

**Risk Assessment Department of Physics and Astronomy**

| **Date:** (1) | **Assessed by:** (2) | **Checked / Validated\* by:** (3) | **Location:** (4) | **Assessment ref no:** (5) | **Review date:** (6) |
| --- | --- | --- | --- | --- | --- |
| **Task / premises:** (7)  Transport, Use and Storage of Gas Cylinders, Regulators and Manifolds  Only trained competent persons should use and transport gas cylinders.  Anyone who is moving gas cylinder must have attended the LOD– TLCA105 – [Gas Safety and Regulators Course](https://app.manchester.ac.uk/training/profile.aspx?unitid=7719&parentId=4) – Compressed Gas Workshop and have the correct PPE (this course requires a refresher every 3 years) and also completed the LOD in-house practical TLCA500 Manual Handling Workshop.  For those using gas cylinders it is accepted to be trained in-house by a competent person, they should be sign off as competent using the P&A process.  Further guidance can be found on Safety Services website: [Compressed gas cylinders and manifolds](http://documents.manchester.ac.uk/display.aspx?DocID=46843) and [Siting of oxygen depletion monitors for use](https://documents.manchester.ac.uk/display.aspx?DocID=15617)  [with inert gases and siting of carbon dioxide monitors for use with carbon dioxide.](https://documents.manchester.ac.uk/display.aspx?DocID=15617)  Please remove all aspects of this RA which are not specific to your scenario | | | | | |

| **Activity** (8) | **Hazard** (9) | | **Who might be harmed and how** (10) | **Existing measures to control risk** (11) | **Risk rating** (12) | **Result** (13) |
| --- | --- | --- | --- | --- | --- | --- |
| Transport of Gas Cylinders | Manual Handling, impact, crush, finger trap/ release of gas/ Asphyxiation/ inhalation of a hazardous substance | | User and others in proximity – cylinder falling over, tipping cylinder cracks  risk of damage to back, crush injuries to hands and feet.  Breathe in gas or toxic gas and collapse | Only trained users must transport gas cylinders around the building.  **NEVER** allow a cylinder to be free standing. The large height to base diameter ratio of a gas cylinder causes it to be unstable.  **NEVER** attempt to catch a falling gas cylinder. If a cylinder is accidently dropped, **DO NOT USE**, send back to the supplier.  Cylinder trolleys **must be used** to transport cylinders around the buildings and a second person must assist with collection/moving of the cylinders in order to open doors etc. Gas cylinders should be firmly secured to the trolley before transit.  Cylinder trollies must be checked before use for any signs of wear or damage. Ensure:   * The trolleys are in good condition, * The wheels have good grips and are not loose, * There are no signs of corrosions on trolley, * The trolley can handle the cylinder weight and size of the cylinder to be moved, * The trolleys’ handle grips are in place, * Chains and straps are good condition, intact and also can be fitted around the cylinder securely.   Do not use a faulty trolley. Take out of use and labelled as faulty.  Correct safety footwear (EN ISO 20345 steel toe cap shoes) must be worn at all times when transporting cylinders. Gripper gloves must be worn when moving cylinders.  **NEVER** try to pick up, carry or roll a cylinder (small cylinder excepted). The valve guard, shroud or caps must not be used as a lifting point. Ensure the trolley is brought as close to the cylinder before moving and placing in the cylinder trolley. Use the Churning motion to manoeuvre gas cylinders – tip the cylinder slightly and ensure two hands are firmly positioned near the top of the cylinder, whilst gently turning the cylinder into place on the trolley.  Small cylinders may be lifted using the appropriate carrying handles provided and placed carefully in the appropriate trolley.  **NEVER** transport a cylinder with attached regulators or hoses. The cylinder should be closed at the cylinder head valve.  All cylinders should be visually inspected before moving. Faulty cylinders should never be moved, and the supplier should be contacted.  **TILE** should be used when moving a gas cylinder.  *Task* – consider the route, length, slope, wide enough, not along a public highway (road).  *Individual* – the user is trained and been on the in-house LOD manual handling course and physically capable of handling the load.  *Load* – consider its weight, size/shape.  *Environment* – Is it well lit, even floor/slope, any obstruction and weather conditions. A trolley may slip if the surface is wet.  When transporting cylinder from outside the building, allow to acclimatise to room temperature before use, otherwise the sudden change in temperature can damage the cylinder and cause a release of gas. | Low | A |
