

**Pressure Systems Safety**

**1 Introduction**

Pressurised systems (and associated equipment) are commonly used across the University in research, teaching and support services. However, if not properly designed, maintained and operated they can fail catastrophically with the potential to cause serious injury and/or significant damage to property. Accidents involving pressure systems are most commonly caused by:

* Poor quality equipment and/or badly designed systems
* Improper installation
* Inadequate maintenance and inspection of equipment
* Unsafe procedures /systems of work
* Operator error (including poor training, lack of supervision)
* Inadequate repairs or unsafe modifications

Accidents involving pressure systems are considered very serious and have the potential to cause loss of life. To reduce the risk of such accidents most pressure equipment placed on the market has to meet the requirements of the Pressure Equipment (Safety) Regulations 2016 (PESR) which specifies how such equipment is designed and manufactured. Further requirements including the need for regular inspections by a competent person are set out in The Pressure Systems Safety Regulations 2000 (PSSR).

**Note: This guidance note concentrates primarily on the hazard presented by the pressurised fluid contained within the system rather than the design of the equipment itself. Remember that the physical and chemical properties of the fluid may also present a hazard in the event that the system fails in such a manner as to release the contents (i.e. if a pressure system contains a corrosive liquid the chemical hazard must be considered alongside the hazard associated with the pressure system).**

**What is a pressure system?**

A pressure system is defined as follows:

* Any system which contains (or is likely to contain) a relevant fluid and which contains one or more vessels of rigid construction along with any associated pipework
* Any pipework and its protective devices intended to be connected to a transportable pressure receptacle (e.g. a compressed gas cylinder)
* Any pipeline and its protective devices in which the relevant fluid is at a pressure more than 2 bar above atmospheric pressure (or 2.7 bar above atmospheric pressure if the normal pressure does not exceed 2 bar and the overpressure is caused solely by the operation of a protective device).

Under the regulations a “relevant fluid” is considered to be any of the following:

* Steam (at any pressure)
* Water in a sealed vessel that has been heated to more 110°C (usually found in high pressure hot water boilers)
* Any fluid (or mixture of fluids) at a pressure greater than 0.5 bar above normal atmospheric pressure, and which fluid (or fluids) is:
	+ A gas
	+ A liquid which would have a vapour pressure greater than 0.5 bar above atmospheric pressure (when in equilibrium with its vapour at **either** the actual temperature of the liquid or at 17.5°C). Note that this definition includes dissolved acetylene.

Some examples of pressure systems used across the University include:

* Boilers and other steam heating systems
* Compressed air systems (fixed and portable)
* Pressure cookers
* Autoclaves (including benchtop autoclaves)
* Heat exchangers and refrigeration plant
* Pipework and hoses (including laboratory gas supply manifolds)
* Pressure gauges and level indicators
* Cryogenic pressure vessels (e.g. liquid nitrogen, helium or argon)
* Commercial coffee machines

**2 Safe Design and Operation of Pressure Systems**

**Provision of Suitable Equipment**

Most pressure systems will be subject to the requirements of the legislation which puts duties on to the supplier to ensure the equipment is fit for purpose. The equipment (and accessories) should be constructed of a suitable material for the substances, temperatures and pressures to which they will be exposed.

The system should be installed in accordance with the manufacturer’s instructions and it should be possible to operate it (including all adjustable components) safely i.e. there should be no need to climb across pipework, enter confined spaces etc.

Pressure systems (and associated pipework) should be fitted with appropriate protective devices such as safety valves, bursting discs, electronic control systems etc. that are designed to shut down the system in the event that pressure, temperature, fill levels etc. exceed safe limits. Protective devices should meet the following criteria:

* Adjusted to the correct settings. Once set only an authorised person should be able to alter the settings and accidental adjustment should be impossible.
* Protective devices should be checked regularly and kept in good working order at all times. The operational status of a protective device should be easy to determine.
* Where fitted, protective devices such as relief valves, bursting discs etc. should discharge to a safe place where they will not pose a threat to anyone.
* Warning devices (where fitted) should be easily observed either by sight or sound (e.g. flashing lights, sirens, klaxons etc.

**Note: While it is possible to design and construct pressure systems in-house in practice ensuring that the system complies with the legislation and meets the appropriate standards is extremely complex and laborious. It will be necessary to have the equipment independently inspected, tested and certified which can be an expensive prospect. If there is a requirement to design any equipment in-house it is strongly recommended that you consult with both SEPS and a suitable external consultant at the design stage.**

**Note: The procurement of refurbished or second-hand pressure systems should be avoided to minimise the risk of failure due to poor condition / maintenance especially in cases where a complete, verified service history is not available. If procuring such equipment cannot be avoided then it must have a written scheme of examination prepared, be examined by a competent person and serviced prior to being put into service.**

**Operational Instructions and Training**

When a pressure system is in use it is important that all users (and others who might be affected in the event of an incident) have a working understanding of how the equipment operates and the risks in the event of foreseeable accidents. This should include:

