition. All plant personnel shall be familiar with the nature and identification of a hot cylinder, and the actions to take on discovery or suspicion of a hot cylinder. Whenever a hot cylinder is detected or suspected, immediate quick action is required. Do not waste any time and proceed with the steps as listed in Table 18.

Table 18 Procedure to deal with hot cylinders

Step	Action
1	Never move a “hot” cylinder.
2	Avoid approaching the cylinder wherever possible.
3	Raise the alarm so other personnel know that there is a “hot” cylinder.
4	Initiate the Site Emergency Plan for “hot” cylinders and evacuate all personnel from the plant.
5	The plant deluge system and any fixed fire monitors must be turned on as soon as possible.
6	Personnel involved with periodic checking of the hot cylinder shall perform the check from the furthest possible distance and keep behind a solid structure wherever possible; wetting tests shall be performed according to EIGA Safety Info 02, *Handling of Gas Cylinders during and after Exposure to Heat or Fire* [4].
7	All cylinders or bundles involved in hot cylinder incidents (or suspected hot cylinder incidents) shall be condemned and removed from circulation and further use.

14.2 Decomposition starting from a cylinder valve

Under some conditions, a decomposition can be started when a cylinder valve is closed. When closing the cylinder valve, typically at the end of filling cycle, a muffled “crack”, “snap” or other sharp sound can be heard or felt by hand. This can be followed by rapid heating of the cylinder neck/shoulder or the entire cylinder. The above could also be applicable to closing filling rack isolation valves.
In these cases, treat the cylinder as if it is a hot cylinder from the moment of detection. It is possible for the cylinder to rupture in less than a minute, which is not enough time for the cylinder to start heating up externally. All plant personnel operating the cylinder and filling rack valves shall be sensitive to unusual valve behaviour when operating valves; for this reason, closing acetylene cylinder and rack valves with powered tools is not recommended.

14.3 Blowing down and scrapping incident cylinders

Cylinders involved in hot cylinder incidents can still have gas inside the cylinder after they have been completely cooled. This gas can contain hydrogen. Table 19 lists the procedure for blowing down/scrapping incident cylinders.

Table 19 Procedure to blow down/scrap incident cylinders

Step	Action
1	Gas removed from cylinders involved in hot cylinder incidents shall be safely vented to atmosphere by using a blowdown manifold.
2	Cylinders involved in hot cylinder incidents shall be condemned, even if there is no visual evidence of decomposition.
3	Bundles involved in a hot cylinder incident: check all components for signs of decomposition, heat exposure or over-pressurisation, and replace as required. Bundles involved in a hot cylinder incident should be fully refurbished before being put back into service.

14.4 Return filling racks back into service

Where a hot cylinder is discovered on a filling manifold, follow the procedure as listed in Table 20 before putting the filling rack back into service.

Table 20 Procedure to return filling racks back into service

Step	Action
1	After the "hot" cylinder is removed from the rack, carefully check all the remaining cylinders for signs of becoming hot for the next 24 hours.
2	Disconnect the cylinders from the rack and quarantine them.
3	Check each cylinder outlet for signs of decomposition (blackening, soot, unusual deposits). Any suspect cylinders must be safely vented to atmosphere before being internally examined.
4	Check all cylinder connections, hoses, valves and fittings on the filling manifold for signs of decomposition, heat exposure or over-pressurization. Replace all suspect equipment as require.
5	Check filling system piping, flashback arrestors and other equipment for signs of decomposition, heat exposure or over-pressurization. Replace, repair or clean as permitted by local regulations.
6	Filling systems shall only be put back into service after detailed inspection and necessary repair as required.

14.5 Acetylene leaks

A major leak of acetylene is one which could create a large flammable atmosphere within a short time. Examples include:

- failure of a safety device on a cylinder (e.g. fusible plug);
- rupture of a filling hose or distribution board hose;
- rupture of a high-pressure pipe, valve, fitting, flange etc.

Table 21 sets out the procedure to deal with acetylene leaks during filling.

Table 21 Procedure to deal with acetylene leaks during filling

Step	Action
1	Immediately trigger the plant emergency stop and evacuate the plant.
2	Start the filling plant deluge system. Initiate the plant emergency plan.
3	Stop the generator and compressors and isolate the leak.
4	Ensure all available doors and windows are open to maximize ventilation and allow the acetylene gas to disperse.
5	Once the plant has been made safe, start an investigation into the cause of the leak. The plant should only be restarted after the conclusion of the investigation, and completion of corrective actions.

14.6 Air in cylinders

Air in acetylene cylinders is a very hazardous situation which could easily lead to a fire or explosion. Air can enter acetylene cylinders in a variety of ways, including:

- gasholders or water seals run empty;
- generator return water supply run empty;
- compressor suction pipe work not connected;
- valves (e.g. drain valves) left open;
- compressed air line connected to process (water or gas) pipe work or equipment;
- air entrained in process water or fresh water supply;
- failure to purge plant after maintenance.

Indications that air (or nitrogen) can have entered the acetylene cylinders include:
- filling pressures increase faster than normal on manifold filling systems;
- acetylene purity test results lower than 98%;
- high level of filling rejects in fast-fill systems.

If it is known or suspected that air (or nitrogen) could have entered the acetylene cylinders, the actions from Table 22 should be considered.