| Use of lifts to transport cylinders | Confined space, release of gas  Asphyxiation  Inhalation of a hazardous substance | | Anyone present in lift.  Trapped in a confined space. Breathe in gas and collapse. | Cylinder must only be transported between floors via the goods lift, **unaccompanied**. **NEVER** travel in a lift with a cylinder, even if thought empty.  Schuster: The goods lift **must be locked out** during this time to prevent entry by any other user and the double ended signage stand must be placed inside the lift to warn others not to enter the lift during transit of the hazardous material. Good lift keys can be obtained from Physics Stores.  Schuster building users are not permitted to start using the passenger lift for transport of hazardous materials when the goods lift is broken. Contact Physics Stores, I&F team or the Safety team who will arrange safe transport.  For Alan Turing the passenger lift is used (as there is no goods lift), there is a SOP for this operation and users should be trained. The lift must be locked out and the barrier placed inside the lift at the front to prevent anyone from entering.  **Do not use the goods lift to transport hazardous material during the weekly fire alarm test in Schuster on Wednesday at 9:15 am.** The lift controls are overridden in the event of a fire alarm and the lift will descend to street level. However, on deactivation of the fire alarm anyone can then enter the goods lift.  **Do not use the passenger lift to transport hazardous material during the weekly fire alarm test in Alan Turing on Mondays at 8:00 am.** The lift controls are overridden and will descend to the ground floor and the doors will open. | Medium | A |
| Hiring of Gas cylinders | Pressurised gas | | User and others in proximity  Breathe in gas, collapse, exposure to a hazardous substance | Only hire cylinders from approved suppliers, and preferably from Physics Stores. The cylinders are rented, so the manufacturers is responsible for carrying out routine tests and inspections on their cylinders (~10 years – see neck of cylinder for when inspection test is due). For corrosive gases the maximum time a cylinder should be kept is twelve months.  Manufacturers are also responsible for scrapping their own cylinders; **NEVER** scrap a cylinder you do not own – return it to the manufacturer. In most cases return the cylinder to Physics Stores.  Lecture bottles – only buy lecture bottles from manufacturers who will accept a return of the cylinder, they are very expensive to dispose of otherwise and this will come out of your own budget.  When cylinders are owned by the Department it is the responsibility of the person who owns the cylinder to ensure the 10-year statutory inspection occur. This will come at a charge and the cylinder may need to be sent away for this to occur. **NEVER** use a cylinder past its 10-year statutory inspection. | Low | A |
| Storage of gas cylinders | Pressurised  gas  Gas leak    Asphyxiation  Inhalation of a hazardous substance | User and others in proximity  Cylinder falling over, tipping, being exposed to heat, electricity, motion, vibration could cause cylinder to crack, releasing gas, explosion, flying debris and blast impact. | | All users must be trained in the safe use of compressed gases.  List all gas cylinders present in lab/workshop or cleanroom here:  All cylinders are clearly labelled and are not to be used if the label is unclear or missing. All cylinders must go on the chemical inventory section of LabCup along with their expiry date (neck of cylinder).  Ideally all cylinders must be stored upright (there are exceptions to this rule). Some gases pressurised become liquids (liquified compressed gas, there will be a combination of gas/liquid), these must be stored upright at all times. All cylinders must be segregated from others dependent on compatibilities (see SDS).  Corrosive materials can prove particularly hazardous if they come into contact with cylinders and care must also be taken to avoid contact with electricity and high temperatures. Some small cylinders are not fitted with rupture devices and may explode if exposed to high temperatures.  Cylinders should not be kept for longer than necessary and should be returned to Stores (even if gas is still present) when not required.  Cylinders must always be stored in an appropriate secure chain, clamp to a sturdy bench or in an appropriate stand, even when not in use. Cylinder trolleys are not suitable for the use or storage of cylinders.  The number of cylinders kept within the building should be kept to a minimum.  Any intention to use flammable, oxygen or toxic gases within the building must consult the safety team **BEFORE** ordering so the siting and risk assessment can be reviewed.  Never store compressed gases in corridors or offices, they must only be stored within labs, workshop or cleanrooms.  Gas cylinders should not be placed near the entrances to door as in a release situation it could block the escape route.  **NEVER** store Oxygen and flammable cylinders **within 3 m of one another** and preferably not in the same laboratory.  Acetylene is strictly forbidden from the buildings. Storage of flammable gas cylinders should ideally be within a fire safety storage cabinets constructed according to BSEN 14470-2:2006. | Low | A |
