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REFRIGERATION AIR CONDITIONING HEAT PUMPS

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Pressure Equipment and Systems
A guide to the regulations

Service Engineers Section
Guidance Note 67

SES Good Practice Guide 67

1. The Pressure Equipment Directive (2014/68/EU)

The Pressure Equipment Regulations (1999) enacted the European Pressure Equipment Directive (97/23/EC). These defined categories of pressure equipment depending on the pressure, size and contents of the system and specify design, construction and testing requirements. They are generally applicable to components and new systems being placed on the market for the first time ranging from small factory-assembled units to large site installed systems. Most of the obligations under these regulations fall on the "manufacturer" of the system, which in the case of a site installed system is likely to be the specialist installation contractor. The Regulations were subsequently amended by the Pressure Equipment (Amendment) Regulations 2002 (SI 2002 No 1267), which came into force on 30 May 2002 and the Pressure Equipment (Safety) Regulations of 2016 (SI 2016 No 1105)

2. The Pressure Equipment (Safety) Regulations (2016)

The UK revisions came into effect on 8th December 2016 and relate to the implementation of the new Pressure Equipment Directive (PED), Potentially Explosive Atmospheres (ATEX) Directive and the Simple Pressure Vessels Directive (SPVD). There are two key drivers behind the new PED:

1. The current basis for the determination of fluid group (1 or 2) in PED Article 9 (i.e. Directive 67/548/EEC) is being replaced by a new Classification, Labelling and Packaging Regulation from 1st June 2015.

2. The "New Legal Framework": This is a larger initiative by the European Union to bring nine EC "New Approach" directives into alignment with the "New Legal Framework" (NLF), which was adopted in 2008. According to the European Commission, the NLF aims to streamline and simplify the rules for putting pressure equipment on the market in the face of increasing competition from fraudulently certified equipment. The EC also states that the revision will lower costs for businesses to comply with the legislation.

It is important to note that the changes are classified as an 'alignment' with the NLF, because it means there is no change in the scope of the PED or Hazard category tables. While there are no changes to the essential safety requirements either, there is a change to a fundamental safety philosophy of the PED. There is now an obligation for manufacturers to analyse the risks of pressure equipment as well as the hazards.

3. Equipment considerations

The key principle of pressure equipment design is that an assembly should be constructed of components, each of which is suitably rated for inclusion in the assembly. It follows from this that each component must have a design pressure at least as high as the required design pressure for the system. It is sometimes useful for cost or operational reasons to divide the system into sections which may have different design pressures – in which case the component need only be suitable for the subsection of the system in which it is used.

The danger associated with pressure systems is primarily the amount of damage that could be caused by a sudden release of stored energy if the system burst. Pressurised gas is much more damaging in this respect than liquid because more energy is stored. In refrigerating systems, where liquid is close to its boiling point, the sudden boiling caused by a drop in pressure poses an additional hazard. For this reason all parts of a refrigeration system are assumed to contain pressurised gas. Additional dangers arise from the sudden release of large quantities of vapour, which might be a hazard to people or property in the vicinity, or the ejection of pieces from the system, either through component failure or loosening of non-permanent joints. Liquid in the cold side of a system also poses a hazard if it is trapped in a fixed volume between shut off devices. When the liquid warms up very high pressures may be generated by thermal expansion of the liquid, causing pipes to burst or components to deform. The liquid may be trapped between isolating valves during a maintenance operation, or it could be between components in normal operation, for example a check valve on a pump discharge and a solenoid valve at an evaporator inlet.

4. Pressure relief devices

For systems over a certain size protection against excessive pressure is provided by pressure relief devices. These can either relieve to atmosphere or to a lower pressure part of the system, which in turn must have relief to atmosphere. Hydrostatic relief valves provide protection against the effects of trapped liquid. They do not require much capacity but must be able to reseat tightly, and must be accessible for calibration or replacement. This can only be achieved by pumping out the parts of the system on both sides of the valve, or by fitting shut off valves on either side. If valves are fitted they must normally be locked in the open position and ideally should be configured to prevent normal use of the system when the relief valve is out of circuit. This can be achieved, for example, by using a three-way valve which vents the main liquid line to the suction side. Details of suitable configurations of relief valves can be found in EN378 part 2.