Table 22 Procedure to deal with air (or nitrogen) compressed in acetylene cylinders during filling

Step	Action
1	Shut down the compressors and generators.
2	Assess the evidence for air contamination and the extent of the potential hazard.
3	Isolate any gas lines leading to or from the fill manifold.
4	Depressurize all filling manifolds and high-pressure pipe work.
5	Clearly identify the cylinders as quarantined.
6	Slowly and safely blow down the gas from the cylinders to atmosphere using a blowdown manifold.
7	Prepare the cylinders for filling (e.g. add acetone if necessary).
8	Identify and repair the technical issue causing the ingress of air (or nitrogen).
9	Repurge the process system.
10	Fill the cylinders, paying attention to any unusual filling conditions such as elevated pressures, slow fillers, …
11	Check the purity of the gas in a sample of cylinders involved in the incident, across the range of cylinder types, to ensure no air (or nitrogen) has remained in the cylinder.

15 Cylinder test shop incidents

15.1 Gas release when removing valve

If an unusual gas release occurs while removing an acetylene cylinder valve, the actions listed in Table 23 should be taken.

Table 23 Procedure to deal with gas release when removing the valve

Step	Action
1	Operate emergency stops.
2	Stand well clear and evacuate the cylinder retest area in case of an ignition or explosion.
3	Where fitted, ensure that the extraction or forced ventilation system is operating.
4	Allow escaping gas to vent and disperse.
5	If the cylinder retest area is equipped with a deluge it should be activated.

15.2 Failure of a vacuum bag containing asbestos

In the periodic requalification of acetylene cylinders, it is sometimes necessary to vacuum out dust from the top/plug section due to crumbling of the porous material. Certain older cylinders (pre 1990) can have porous material containing small amounts of asbestos. If those cylinders are part of the requalification process the vacuum bag used to collect the dust will contain asbestos. The disposal of

this material requires certified waste transfer control, but whilst in use there is potential for the bag to burst/fail and release asbestos. The protocol in Table 24 applies to such an inadvertent release.

Table 24 Failure of a vacuum bag containing asbestos

Step	Action
1	Leave the area Take time to make an action plan, but do not waste time. A potential exists for increased distribution of the asbestos fibres which will make the clean-up task longer and more difficult. Timely intervention is important, but it is not an emergency causing immediate risk to life.
2	Ensure that any personal exposure is minimized Dispose of all clothing present at time of spillage Clean the persons exposed: a. Use a vacuum cleaner to remove fibres from the skin. b. Have a shower and scrub away all fibres from skin.
3	Put on correct PPE to protect from asbestos fibres: a. disposable dust particulate respirator b. disposable non-woven overalls c. disposable gloves d. disposable boot covering e. safety goggles.
4	Prevent further release/spread of material: a. Use a plastic bag to secure the material. b. Once complete seal this bag in a secondary plastic bag and then place in secure packaging.
5	Clean the workplace and the exposed equipment: a. Vacuum all areas and equipment. b. Wash the floor and wipe down with wet sponge (dispose of the sponge as contaminated waste).
6	After the clean-up is complete: a. Place all disposable PPE into the contaminated waste material. NOTE Take care to turn items like overalls, glove and shoe covering inside out as it is taken off to avoid exposing oneself whilst removal. NOTE Contaminated waste shall be disposed by a certified waste disposal contractor. b. Wash any non-disposable PPE or clothing i.e. boots/footwear, personal clothing. c. Have a shower and scrub away all fibres from skin.

16 Solvent incidents

16.1 Solvent fires

Avoid using fire hoses or sprinklers on an acetone fire, as this can spread the fire and increases its intensity. If the burning acetone is close to or between acetylene cylinders, activate the plant deluge system immediately. The risk of spreading the acetone fire is less than the risk of the cylinders becoming involved in the fire. Table 25 gives the procedure to deal with solvent fires.

Table 25 Procedure to deal with solvent fires

Step	Action
1	Identify the source of the solvent leak and isolate.
2	If isolation is not possible: the site emergency plan shall be initiated.
3	Where contaminated firewater run-off is captured, it shall be disposed of in accordance with local environmental regulations which may require a licensed waste disposal contractor.

16.2 Solvent spills

Acetone is a highly flammable and volatile liquid. Any acetone spill can create a significant fire hazard. All acetone spills should be treated with extreme caution.

Although dimethylformamide (DMF) is also highly flammable, it is far less volatile, and therefore is less likely to create a large flammable atmosphere. DMF poses a significant toxic hazard to people involved in the clean-up, requiring suitable PPE to be worn.

Table 26 gives the procedure to deal with solvent spills.

Table 26 Procedure to deal with solvent spills

Step	Action
1	Do not use fire monitors or sprinklers on a solvent spill, as this increases the area covered by the spill and makes the clean-up operation more difficult.
2	Use booms and spillage containment kits to contain spill and prevent it going down surface water drains.
3	Collect all spillage into empty drums (for example by using a suitable portable pump). If not possible, allow to evaporate to atmosphere naturally.

17 References

Unless otherwise stated the latest revision shall apply.

[1] EIGA Doc 123, *Code of Practice Acetylene* www.eiga.eu

[2] EIGA Doc 136, *Selection of Personal Protective Equipment* www.eiga.eu

[3] EIGA Doc 40, *Work Permit Systems* www.eiga.eu

[4] EIGA Safety Information 02, *Handling of Gas Cylinders during and after Exposure to Heat or Fire* www.eiga.eu