| Use of Regulators | Pressurised gas  Gas leak    Asphyxiation  Inhalation of a hazardous substance | | User and others in proximity  Breathe in gas, collapse, exposure to a hazardous substance | Regulators must be to European or British standard BS EN 2503. **ALWAYS** open connections slowly and close all valves on the gas cylinder and make safe any experiments. Multi stage regulators are recommended as they ensure a consistent pressure.  Regulators must be check before use. All regulators should have an annual in-house inspection by a suitably qualified, competent and trained person. [Regulator checklist](https://www.staffnet.manchester.ac.uk/physics-and-astronomy/health-and-safety/forms/) can be found on the Physics intranet under forms.  Out-of-date regulators **MUST NOT** be used. Regulators must be register on LabCup asset register along with their expiry date. | Low | A |
| Use of Gas Cylinder and Regulators | Gas leak/ Explosion  /Asphyxiation/ inhalation of a hazardous substance | | Staff and others in the proximity/ misuse could lead to serious injuries or death.  Cylinder falling over, tipping, being exposed to heat, electricity, motion, vibration could cause cylinder to crack, releasing gas, explosion.  Breathe in gas, collapse. exposure to a hazardous substance. | Never lubricate, modify, force or tamper with a cylinder valve. The cylinder valve must be closed when a gas cylinder is not in use or before attempting to stop leaks between the cylinder and regulator.  Cylinders should be fitted with the correct regulator and key and **should be closed** when not in use. Do not store cylinder keys in cylinder when not in use. The cylinder pressure should not be more than the regulator pressure rating. **Note:** Inert or non-flammable gas cylinders (like Oxygen, Argon) use the conventional Right-Handed screw threads.  **NEVER** use a faulty regulator. Take out of use and label.  Follow the P&A Standard Operating Procedure (SOP) for [Regulator checks](https://www.staffnet.manchester.ac.uk/physics-and-astronomy/health-and-safety/standard-operating-procedure-sop/) and [Cylinder checks](https://www.staffnet.manchester.ac.uk/physics-and-astronomy/health-and-safety/standard-operating-procedure-sop/).  After connecting a regulator to a cylinder use a leak detection spray to check for any gas leaks or use the pressure drop test, where the regulator is pressurised, the cylinder valve and outlet pressure valves are closed, and the outlet pressure is monitored for a reduction over time. If it reduces a leak is present.  **DO NOT** use oils, greases, solvents or PTFE tape on cylinder NEVOC valves or regulator bullnoses.  All gases cylinders must have an appropriate [chemical risk assessment (CRA)](https://www.staffnet.manchester.ac.uk/physics-and-astronomy/health-and-safety/chemical-risk-assessment-cra-library/) form which should be kept in the safety file of the area and signed by all users.  **NEVER** open a gas cylinder without a regulator in place. **ALWAYS** open connections slowly and close all valves on cylinders and regulators when not in use, even when empty. | Low | A |
| Use of oxygen depletion monitors | Release of gas  Asphyxiation  Inhalation of a hazardous substance | | Staff and others in the proximity/ misuse could lead to serious injuries or death.  Breathe in gas and collapse | All gases must have an appropriate gas calculation for the room; which should consider a full release of gas.  **The calculation must be included within this RA** (append at end of document) for all gases present (need to consider a release of all gases at the same time).  Calculation of oxygen depletion in room from full release of gases present: INPUT VALVE HERE %  Oxygen depletion monitors **MUST** be installed where there is a chance of an oxygen depleted atmosphere being generated.  All gas alarms should be able to be heard from outside the room, so in the event of a release of gas it would ensure that a person does not enter the room.  If the oxygen depletion is calculated to be below 19.0%, then an oxygen monitor must be provided. The I&F team must be contacted for advice. Consideration is required on where the placing of the monitor will go, depending on the density of the gas e.g. Helium is a light gas and so the siting of the gas monitors should be placed at height, Nitrogen at ~ 1.5 m and heavy gases near the floor such as Argon. Ideally the monitor should be placed near the gas cylinder to ensure the alarm is activated as soon as possible.  Gas monitors should not be placed near the entrance to doors as the air flow can affect the sensor reading.  All gas monitors must be registered with the I&F team and will be inspected by an external contractor every 6 months. | Low | A |