Relief valve sizing is based on a formula in EN13136:2013 which ensures sufficient capacity of the valve to relieve pressure safely in the event of the refrigeration system being subjected to excessive temperatures, for example during a fire. The formula in EN13136 is valid for system operation at normal temperature levels. When the relief device setting is close to the critical pressure of the refrigerant, this sizing method may not be applicable. The calculation also uses the dimensions of the pressure vessel (eg high pressure receiver, shell and tube condenser) to calculate the size of relief valve required. If several vessels are protected by a common valve, for example a high pressure receiver and a liquid supply pot, then the valve sizing calculation should account for the total of the vessel sizes. The equation used includes length times diameter because the heat gain to the vessel in the event of a fire is a function of the vessel's surface area, not the internal volume. Although the valve is primarily protecting the pressure vessel, it is good practice to set the relief pressure to be that of the section of the refrigeration system in which the vessel is installed. For example a system might use a high pressure receiver with a design pressure of 28 bar gauge in a system with a design pressure of 21 bar gauge. In this case the relief valve shall be sized on the basis of the length and diameter of the receiver, but should preferably be selected to relieve the pressure at the system allowable pressure of 21 bar gauge to ensure that the pipes and fittings are not damaged before the relief valve lifts. Relief valves and other pressure safety devices are all considered to by Category IV devices under the PER irrespective of their size or working fluid.

5. The Pressure Systems Safety Regulations: 2000

The PSS Regulations (PSSR) mainly relate to pressure systems in use at work and so they primarily affect the user or owner of pressure equipment. The refrigeration contractor may be considered to be the "user" in terms of the Regulations at the time a new system is first set to work and may therefore be required to fulfil certain requirements of the Regulations.

The PSSR are complimentary to the Pressure Equipment (Safety) Regulations (PER). The PER are concerned with the design, manufacture and conformity assessment of pressure equipment and assemblies which are new to the EU market when they are first placed on the market, and so primarily affects the manufacturer or supplier of pressure systems. However the main duties under PSSR are placed on the user or owner of the system. The regulations are concerned with the safe operation and the ongoing safety of the system with respect to the hazard of a release of stored energy within a pressurised system in the event of the failure of the system or one of its components.

The HSE publishes guidance as "Safety of pressure systems – Approved code of Practice (ACOP) L122" (2014) as a free download from their website (link below). Everyone concerned with pressure systems is recommended to refer to this document. The ACOP has a special legal status and if the provisions are not

followed you will need to show that you have used alternative methods to comply with the law. The guidance is not compulsory but if you do follow the guide you would normally be considered to be doing enough to comply with the law.

The ACOP draws particular attention to the following details regarding refrigeration plant:

1. The regulations apply to vapour compression refrigeration systems incorporating compressor drive motors, including standby compressor motors, having a total installed power exceeding 25kW.

2. Some of the regulations do not apply to systems if the product of the internal volume of the largest vessel in litres and its maximum allowable pressure in bar is less than 250 bar-litres.

3. The regulations state that pressure systems that have been supplied in accordance with the PER are considered to meet the requirements for design and construction of regulation 4 of the PSSR. The user is advised to confirm that they have been provided with appropriate documentation as evidence of conformity with the EU Directive.

4. The guidance notes advise that British, European or International Standards where they exist provide a sound basis for the design and manufacture of certain types of pressurised equipment. It is also recommended that independent verification of this be obtained.

5. Before they may operate a refrigeration plant, the user must establish its safe operating limits. These are defined in paragraph 92 of the ACOP. PSSR defines the safe operating limit as "the operating limits (incorporating a suitable margin of safety) beyond which system failure is liable to occur". The maximum allowable pressure (PS) of a system, or portion of a system, is its safe operating limit. The system and its components must undergo a strength pressure test at between 1.1 and 1.43 x its maximum allowable pressure (PS) which will provide a margin of safety described in the ACOP. The system must be fitted with appropriate Protection Devices, to prevent a dangerous situation arising, by exceeding the safe operating limit.

6. Responsibility for complying with regulations lies in most circumstances with the 'user' and this is generally a corporate responsibility. It is usually clear who the user is, as the user retains the authority to decide when the plant will be turned on or off the plant and decides who has access to it. Paragraph 53 of the ACOP provides further clarification. Maintenance contracts should state clearly who 'the user' is in respect of the regulations and advise them of their responsibilities under the regulations as appropriate.

7. The user shall not let a system be operated until a written scheme of examination (WSE) is available. The user is responsible for appointing a competent person to provide this. It should be noted that this applies to new systems being commissioned and that in addition to preparing the WSE, the first inspection against it should be undertaken at the time of start up. Clause 107 of the ACOP provides further guidance.

The "user" may be the refrigeration contractor during installation and start-up. Once the plant is handed over, the user would typically be the plant owner/operator. The contractor can fulfil the role of Competent Person for the purposes of preparing a Written Scheme of Examination or conducting an inspection provided they meet the requirements on knowledge, experience, professional probity and independence for a Competent Person set out in Clauses 28-36 of the ACOP.

8. The requirements for the competent person responsible for the written scheme of examination will depend on the complexity of the system. Systems are divided into three categories, minor, intermediate, and major, for this purpose. These categories are an indication of the range, rather than clear-cut divisions. Minor systems include small inert gas or fluorocarbon refrigerant systems and are described as presenting few engineering problems. Such systems should be less than 20 bar and the product of pressure x volume of the largest vessel should be less than 2×10^5 bar-litres. Major systems are defined as those that are complex and require the highest expertise. The pressure-volume product for the largest vessel in such a system is indicated as greater than 10^6 bar litres. By default intermediate systems are those systems that fall between the minor and major categories.

9. The user must ensure that the system is examined by a competent person in accordance with the written scheme and at the frequency specified.

10. The user must take all appropriate safety measures to prepare the system for examination.

11. If the competent person considers that the system, or any part of it, will give rise to imminent danger unless repairs or changes are made the competent person must;

a) Immediately make a written report to the user
b) Send a formal written report to the enforcing authority

The user shall ensure that the system or that part of it is not operated until the changes are carried out.

12. The user must provide adequate instructions to the operator regarding safe operation and action to be taken in the event of an emergency. The user should ensure that the system is only operated in accordance with the instructions.

13. The user shall ensure that the system is properly maintained in good repair, so as to prevent danger.

14. The user must keep the following information which should be readily available:

a) The last report by the competent person
b) Any previous report that will assist in assessing the system
c) Information required under Section 5 or instructions as required by the PER.

The PSSR allow the written scheme of examination to be stored and generated electronically with appropriate authorisation. It must be able to be reproduced readily as a written scheme and protected from unauthorised alteration. Where the user changes the previous user must give these documents to the new user. For further information see HSE Guidance L122 "Safety of pressure systems".

6. Key obligations under the regulations

Obligation	Regulation	Manufacturer	User/Owner
Determine the relevant category	PER [6,7, Sch3]	✓	
Assess Essential Safety Requirements	PER [9, 41, Sch2]	✓	
Engage Notified Body as required	PER [51, Sch4]	✓	
Declaration of Conformity	PER [11, Sch11]	✓	
Apply the CE mark to the product or assembly	PER [11]	✓	
Provide foreseeably necessary information	PSSR [5]	✓	
Prepare a written scheme	PSSR [8]		✓(1)
Engage a competent person to inspect the system	PSSR [2,9]		✓(1)
Inspect regularly against the written scheme	PSSR [9]		✓(2)
Take remedial action	PSSR [10]		✓
Keep written records of inspections	PSSR [14]		✓

Notes:
(1) Before the plant is handed over to the purchaser the installation contractor may be required to meet the obligations of the User
(2) Although the inspection needs to be conducted by an independent competent person, it is the user's responsibility to appoint the competent person. Users/owners may wish to consider using accredited bodies for example those with UKAS accreditation to BS EN ISO/IEC 17020:2012.

7. Details of the Regulations and other guidance can be found on the following websites:

Pressure Equipment Regulations – Statutory Instrument 1999/2001 www.legislation.gov.uk
Pressure Systems Safety Regulations - Statutory Instrument 2000/128 www.legislation.gov.uk
Pressure Systems Safety Regulations 2000 "written schemes of examination" INDG178 (rev2) 2012 www.hse.gov.uk/pubns/indg178.pdf
Pressure Systems Safety Regulations 2000 Approved Code of Practice and Guidance on Regulations updated 2014 L122 (Free from HSE) http://www.hse.gov.uk/pubns/books/l122.htm
PED guidelines from Commission Working Group "Pressure"
https://ec.europa.eu/growth/sectors/pressure-gas/pressure-equipment/guidelines_en
European standards can be purchased from the BSI on line shop: http://shop.bsigroup.com/
IOR Guidance note on EN378:2016 changes http://www.ior.org.uk

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