

Safe Working with Cyanides

Introduction

Metal cyanide salts such as sodium cyanide (NaCN) and potassium cyanide (KCN) are acutely toxic by ingestion or in contact with the skin. Cyanide salts react with moisture or acids to produce hydrogen cyanide gas (HCN). Hydrogen cyanide is a flammable, toxic colourless gas that reportedly smells of bitter almonds (although a large proportion of the population are unable to detect the odour).

Cyanide salts are used in industry and research and can be handled quite safely under controlled conditions by a competent researcher using suitable safety equipment. However, when handled incorrectly they can be deadly. Cyanides inhibit the body from using oxygen and exposure to high concentrations can lead to serious illness or death with little warning. The HSE publication EH40 gives occupational exposure limits for some cyanide compounds (see table 1). However, our aim should always be to reduce our exposure to as close to zero as possible.

Substance	15min STEL	8h TWA
Hydrogen Cyanide	4.5ppm	0.9ppm
Sodium Cyanide	5mg.m ⁻³	1mg.m ⁻³
Potassium Cyanide	5mg.m ⁻³	1mg.m ⁻³
Other cyanide salts	5mg.m ⁻³	-

Table 1: Occupational exposure limits for cyanide compounds (HSE EH40, 3rd Edition)

This guidance note is intended to provide an overview of the precautions that should be implemented to ensure a safe system of work when working with any cyanide compound.

Safe Storage of Cyanide Salts

Metal cyanide salts (other than ferrocyanides and ferricyanides) are listed in Part 1 of the Schedule of the Poisons Act 1972 and The Poisons List Order 1982 due to their high toxicity. This means that they should be securely stored, and access strictly controlled. Consider the following:

- Cyanide salts should always be kept in a locked cabinet to prevent unauthorised access and should **never be stored on the open bench or in unlocked cupboards**. Cabinets used for storing poisons should be clearly labelled and designed such that they cannot be easily removed from the laboratory i.e. if a strongbox or small cabinet is used it should be secured to a bench, wall or other fixed point. This should be the case even when laboratories or buildings have a secure entry system.
- Access to the keys (or combination) to cyanide storage cabinets should be tightly controlled by a competent person and only authorised users should be given access.
- Recording the use of cyanides is highly recommended both to manage stocks and to help ensure that any thefts or losses are identified. A detailed inventory of cyanide salts should be maintained, and stock levels and usage recorded.
- If any significant discrepancies in the inventory are identified, then an internal investigation should be conducted to determine if any material has in fact been lost. In the event that missing stock cannot be located then SEPS should be notified in the first instance.

- Consideration should be given to storing cyanide salts inside a secondary container (e.g. Safepak or equivalent) to minimise the risk a leak or spillage either in the storage cabinet or in other uncontrolled areas. However, care should be taken to choose an appropriate secondary container that allows easy access to the contents without tipping or pouring.

It is generally good practice when working with highly toxic substances to ensure that only the minimum amount is purchased in the first place and that excess stocks are not held. This reduces both the risk to staff and students but also minimises the cost of disposal of obsolete materials.

Note: When stocks of cyanide salts are no longer required it is strongly recommended that they are disposed of via the University's approved chemical waste contractor.

Note: Cyanide salts are highly reactive and will release highly toxic hydrogen cyanide when damp or in contact with acids. They must be stored in a cool, dry area and separated from incompatible chemicals (in particular organic and inorganic acids).

Prior Permission and Risk Assessment

With all chemical processes work should only begin after the process has been fully risk assessed to ensure the risk to users is minimised. Where cyanide salts or hydrogen cyanide are involved every effort should be made to eliminate the risk of exposure. In particular consider the following:

- Use of cyanides should be subject to a "Permission to Work" scheme where approval is required before work can commence. Projects involving cyanides should be reviewed by a competent person and safety measures agreed before they can be undertaken.
- Many management units operate a local policy for purchasing of cyanide salts where a senior member of the management team must authorise each purchase. Consideration should also be given to how cyanide salts are managed by central stores to ensure the safety of everyone who could encounter these toxic substances.
- Only competent personnel should be permitted to work with cyanide salts, this should involve training in the hazards, control measures and safety procedures required to handle cyanide salts safely. This should be formally recorded to produce a list of authorised users.
- A robust CoSHH assessment should be in place before the work begins. This should be signed by the person carrying out the work and countersigned by a suitable second person, often this will fall to the PI in charge of the group.
- Lone working with cyanides should not be permitted under any circumstances, a "buddy system" should be operated whereby a second person is available to provide assistance if required. A trained oxygen therapy first aider should be present during operations involving cyanide.
- Out of hours working with cyanides should not be permitted.
- Overnight experiments should be avoided where possible and the risks to anyone who might enter an area where cyanides are in use (e.g. cleaning staff, contractors and emergency services) should be clearly communicated and control measures put in place.
- Areas and equipment used for cyanide work should be clearly labelled while work is ongoing (including destruction of residues).

Note: No work with cyanides should be undertaken unless a qualified oxygen therapy first aider equipped with an oxygen therapy first aid kit is present.

Control Measures

To help inform the risk assessment some recommended control measures to reduce the risk of exposure to cyanides are listed below. Most of these are straightforward to implement:

- In accordance with the control measures set out in the CoSHH regulations the best method of control is to try and find safer alternatives to cyanides. Where safer alternatives exist, these should be used unless there is a compelling reason not to do so.