* The fluid(s) (liquid/gas) contained, stored and processed inside the system and the hazards posed in the event of a release (e.g. corrosive, flammable etc.)
* Understanding the process (or storage) conditions of the equipment such as the pressure contained, whether the contents are at high (or low) temperature) etc.
* The safe operating limits of the system and of any equipment associated with, linked to or otherwise affected by it. This should include how to ensure the system etc. remains within these limits.
* Details of any safety systems and how they operate along with any associated emergency procedures

Everyone who operates, installs, maintains, repairs, inspects and/or tests a pressure system should have the necessary skills to work safely. Training may be formal (i.e. classroom sessions, training provided by suppliers) or can be provided informally at a local level by a competent person but in either case training records should be kept confirming both what training has been given and who is competent to complete a given task. Remember that the completion of a training course does not automatically confer competence and ongoing refresher training, supervision and support will be required. Training should be refreshed regularly and may be supported with standard operating procedures (SOPs) and aide memoirs to help users operate equipment correctly. Where practical these should be displayed next to the equipment in question.

**Maintenance and Modifications**

All pressure systems and associated equipment should be properly maintained with the system as a whole included within the maintenance regime. The manufacturer of the equipment is required to specify servicing and maintenance requirements for a pressure system. These may need to be adjusted to account for the age of the equipment, how often it is used and environment in which it is located. The maintenance guidelines from the supplier should be treated as the minimum standard (further advice on adjustments to the normal maintenance regime should be sought from the manufacturer).

During use of the equipment users should look for any evidence of problems with the system e.g. safety valves discharging repeatedly which could indicate that the system is over-pressurising (or that the safety valve is contaminated or faulty). The general condition of the equipment should also be examined for evidence of damage, wear, corrosion, deformation or leakage which could indicate the beginnings of a problem.

Modifications to a pressure system should only be carried out when absolutely necessary. Advice should be sought from the manufacturer before undertaking any such works to ensure the integrity of the system is maintained. Equipment should only be modified by a competent person and modifications should be completed using appropriate materials.

Details of any repairs and modifications should be documented, and accurate records kept for the lifetime of the equipment, a logbook is often the easiest way to achieve this.

**Note: Before any maintenance work is carried out the system should be fully depressurised to render it safe for examination and repair.**

**Note: Any pressure system that has been subjected to major repairs or modification will need to be formally examined by a competent person before it can be returned to service to ensure that it is safe to use. The equipment must not be used until this examination has been carried out. If you are in any doubt as to whether the system requires re-examination you should discuss with the University’s appointed competent person (contact SEPS for advice).**

**3 Written Scheme of Examination**

**Written Scheme of Examination**

A written scheme of examination is required for most pressure systems. Some systems are exempted from this requirement (see Appendix 1) but for the most part these are small systems or those with specialist applications. A written scheme of examination is a document which contains information about a pressure system typically:

* Identification of the items of equipment / plant within the system
* The parts of the system that require examination
* The nature of the examination required (including inspection and testing of protective devices)
* Preparatory work required for the examination to be carried out safely
* Nature of examination needed before a system is first used
* Maximum interval between examinations
* Critical parts of the system which is repaired / modified would require the system to be examined before the equipment is used again
* The name of the competent person certifying the written scheme of examination
* The date of certification

The written scheme should be created (or checked and certified) by a competent person and it is the duty of the user / owner of the system to identify relevant equipment and ensure this is carried out.

In addition to ensuring that each pressure system operated by the university has a written scheme of examination we have a duty to ensure that all equipment is examined regularly in accordance with the written scheme. This is a statutory requirement (in much the same way as an MOT is required for a car) but should not be treated as a substitute for regular ongoing inspection and maintenance.

Producing a written scheme of examination is a complex task which requires specialist knowledge. The University of Glasgow has appointed Zurich Risk Systems to fulfil this role. Zurich are accredited by UKAS to provide competent persons in fulfilment of these requirements (both preparation of written schemes of examination and examination of equipment in accordance with the written scheme).

Both written schemes of examination and examination reports are available via Crimson (Zurich’s online reporting system) and reports will be sent electronically to a named person in each management unit on completion of examination (a copy is also sent to SEPS). This provides a formal record of examination and is used by Zurich as a register of the pressure equipment owned or used by the University which requires formal examination. Equipment that has been examined will be clearly marked with an inspection label by Zurich, equipment that is not labelled should not be used. To ensure that we meet our legal obligations every effort should be made to facilitate the examination of pressure systems by Zurich by taking equipment out of service for inspection and allowing access to laboratory areas on request.

It is the responsibility of owners and users of pressure systems to make sure that all of their equipment is registered with Zurich and that it is safe to use unless exempt from written scheme of examinations (see appendix 1). This can be arranged via SEPS or by contacting our local Zurich Competent Person (details available via Crimson). Similarly, when equipment is removed from service or disposed of it should be removed from the register by the owner.

**Note:** **Just because a pressure system is exempt from having a Written Scheme of Examination does not mean that that an annual examination by a competent person is not required. All pressure systems should be examined regularly by Zurich as part of a safe system of work.**

**Note: It is illegal to operate a (non-exempt) pressure system without a written scheme of examination and to operate a pressure system that has not been examined by a competent person in accordance with the requirements of the scheme.**

**Failing an Examination (Imminent Danger)**

In some cases, the competent person may find during examination that a pressure system (or part thereof) poses an imminent danger to operators if it remains in operation. In this event the competent person will inform the person in charge of the equipment immediately. In the event that a piece of equipment is deemed to pose an imminent danger it must be immediately removed from service and steps taken to prevent it being used or returned to service until it has been repaired.

The competent person will then issue a report highlighting the defects and making recommendations for modifications / repairs that are required before the equipment can be returned to service. A copy of this report will be automatically sent to the enforcing authority (HSE) by the competent person within 14 days.

**Note: In the event that a pressure system under your control should fail an examination and is deemed to present an imminent danger remove it from service immediately inform the SEPS team as soon as possible.**

**Note: As with any report sent to the HSE this may trigger a formal investigation and/or enforcement action. It is therefore important to ensure that pressure systems are maintained properly and examined regularly to ensure they remain in a safe operating condition.**

**Reportable Dangerous Occurrences**

The failure of any closed vessel, its protective devices or of any associated pipework forming part of a pressure system (as defined by the Pressure Systems Safety Regulations 2000), where that failure **has the potential** to cause the death of any person is a reportable dangerous occurrence under RIDDOR.

This includes scalding or burns arising from contact with hot substances, immersion in liquids or splashing with toxic chemicals. Other examples of incidents which might be notifiable as having ‘potential to cause death’ would be those where a person was either struck by (or could have been struck by) a projectile emitted from the failure of a closed vessel or pipeline under pressure. In the event of an explosion, this might be a fixture or component, the vessel or pipeline itself, or a secondary projectile arising from the destruction of structures close to the vessel.

**Note: In the event that such an incident occurs (whether it results in injury or not) it must be reported to SEPS using the online reporting form as soon as possible after the incident. SEPS will then report the incident it to the HSE if required.**

**4 Further Guidance and Support**

Pressure systems have the potential to cause significant injury and damage to infrastructure in the event of a failure and it is imperative that they are designed, operated and maintained properly. A key part of this process is ensuring that they are examined regularly by a competent person and where required this is done under a written scheme of examination. Further information is available on the HSE website or from SEPS.

<https://www.hse.gov.uk/pressure-systems/>

<https://www.hse.gov.uk/pressure-systems/resources/publications.htm>

**SEPS Contacts**

**Head of Service:** 0141 330 4678

**Biological Safety Adviser** 0141 3307105

**Chemical Safety Adviser:**  0141 330 2799

**Environmental (Waste) Adviser:** 0141 330 5854

**Appendix 1: Key Exemptions\***

**Exempt from all regulations**

* Pressure systems that form part of any braking, control or suspension system of a wheeled, tracked or rail-mounted system.
* Any part of a system that is only pressurised by a relevant fluid for the purpose of leak testing the system. (not including pipelines) and is not otherwise a pressure system.
* Systems that are pressurised unintentionally (where pressurisation is not reasonably foreseeable)
* Pipelines pressurised by a relevant fluid solely as part of a test or line clearance operation **unless** the pipeline is used for conveyance of a relevant fluid or is pressurised beyond safe operating limits.
* Any pressure system (or part thereof) which is **the subject** of a research experiment of comprises temporary apparatus being used in a research experiment but only if it is deemed not reasonably practicable to comply with the regulations.
* Any water-cooling system on an internal combustion engine or on a compressor.
* Any tyre used (or intended to be used) on a vehicle.
* Vapour compression refrigeration systems incorporating compressor drive motors (including standby compressor motors) having a total installed power not exceeding 25kW.
* Any pressure system containing sulphur hexafluoride (SF6) and forming an integral part of high voltage electrical systems.
* Any portable fire extinguisher with a working pressure below 25 bar at 60°C and having a total mass not exceeding 23kg.
* Any part of a tool or appliance designed to be held in the hand which is also a pressure vessel.

**Exempt from certain regulations**

* Any pressure system containing a relevant fluid **(other than steam)** is exempt from regulations 5(4), 8 – 10 and 14 if the product of the pressure in bar and the internal volume in litres of its pressure vessels is **less than 250 bar litres**.

5(4) Marking of pressure vessels by manufacturers

8 Requirements for written scheme of examination

9 Examination in accordance with written scheme

10 Action by competent person in case of imminent danger (due to removal of requirement for examination under written scheme)

14 Keeping of records of examination in accordance with written scheme of examination

**\*Note: This list covers some of the exemptions most likely to apply to University users but is not exhaustive. For a complete list of all exemptions (partial and complete) see Schedule 1 (parts I and II) of The Pressure Systems Safety Regulations 2000.**

**Appendix 2: PSSR Selection / Inspection Flowchart**

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