| Use of oxidising gases | Oxygen enrichment  Significantly increased risk of a fire or explosion  Burns | | Staff and others in the proximity.  Breathe in gas and collapse  Releasing gas coming in to contact with fire, flames and hot surfaces. | Oxygen is an oxidiser, support combustions and so may cause or intensify a fire. Dirt, oil, grease or any other contamination can cause a fire and explosion if left on the bullnose or threads of oxygen regulator and fittings. All components should be inspected for cleanliness before installing.  Calculation of oxygen enrichment in room from full release of oxygen gas: INPUT VALVE HERE % (append calculation at end of document)  All oxygen cylinders must be calculated for release if the oxygen level is above 23.5% (oxygen enrichment) then a monitor will be required. The I&F team must be contacted for advice. **NOTE**: oxygen is a heavy gas and so the monitor must be stored near the ground level. | Low | A |
| Use of toxic gases | Release of toxic gas | | Staff and others in the proximity.  releasing gas, exposure to a toxic substance.  Serious injuries and death | For toxic gases an additional calculation will be required in addition to oxygen depletion calculation. If the release of the toxic gas is above the [working exposure level](http://www.hse.gov.uk/pubns/priced/eh40.pdf) (WEL - see SDS) then a monitor for this specific gas will be required.  Calculation of all toxic gases in room for a full release of toxic gases: INPUT VALVE HERE, along with the WEL. If different toxic gases are present calculate for each toxic gas. (append calculation/s at end of document)  The I&F team must be contacted for advice. Toxic gases may only be used within a fume hood.  **Note**: For CO2 cylinders if the release is greater than 0.5% then a monitor is required. CO2 is a heavy gas and so the monitor must be installed at ground level and close to the cylinder, in order to ensure a quick alert. I&F team must be contacted for advice. | Medium | A |
| Use of flammable gases | Gas leak  Explosion  Asphyxiation  Burns | | Staff and others in the proximity.  releasing gas, explosion, flying debris and blast impact. | For all flammable cylinders, an additional calculation will be required in addition to oxygen depletion calculation to calculate the release of flammable gas. If the release is within the upper explosive limit (UEL) and lower explosive limit (LEL) – see SDS, then a monitor will be required.  For flammable liquid gases such as propane and butane the calculation should consider the gas/liquid ratio and the weight of the cylinder (the pressure in these circumstances is not part of the calculation). Seek advice from the safety team if unsure.  Calculation of all flammable gases in room for a full release: INPUT VALVE HERE, along with the LEL and UEL. If different flammable gases are present calculate for each flammable gas. (append calculation/s at end of document).  The I&F team must be contacted for advice. Consideration is required on the placing of the monitor as H2 is a light gas whereas propane is a heavy gas.  Flammable gases use Left-Handed screw threads, this is to ensure that fuel gas cylinders are not interchanged with the non-flammable gas cylinders.  Avoid naked flames and other ignition sources near flammable gas cylinders. Some flammable gases burn with an invisible flame, so it may not be obvious.  All flammable gases MUST be fitted with a flashback arrestor. Flashback arrestors MUST be fitted downstream of the regulator, for any flammable gas. They must conform to ISO 5175. Flashback arrestors must be placed on asset section of LabCup along with their expiry date, so that all safety critical equipment can be tracked.  Purge equipment before use. 90% of all flashback incidents were caused by failure to carry out a purging procedure. Notches on the compressed gas fitting indicate that a left hand thread should be used for flammable gases, do not use on other gases.  Flame retardant lab coat and EN 166 safety glasses must be worn. | Medium | A |