- In addition to a risk assessment it is recommended that a specified scheme of work or standard operating procedure is used for processes involving cyanides. This scheme should be regularly reviewed, easy to understand and ideally should include key safety information (including emergency procedures).
- All work involving cyanides (including weighing out and treatment of waste) should be carried out in a fume cupboard (or equivalent). Where recirculating fume cupboards are used the filter should be suitable for cyanides and regularly checked to ensure it has not become saturated.
- Although spillages in fume cupboards tend to be contained it is worth considering working in a shallow tray to further contain any spilled material. Care should be taken to ensure that equipment such as balances etc. are cleaned fully should a spillage occur.
- For the most part normal laboratory PPE is sufficient for working with cyanide salts in a fume cupboard i.e. lab coat, safety glasses and disposable nitrile gloves. It may be worth considering double gloving where practical.
- Respiratory protection suitable for hydrogen cyanide is available but is rarely as effective as the use of a suitable fume cupboard and only protects the individual and therefore should only be used in exceptional circumstances (with prior permission). **Remember that face-fit testing will be required if respirators are deemed necessary.**
- All glassware and other containers used to contain cyanides should be clearly labelled with the contents, appropriate hazard symbols and the name of the researcher. Where possible cyanides should only be stored in their original containers.

Destruction and Disposal

Unused stocks of cyanide salts and cyanide-containing residues should either be destroyed or disposed of as soon as possible:

- Bulk cyanide waste including obsolete or unused stocks should be disposed of via the University's approved chemical waste contractor. Care should be taken to ensure that the risk to the contractor(s) removing the stocks are minimised.
- Large amounts of waste products contaminated with cyanides should be clearly labelled and stored in a secure chemical waste store for collection by the University's chemical waste contractor. Ideally the storage area should be secure and secondary containment should be used to contain any spills or leaks. **Under no circumstances should cyanide waste be mixed with any other kind of waste.**
- Small amounts of waste can be destroyed by mixing it with an excess of sodium hypochlorite solution in alkaline solution (pH 10) for a period of 24 hours. **This process must be carried out in a fume hood and it should be monitored to ensure that the waste never becomes acidic.**

Emergency Procedures

Work with cyanides should not be undertaken unless the actions to take in the event of an emergency such as a spillage or exposure to cyanides have been considered and suitable mitigation procedures put in place. Consider the following:

- Small, contained spills of solid material in controlled areas such as fume cupboards can be swept up and disposed of through the usual route. Small liquid spills and contaminated equipment can usually be cleaned up using an alkaline solution of sodium hypochlorite ensuring that the pH of the solution never becomes acidic. **Remember that appropriate PPE must be worn during cleaning operations.**
- Large spills (or spills in open lab areas) are likely to require evacuation of the area. While it may well be possible to clean up larger spills in a controlled area such as a fume cupboard this should be subject to risk assessment, specialist assistance may be required for very large spills and/or those occurring outside the fume cupboard.
- In the event of coming into contact with cyanide salts (or solutions) any contaminated PPE or clothing should be removed as quickly as possible. The affected area of skin (or eyes) should be washed for 15 minutes and

oxygen therapy applied in a safe area. **If anyone is believed to have come into contact with cyanide an ambulance should be called via security.**

- In the event of an accidental inhalation of hydrogen cyanide (or cyanide salts) the affected person should be removed to fresh air and oxygen therapy first aid administered. **If anyone is believed to have inhaled cyanide an ambulance should be called via security.**
- In the event of a cyanide salt being mixed with acid, hydrogen cyanide will be generated. In the event that this occurs inside a fume hood the sash should be pulled down and the area evacuated, an assessment of further actions can then be undertaken but it is likely that specialist assistance may be required. In an open lab the lab and surrounding area should be evacuated immediately, and the emergency services called.
- A qualified oxygen therapy first aider (with oxygen therapy first aid kit) should be available during any work involving cyanide. Oxygen therapy first aid kits should be centrally located and subject to regular inspection and maintenance to ensure they are available for use if required. Oxygen therapy first aiders **must** receive regular refresher training and be made aware of the hazards of cyanide exposure.

Note: Oxygen therapy first aiders and other emergency responders must be made aware of the risks of entering an area where a release of hydrogen cyanide may have occurred and should only intervene where it is safe to do so. If it is deemed safe to provide assistance, casualties should be removed to fresh air for treatment.

Note: Under no circumstances should mouth-to-mouth resuscitation be attempted on a casualty who is believed to have inhaled or ingested a cyanide compound.

Note: In the past several different “antidotes” have been used in laboratories for suspected cyanide poisoning including amyl nitrate, solutions A and B (oral solutions of ferrous sulphate in aqueous citric acid and aqueous sodium carbonate) and intravenous dicobalt edetate (Kelocyanor). These treatments are considered obsolete and should not be used under any circumstances.

Further Information

Cyanides can be extremely hazardous, and their use should only be considered in cases where no practical alternative exists, and a robust risk assessment has been completed. Individual management units must put in place a procedure for purchasing, storage and use of cyanides which is clearly communicated to staff.

Further information can be obtained by contacting the Safety and Environmental Protection Service. Information on antidotes and oxygen therapy first aid was taken from the HSE website <http://www.hse.gov.uk/pUbns/misc076.htm>

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