

Safety of Pressure Systems

Pressure Systems Safety Regulations 2000

Introduction

This document informs Schools/Departments of the key requirements of the Pressure Systems Safety Regulations 2000 (PSSR) (SI 2000/128) which came into force on 21st February 2000.

The aim of PSSR is to prevent serious injury from the release of stored energy as a result of the failure of a pressure system or one of its component parts.

With the exception of the scalding effects of steam, the Regulations do not consider the hazardous properties of the contents released following system failure. The stored contents properties are of concern only to the extent that they may be liable to accelerate wear and cause a more rapid deterioration in the condition of the system, so leading to an increased risk of failure.

Please note that the requirements of PSSR apply to all pressure systems including those constructed or adapted by the University of Nottingham.

Definition of a Pressure System

The regulations are concerned with steam at any pressure, gases which exert a pressure in excess of 0.5 bar above atmospheric pressure and 'relevant fluids' which may be mixtures of liquids, gases and vapours where the gas or vapour phase may exert a pressure in excess of 0.5 bar above atmospheric pressure.

In the case of some storage systems where gas is kept in liquid form at very low temperatures in a tank, if the pressure above the liquid is below 0.5 bar (gauge), PSSR would not apply unless the pressure rises above 0.5 bar (gauge). The

Regulations do not apply simply as a result of pressure exerted by a head of liquid.

The Regulations do not apply to vacuum conditions.

Pressure systems exempt from PSSR

Low pressure gas distribution pipelines, provided that, the operating pressure does not exceed 2 bar above atmospheric pressure, and, a protective device prevents the pressure from exceeding a maximum of 2.7 bar above atmospheric pressure in the event of a temporary pressure excursion occurring.

Pressure systems containing a relevant fluid other than steam where the 'combined capacity' of the pressure (in bars) and the internal volume (in litres) in each vessel in the system is less than 250 bar / litres. Where the relevant fluid is steam all the regulations apply, irrespective of the vessel pressure and size.

Key Requirements of PSSR

Design and construction

PSSR places duties on designers, manufacturers and any person who supplies equipment or a component intended to be part of a pressure system to ensure that it is fit for purpose. Certain British Standards are in common use for the design and manufacture of pressurised equipment. Where they exist, British Standards, other national or international standards (where they provide an equivalent level of safety) provide a sound basis for the design of pressurised equipment. Confirmation that pressure systems are designed and constructed to relevant standards should be sought at time of purchase. Typically the following should be considered:

- Expected working life (the design life) of the system;
- Properties of the contained fluid;
- Extreme operating conditions including start-up, shutdown and reasonably foreseeable fault or emergency conditions;
- Need for system examination to ensure continued integrity throughout its design life;
- Foreseeable changes to the design conditions;
- Conditions for standby operation;
- Protection against system failure, using suitable measuring, control and protective devices as appropriate;
- Suitable materials of construction for each component part;
- External forces expected to be exerted on the system including thermal loads and wind loading;
- Safe access for operation, maintenance and examination, including the fitting of access (e.g. door) safety devices or suitable guards, as appropriate.

Provision of information and marking

The designer or supplier of a pressure system or component part covered by PSSR should consider the most effective way of providing the appropriate information to those who need it. As a minimum, the provision of the following information on pressure vessels should be considered where relevant:

- The manufacturer's name.
- A serial number to identify the vessel.
- The date of manufacture of the vessel.
- The standard to which the vessel was built.
- The maximum allowable pressure of the vessel.
- The minimum allowable pressure of the vessel where it is other than atmospheric.
- The design temperature.

Installation

The complexity of the planning and installation process will depend on the nature of each individual system and the amount of detail given in the specification for the work. The specification will normally be supplied by the user/owner. It will include any information available from the manufacturer/supplier. There may be a detailed installation specification or a simple broad outline. Whatever the level of information provided, it is

the responsibility of the employer of the installer to ensure that nothing in the installation process affects the integrity of the system or could give rise to danger. Nor should it affect the operation of the protective devices or hinder access for maintenance, examination or inspection tasks.

When planning the installation, the employer of the installer should ensure that all of the following items which are relevant to the system are actioned (this list is not exhaustive and additional actions may be needed depending on the type of system, its location, and planned operating conditions:

- Ensure that those doing the installation have the required training, skills and experience; provide adequate supervision, taking into account the complexity of the system being installed;
- Prepare suitable foundations to support the system, taking into account the nature of the ground and design loads such as the weight of the system and any likely external forces;
- Decide on the most suitable method of lifting and handling the vessel(s), protective devices and pipe-work so as to avoid accidental damage;
- Check for signs of damage in transit;
- protect the system from adverse weather conditions before and during installation;
- Remove any protective packaging carefully before commissioning;
- Ensure that any hot work such as welding or cutting will not affect the integrity of the system;
- Ensure that protective devices are clear of obstruction, operate correctly without hindrance or blockage and that the discharge is routed to a safe place;
- Ensure that any access doors/hatches are clear of obstruction and operate correctly;
- Ensure that any labels or markings attached to the system are clearly visible;
- Provide adequate access for maintenance and examination purposes;
- Provide suitable physical protection against mechanical damage, eg accidental impact by vehicles;
- Allow sufficient space for access around and beneath valves, in particular drain valves;
- Clear away any debris such as metal shavings or dust arising from the installation process.

Specific points which should be noted for compressed air systems are:

- The installation site should provide a well-ventilated, cool and clean air environment;
- Intercoolers and after-coolers should, where they are cooled by air, be located so that the air flow over their surfaces is not obstructed;
- Inlet air should be drawn from an area which is free from potentially flammable or corrosive concentrations of fumes or vapours;
- The inlet air should not be excessively laden with moisture or dust.

Safe operating limits

Where the system consists of a standard production item, the designer/manufacturer should assess the safe operating limits and pass the relevant information to the user/owner. In these circumstances, the user/owner will not always need to carry out

the detailed work required to establish the safe operating limits of the system. In cases where the user/owner has specified the design, the responsibility for establishing the safe operating limits rests with the user/owner.

If the user/owner does not have sufficient technical expertise to establish the safe operating limits, an organisation which is competent to carry out the task should be used.

The exact nature and type of safe operating limits which need to be specified will depend on the complexity and operating conditions of the particular system. Small, simple systems may need little more than the establishment of the maximum pressure for safe operation. Complex, larger systems are likely to need a wide range of conditions specified, e.g. maximum and minimum temperatures and pressures, nature, volumes and flow rates of contents, operating times, heat input or coolant flow. In all cases the safe operating limits should incorporate a suitable margin of safety.

Every plant item in which the pressure can exceed the safe operating limit (i.e. those which have not been designed to withstand the maximum pressure which can be generated within the system) should be protected, whenever operational, by at least one pressure-relieving or pressure-limiting device. The device should be suitable for its intended duty and should be fitted as close as practicable to the plant item it is designed to protect.

Written scheme of examination

Before a pressure system is operated the user/owner must ensure that a written scheme of examination has been prepared. The written scheme of examination should be drawn up by a competent person. The responsibility for ensuring the scope of the written scheme of examination is suitable rests with the user/owner. The University of Nottingham has appointed Allianz Engineering as their competent person(s).

The frequency of examinations is determined to ensure that sufficient examinations are carried out frequently enough to identify at an early stage any deterioration or malfunction which is likely to affect the safe operation of the system. Different parts of the system may be examined at different intervals, depending on the degree of risk associated with each part. The examination frequency is set by the competent person(s).

Examination in accordance with the written scheme

Although PSSR places duties on the competent person in relation to carrying out the examination, there is a clear duty on users/owners to ensure that the equipment is not operated beyond the date specified in the current examination report. The competent person(s) will contact schools/departments to arrange to inspect vessels and systems prior to the expiry of date specified in the current examination report.

The user/owner should ensure that any necessary preparatory work is completed so that the competent person can carry out the examination safely. Preparatory works may be specified in the written scheme. Whether any special preparatory works form part of the written scheme or not, the user/owner should consider the type of preparations required, seeking advice from a suitably qualified person where necessary.

At the end of the examination, the competent person should be satisfied that the protective devices, especially any safety valves, have been tested and set correctly. Where protective devices which have been removed during an examination are found to be defective, the cause of the problem should be investigated further by the user/owner and the necessary corrective measures taken.

Action in case of imminent danger

The user/owner should be notified immediately of those defects which the competent person considers could cause imminent failure of the system. Therefore, the written report to the user/owner should be made immediately.

Defects which are identified only as a result of the competent person's examination, rather than as a result of checks under the maintenance regime, can point to failings in the general management of the system. Although the particular fault may be rectified immediately it is identified, the competent person should, as required, complete the report to the user/owner and relevant enforcing authority.

Operation

It is good practice to prepare a schematic circuit or flow diagram for the system, including pipe-work. The diagram should include all significant controls, valves and relevant safe operating limits with those of importance in an emergency clearly identified. Its purpose is to provide an easily accessible 'picture' of how the system is operated and controlled and to aid identification of the system's parts. It should be updated when changes are made to the system and be kept with the operating instructions.

Maintenance

Where the manufacturer/supplier has provided maintenance instructions for all or part of the system, these should form the basis of the maintenance programme. They should be supplemented as appropriate where they are not sufficiently comprehensive to cover the particular installation. In assessing whether the manufacturer's/supplier's instructions are sufficient, account should be taken of the complexity of the system, whether they cover the particular installation and reflect the on-site operating conditions.

The extent and complexity of maintenance can vary substantially from simple checks on basic equipment to integrated programmes for complex plant. Checks will be necessary to ensure that safety-related features are operating correctly. This is because a fault affecting production is normally apparent within a short time whereas a fault in a safety critical part, such as a protective device, could remain undetected unless appropriate safety checks are included as part of the maintenance programme.

Modification and repair

Where substantial modifications or repairs (including extensions or additions) are to be carried out which might increase the risk of system failure, the user should consult a person who is competent to advise before work begins.

Repair or modification of non-pressure containing parts of the system should be carried out so that the integrity of the pressure system is not adversely affected. This should ensure that any repairs, modifications (including extensions or additions) do not affect the operation of any protective devices.

Any repair or modification (including extensions or additions) should be designed in accordance with appropriate standards, taking into account the expected future duty of the system as well as the original design specification. It should be done by a person competent to do such work.

Keeping of records

Examination reports and the written scheme of examination may be kept in hard copy form, stored electronically or on computer disc. If a computer system is used to keep this information then it must be able to reproduce it as a written copy when necessary, for example to an inspector from the relevant enforcing authority. It should be protected from unauthorised alteration and be authenticated only by the competent person who carried out the examination.

Allianz Engineering maintains electronic records of inspection schedules, inspection reports and written schemes of examination on behalf of the University.

Precautions to prevent pressurisation of certain vessels

The purpose of this operating requirement is to prevent an unintentional build-up of pressure in a vessel which is provided with a permanent outlet to atmosphere, or to a space where the pressure does not exceed atmospheric pressure and applies and applies principally to steam plant, however, other processes may have a similar operating requirement. For example, where a reactor vessel is provided with a vent to atmosphere it may be necessary to keep the vent clear of obstruction to ensure that the reaction proceeds at or near atmospheric pressure. If the outlet becomes blocked with deposits etc. the temperature in the reactor could build up to a point where control of the process is lost, the contents decompose, the vessel becomes over pressurised and then fails.

In such circumstances, the user of such a vessel could have a condition applied to its operation which stipulates that the outlet is at all times kept open and free from obstruction when the vessel is in use.

Modification of duties in cases where pressure systems are supplied by way of lease, hire, or other arrangements

This allows the supplier, in the case of a leased installed system, to assume responsibility in writing for compliance with those regulations which deal with written scheme examinations, operation, maintenance and record keeping. Formal documented contracts should be in place where this type of relationship is operated.

Complimentary legislation

Pressure Equipment Regulations 1999

These regulations apply primarily to suppliers, installers, manufacturers and importers of pressure equipment, making it an offence to place on the market, put into service or otherwise supply pressure equipment and assemblies above specified pressure/volume thresholds, unless they meet essential safety requirements covering design, manufacture and testing, and satisfy appropriate conformity assessment procedures.

The regulations cover pressure equipment - vessels, piping, safety accessories, pressure accessories and assemblies of several pieces of pressure equipment assembled by a manufacturer to constitute an integrated and functional system.

The regulations classify equipment based on:

- Type of equipment concerned - vessel, steam generator or piping;
- State of the intended fluid contents - gas or liquid;
- Fluid group of the intended contents - Group 1 or Group 2

Group 1 fluids are those classified as explosive, extremely flammable, highly flammable, flammable, very toxic, toxic, and oxidising. Group 2 comprises all other fluids, including steam

For pressure accessories the regulations classify equipment into groups based on:

- State of the intended fluid contents - gas or liquid;
- Classification of the intended fluid contents - Group 1 or Group 2;
- Maximum allowable pressure;
- Volume in litres;

All equipment and assembly's placed on the European market after May 2002 must comply with the regulations. CE marking is the visible declaration by a manufacturer or his authorised representative that the pressure equipment to which it relates satisfies all the provisions of the regulations.

Summary of School/Departmental Arrangements

See guidance document (Statutory requirements for the management of pressure systems, lifting equipment & power presses)

References

- Pressure Systems Safety Regulations 2000
- Pressure Equipment Regulations 1999
- Safety Office Guidance Document (Statutory Requirements for the Management of Pressure Systems, Lifting Equipment & Power Presses.)