| In the event of a release of gas | Gas leak  Asphyxiation | | Staff and others in the proximity.  releasing gas, breathe in gas and collapse.  Serious injuries and death. | In the event of a considerable gas leak:-  Evacuate the area immediately. If safe to do so close gas cylinder and make safe experiments and electrical equipment. Ensure no one re-enters the room until it is safe to do so, as indicated on the gas monitor. Inform I&F and safety team of incident.  In the event of an activation of a gas alarm:  If in the room; leave the area immediately, ensure no one else can enter. Stay out and go get help. Inform I&F and safety team of incident  If outside of room: Do not enter, stay out and go get help. Inform I&F and safety team of incident.  **Note: Do not attempt to rescue an unconscious person, get yourself out and ring 999 and ask for the fire bridge.** Multiple fatalities have occurred when rescuers have themselves been overcome while attempting to assist an unconscious colleague. The temptation to enter an area to affect a rescue is strong. However, the risks of doing so are extremely high. Under no circumstances should any individual attempt a rescue of an unconscious person. The quicker the fire service is alerted the higher the chance of survival of the individual. | Medium | A |
| Use of tubing and hoses | Impact  Flying debris | | Staff and others in the proximity.  Hoses flail and hit person.  Hit by flying objects. | Ensure associated pipework is suitable for the gas and the pressure of the cylinder. Hoses should be securely fixed to equipment using either the manufacturers fittings or suitable clips (**twisted wire and reusable worm screw fittings are NOT suitable**). All connections are checked for security/leaks. Reinforced hoses/ tubing should be used to pipe gas from a cylinder to the point of use. Where possible rigid hoses/ tubing should be installed. They should be inspected regularly for cracking and other degradation. Any found defective should be taken out of use and dispose of.  Hoses are colour coded to indicate gas usage. Never use a wrong hose as this could result in the gas attacking the inner lining.  Always use the correct length hose (no longer than is necessary for the task in hand). Hoses should be checked before use, check the whole length of the hose for damage/defects and free from contamination, oils and greases. Do not use reusable worm drive clips. Never use PTFE tape on joints.  Hoses should be to correct standard – BS EN 559 rubber/ ISO 3821:2019, BS EN 1327 thermoplastic or ISO 14113:2013 rubber plastic hose assemblies (450 bar).  Ensure hoses are not contaminated. Hose connectors should be to of a BS EN 560 standard (connections) and BS EN 561 (quick action coupling).  NEVER wrap tubing/hoses around a cylinder when in use, In the event of a hose fire the flames will encircle the cylinder and the operator will find it difficult to turn the cylinder off. If a fire occurs the hose and regulator must be replaced and the cylinder sent back to the supplier. Do not attempt to repair a damage hose, replace it.  When using hoses ensure EN166 safety glasses are worn. | Low | A |
| Use of Manifolds | Gas leak  Explosion  Asphyxiation  Impact injury from hose. | | Staff and others in the proximity.  Releasing gas, breathe in gas and collapse.  Serious injuries and death.  Hoses flail and hit person.  Hit by flying objects. | **NEVER** use a faulty Manifold.  Cylinders must be chained in place and not free standing. Ensure the supply system is able to withstand the maximum cylinder pressure. Gas cylinders of different pressures or types must **NEVER** be connected to the same supply system.  **DO NOT USE** past manufactures recommendations. They must be register on the insurance database and of had a written scheme of examination **BEFORE** use. Speak to I&F before installing. Do not use if past insurance sticker inspection date.  Visual inspection of manifold, hose and pigtails should be performed before use. Report defects to the I&F team.  Manifolds must be serviced and maintained - which the responsibility of the users. Records should be kept of all servicing, maintenance and local inspection of the systems.  Always depressurise the system and close cylinders before removing. If pressurised the hose could whip back and cause serious injury.  Use only full cylinders as replacements, otherwise the manifold will not operate properly. | Low | A |

**Declaration by researcher**

**I confirm that I have read this Risk Assessment and that I understand the hazards and risks involved and will follow all of the safety procedures stated.**

**Declaration by PI/Line Manager**

**I confirm that the researcher who has signed below is competent to undertake the work. My counter-signature indicates that I am happy for the work to proceed.**.

| **Name (please print)** | **Signed** | **Line manager /PI countersignature** | **Date** |
| --- | --- | --- | --- |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |