



ONR GUIDE			
<b>Pressure Systems Safety</b>			
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## 1. INTRODUCTION

- 1.1 ONR has established its Safety Assessment Principles (SAPs) which apply to the assessment by ONR specialist inspectors of safety cases for nuclear facilities that may be operated by potential licensees, existing licensees, or other duty-holders. The principles presented in the SAPs are supported by a suite of guides to further assist ONR's inspectors in their technical assessment work in support of making regulatory judgements and decisions. This Technical Assessment Guide (TAG) is one of these guides.
- 1.2 Systems containing a fluid under pressure (Pressure Systems) are associated with a wide range of plant and processes found on nuclear sites. The term pressure system incorporates a wide range of equipment from small air receivers to reactor pressure vessels and other primary circuit equipment that is often subject to very high pressures and temperatures. Correct application of legislation supported by available relevant good practice enables ONR inspectors to assess and regulate this diverse range of equipment effectively to ensure safety.
- 1.3 Assessment of pressure systems requires knowledge of structural integrity of metal components combined with an understanding of compliance arrangements. ONR SAPs, covering the safety of pressure systems, are limited in scope although guidance on structural integrity topics exists in other ONR TAGs referred to later. This TAG focuses on compliance arrangements by identifying key UK legislation and explaining the UK regulatory framework. It offers practical guidance and relevant good practice for compliance, and suggests further reading for inspectors that need to assess or inspect pressure systems.

## 2. PURPOSE AND SCOPE

- 2.1 The purpose of this TAG is to expand on the SAPs by identifying legal requirements and sources of relevant good practice to assist and inform ONR Inspectors tasked with assessing compliance arrangements for pressure systems.
- 2.2 The TAG is not specifically written for duty holders although it may be used as a source of guidance or good practice to assist them in complying with legislation and help them avoid potential pitfalls. However, duty holders must realise that this TAG is purely for guidance and is not a prescriptive set of legal requirements.
- 2.3 Pressure systems on nuclear submarines are excluded from key pressure systems legislation and therefore they are excluded from the scope of this TAG.
- 2.4 Certain transport packages for radioactive material are designed to withstand pressure and are subject to a package approval regime. These packages are beyond the scope of this TAG and are not considered further.

## 3. RELATIONSHIP TO LICENCE AND OTHER RELEVANT LEGISLATION

- 3.1 Relationship to Pressure Equipment and Site License Conditions
  - 3.1.1 Each nuclear site licence has 36 standard Licence Conditions [Ref 1] attached which are used by ONR as regulatory tools. ONR issues these Licence Conditions to effect regulatory control of the licensee's activities by facilitating a compliance inspection regime, as well as a permissioning regime for identified activities. Regulatory control is also affected by the specific use of primary and derived powers through these Licence conditions.
  - 3.1.2 Licence Conditions are generic in nature and therefore any of the 36 standard licence conditions are potentially applicable to the safe installation, operation, and maintenance and decommissioning of pressure equipment for nuclear use.

However, certain licence conditions are used more frequently when considering pressure systems regulation and these are listed as follows:

- **Licence Condition 10:** Training - the Licensee shall make and implement adequate arrangements for suitable training for all those on site that have responsibility for operations which may affect safety.
- **Licence Condition 11:** Emergency Arrangements – The Licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects.
- **Licence Condition 15:** Periodic review – The Licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.
- **Licence Condition 23:** Operating Rules – The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interest of safety. Such conditions and limits shall hereinafter be referred to as operating rules
- **Licence Condition 24:** Operating instructions - The licensee shall ensure that all operations which may affect safety are carried out in accordance with written instructions.
- **Licence Condition 25:** Operational Records: The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety.
- **Licence Condition 26:** Control and supervision of operations – The licensee shall ensure that no operations are carried out which may affect safety except under the control and supervision of suitably qualified and experienced persons appointed for that purpose by the licensee.
- **Licence Condition 27:** Safety mechanisms, devices and circuits – The licensee shall ensure that a plant is not operated, inspected, maintained or tested unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order.
- **Licence Condition 28:** Examination, inspection, maintenance and testing – The licensee shall make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.

### 3.2 Relationship to Pressure Equipment and UK Legislation

3.2.1 The Energy Act 2013, which applies at all Licensed sites has the nuclear safety sections of the Nuclear Installations Act 1965 (NIA) as Relevant Statutory Provisions and this empowers ONR to apply Licence Conditions. For conventional safety, manufacture of plant and construction activities the Health and Safety at Work etc Act, 1974 (HSWA), can also be enforced by ONR inspectors. Pressure systems safety regulations are made under HSWA and therefore can be enforced by ONR on nuclear sites. (Note: Certain sections of HSWA don't apply to sites operated by the Crown but this exception does not alter the guidance contained in this TAG). The Energy Act enables regulations to be made in the UK where specific hazards exist. Such regulations made under this process would place legal obligations on licensees on nuclear sites.

3.2.2 Further UK regulations have been established to implement European Directives made through European Treaties. Pressure equipment can be considered as being covered by the key pieces of legislation listed in table 1.

**Table 1 – UK Legislation and EU Directives applicable to Pressure Equipment**

<b>Legislation</b>	<b>Tag Section</b>	<b>Notes</b> [(see - <a href="http://www.hse.gov.uk/pressure-systems/law.htm">http://www.hse.gov.uk/pressure-systems/law.htm</a> ) for more detailed information].
Pressure Systems Safety Regulations 2000. (PSSR)	5.3	This legislation contains the key UK regulations applicable to the majority of pressure equipment found on nuclear sites. Detailed applicability to nuclear plant is provided below to assist inspectors.
Pressure Equipment Directive (97/23/EC). (PED)	5.2	Pressure equipment supplied anywhere within the European Community for non nuclear specific applications must be supplied in accordance with this European Product Directive. Detailed applicability to nuclear plant is provided below to assist inspectors.
Pressure Equipment Regulations 1999 as amended (PER)	5.2	These regulations bring the European requirements set out in the Pressure Equipment Directive into UK law. Detailed applicability to nuclear plant is provided below to assist inspectors.
Simple Pressure Vessel Directive (2009/105/EC). (SPVD)		This Directive applies to simple pressure vessels manufactured in series. For the purposes of this Directive, "simple pressure vessel" means any welded vessel subjected to an internal pressure greater than 0.5 bar above atmospheric pressure (barg), where the product of pressure and volume is less than 10 000 barg.litres, which is intended to contain air or nitrogen and which is not intended to be fired. The minimum working temperature must be no lower than – 50 °C and the maximum working temperature must not be higher than 300 °C for steel and 100 °C for aluminum or aluminum alloy vessels. Air receivers on portable compressors are a typical example of a 'simple pressure vessel'. However, such vessels are exempted where vessel failure might or would result in an emission of radioactivity and these exceptions are described in more detail below under PER.
Simple Pressure Vessels (safety) Regulations 1991 (SPVR)		These regulations bring the European requirements set out in the Simple Pressure Vessels Directive into UK law.
The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations. 2009 (CDG)	5.2	Nuclear sites often make use of commercially available supplies of transportable pressure receptacles (commonly called bottled gas, gas cylinders, or gas bottles). Transportable pressure receptacles are covered in law by CDG.
Pipelines Safety Regulations 1996 as amended.	5.3	These regulations are specific to pipelines which are excluded from PSSR and are beyond the scope of this TAG.

#### **4. RELATIONSHIP TO SAPS, WENRA REFERENCE LEVELS AND IAEA SAFETY STANDARDS**

ONR's SAPs and the WENRA reference levels were re-issued in 2014. This TAG will be updated to reflect these changes in due course and in the meantime inspectors need to check that they are using the correct versions of those publications during their assessments.

##### **4.1 Relationship to Safety Assessment Principles (SAPs)**

- 4.1.1 ONR produced a set of Safety Assessment Principles (SAPs) [Ref 2] that apply to the assessment of safety cases for nuclear facilities. SAPs tend to be generic in nature and inspectors are advised to be familiar with all SAPs. This TAG directly addresses those SAPs which relate to design, operation and through life management of pressure systems. The TAG has been written in general terms so that it applies to all engineering disciplines.
- 4.1.2 SAPs EPS.1-5 are intended to cover pressure systems but they are limited in scope to; requirements for removeable closures, flow limitation, pressure relief, overpressure protection and discharge routes respectively.
- 4.1.3 There are many generic SAPs that are applicable to pressure equipment at a high level, for example SAPs FP.1– FP.8 offer a foundation for safety and radioactive waste principles. However, this TAG particularly directs inspectors towards the following SAPs:
- Equipment qualification is covered by EQU.1
  - Maintenance, inspection and testing is covered by EMT.1 to EMT.8
  - Ageing and degradation is covered by EAD.1 to EAD.5
  - Layout is covered by ELO.1 to ELO.4
  - Integrity of metal components and structures is covered by EMC.1 to EMC 34.
  - Safety classification and standards are covered by ECS.1 to ECS.5.
- 4.2 Relationship to ONR Guidance
- 4.2.1 ONR inspectors assessing pressure systems should be aware of ONR's general expectations for the Licensees' development of safety cases (NS-TAST-GD-051).
- 4.2.2 The long term integrity of pressure systems is heavily reliant on correct application of the fundamental principles set out in NS-TAST- GD 016 which covers fundamental aspects of structural integrity of metal components. Inspectors should therefore ensure that these principles are adopted, particularly during the design of new equipment. Aspects of the guidance contained within NS-TAST-GD017 Civil Engineering may also need to be considered for some aspects of pressure systems safety.
- 4.2.3 In addition to the specific TAGs above, the following generic TAGs are suggested as being helpful when considering pressure systems:
- NS-TAST-GD-005 Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable)
  - NS-TAST-GD 026 Decommissioning of Nuclear Licensed Sites
  - NS-TAST- GD 030 Probabilistic Safety Analysis
  - NS-TAST- GD 050 Periodic Safety Reviews (PSR)
  - T/AST/009 Examination, Inspection, Maintenance and Testing of items important to safety
  - T/AST/057 Design Safety Assurance
  - NS-TAST-GD-021 Containment for Chemical Plant
- 4.3 Relationship to Western European Nuclear Regulator's Association (WENRA)

- 4.3.1 This TAG considers the Western European Nuclear Regulators' Association [Ref 3] (WENRA) publications for specific applicability. WENRA produces 'Reference Levels' and section 5 of ONR document NS-TAST-005 identifies these as relevant good practice for existing civil Nuclear Reactors. WENRA reference levels considered in this TAG are focused on nuclear reactor power plants and so do not have the same broad scope intent of the SAPs and this TAG.
- 4.3.2 UK legislation, and associated design codes for pressure systems should, if properly followed, be adequate to ensure that WENRA reference levels are met. Appendix 1 of this TAG includes a table which identifies those reference levels that are applicable to pressure systems with cross references to the section of this TAG that addresses them.
- 4.4 Relationship to International Atomic Energy Agency (IAEA) Standards
- 4.4.1 In preparing this TAG, no IAEA publications were identified that specifically offer guidance on pressure systems. However, there are a number of IAEA safety standards and guides which inspectors may find useful in support of pressure equipment. These relevant IAEA standards are as follows:
- SSR-2/1 Safety of Nuclear Power Plants: Design specific safety requirements [Ref 4]
  - NS-G-2.6: Safety Guide on Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant [Ref 5];
  - INSAG 19: Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life [Ref 6];
  - INSAG 14: Safe Management of the Operating Lifetime of Nuclear Power Plants [Ref 7].

## 5. **ADVICE TO INSPECTORS**

- 5.1 Hazard Awareness
- 5.1.1 Catastrophic pressure system failures result in uncontrolled release of stored energy as its fluid expands to achieve ambient conditions. Past failures of conventional pressure equipment provide examples of devastating effects resulting in death or serious personal injury coupled with extensive plant and property damage. Failure of conventional plant has caused entire buildings to be demolished sending missile debris considerable distances with resulting offsite property damage. The devastating effects caused by the Chernobyl and Fukushima incidents are examples of catastrophic failure of a pressure system on a nuclear site.
- 5.1.2 ONR inspectors should also be mindful of the risks to other safety critical plant from the secondary effects of a pressure system failure. Risks to other safety critical plant from pressure system failures should be addressed by the plant design and the licensee's safety case.
- 5.2 UK Regulations
- 5.2.1 Application of UK Regulations to pressure systems for Nuclear use
- 5.2.1.1 Table 1 in Section 3.2.2 of this TAG identifies European product directives and UK Regulations that are applicable to pressure systems on nuclear sites in addition to the 36 standard licence conditions. In practice, some of this legislation is product specific, such as the Simple Pressure Vessel Safety Regulations or the Pipeline Regulations and therefore these have not been included in the scope of this TAG, although inspectors should not overlook this product specific legislation.

- 5.2.1.2 The Pressure System Safety Regulations (PSSR) are applicable to the majority of pressure systems on nuclear sites and therefore this TAG offers guidance on the application of these regulations. For pressure systems on nuclear sites where PSSR does not apply, other UK Regulations may still apply and inspectors need to regulate them accordingly. For example, Licence conditions, HSWA or more general regulations such as the Provision and Use of Work Equipment Regulations (PUWER).
- 5.2.1.3 The Pressure Equipment Regulations (PER) contain an important exclusion for nuclear applications which often results in these regulations not being applicable on nuclear sites. Guidance on how to apply this exclusion is offered below.
- 5.2.2 General Description of Product Standards
- 5.2.2.1 New Approach Directives, aimed at eliminating technical barriers to trade, set out Essential Safety Requirements (ESRs) covering a range of products from children's toys through to complex engineering equipment including pressure systems. Manufactures must demonstrate that their products meet these essential requirements and that they have been subjected to a conformity assessment, often involving a notified body, before placing them onto the market within a European Union member state. Some products meeting these requirements need to bear a CE (Conformité Européenne) marking signifying that they can be sold in any of the EU member states.
- 5.2.2.2 The Pressure Equipment Directive (PED) is a new approach directive covering the design, manufacture and conformity assessment of pressure equipment and assemblies subject to an internal pressure greater than 0.5 bar above atmospheric pressure (Barg). It applies to manufacturers of pressure equipment including vessels, pipe-work, safety devices, pressure accessories, and individual pieces of equipment assembled into a 'package' or 'system'. PED has been adopted in the UK by the Pressure Equipment Regulations 1999 (PER) which mirror the ESRs in the directive. Hence, UK manufacturers of pressure equipment must demonstrate compliance with PER, if applicable, if they wish to supply equipment onto the market within the European Economic Area. Manufacturers of simple pressure vessels would also need to follow a similar approach when applying the Simple Pressure Vessel Regulations. Duty holders are entitled to use equipment imported from any country, whether in the EU or not, provided the equipment complies with PED.
- 5.2.2.3 One way manufacturers can meet the ESRs, defined in PER, is to follow harmonised standards. National or International standards containing an annex Z indicate to the reader that the standard has been reviewed by an international technical committee who have endorsed it as a harmonised standard meeting a particular directive. In the UK, harmonised standards are produced and published by the British Standards Institution as European Standards normally identified as having a number preceded by the letters BS EN (British Standard European Norm).
- 5.2.2.4 Harmonised standards have a legal significance because if properly followed it can be assumed that the relevant legislation (ie PER/PED/SPV) has been satisfied. However, harmonised standards are not mandatory and a manufacturer could, if so desired, use alternative means to demonstrate that ESR's have been met.
- 5.2.2.5 Assessment of pressure systems against the ESRs and harmonised standards will vary from simply following good engineering practice and self assessment through to rigorous third party assessment and inspection by an accredited notified body. PER sets out how such assessment should be determined based on the pressure, volume and fluid contained and often there is more than one formal assessment route that can be chosen. The final step is to compile a technical file containing

defined items, to prepare a certificate of conformity and in some cases to mark the product with a 'CE' mark.

5.2.2.6 The above legislation makes it illegal to supply pressure equipment anywhere within the EU unless the Pressure Equipment Regulations have been satisfied; ie. a certificate of conformity has been issued to demonstrate that due process has been followed. There is also an underlying duty to ensure that the equipment is safe regardless of any process followed. It is important to note that if a duty holder manufactures equipment for their own use they are legally considered to be a manufacturer and PER may equally apply unless the nuclear exclusion applies as described below.

5.2.3 Application of Nuclear Exclusion To Pressure Equipment Regulations (PER)

5.2.3.1 Inspectors must realise that equipment built in accordance with PER should give confidence that equipment is safe for conventional industrial applications. Pressure equipment for nuclear use may require additional safety measures and PER therefore excludes Items '*specifically designed for nuclear use, failure of which may cause an emission of radioactivity*'. The exclusion recognises that PER does not cover the hazards associated with radioactivity and applying PER to nuclear pressure systems could result in equipment that is not adequate for nuclear use, albeit that it is perfectly adequate for non nuclear applications.

5.2.3.2 In practice, the exclusion needs careful consideration because the two components making up the exclusion are open to interpretation, i.e '**specifically designed**' for nuclear use and '**failure of which may cause an emission of radioactivity**'. Inspectors must consider each application in turn and some guidelines are offered in this TAG as follows:

- A reactor pressure vessel would have been '**specifically designed**' for nuclear use and its failure would foreseeably lead to a '**release of radioactivity**'. This vessel would clearly be excluded from the PER by the nuclear exclusion and is unlikely to require any legal clarification.
- Component design does not need to be wholly unique (**specifically designed**) to the nuclear industry to give it a real connection with the nuclear activities. Slight adaptations to standard equipment could bring it within the exclusion provided that it is clearly for nuclear use.
- Components used on nuclear sites may have been **specifically designed** in accordance with standards for nuclear plant. However, their application may be in non nuclear plant that does not foreseeably lead to a release of radioactivity and therefore it could be argued that these do not come within the exclusion.
- A '**release of radioactivity**' may either be linked to the failure of the item directly, or by a chain of reasonably foreseeable events. The use of "may cause" enables this wider interpretation to be applied. Hence, if failure of a pressure system can foreseeably lead to a release of radioactivity then it may come within the exclusion.

5.3 Pressure Systems Safety Regulations 2000 (PSSR)

5.3.1 Application to Nuclear Systems



5.3.1.1 In the UK, the Pressure Systems Safety Regulations 2000, hereafter referred to as PSSR, are concerned with preventing serious injury from the hazard 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, PSSR does not consider any hazardous or toxic properties of the contents released following system failure.

5.3.1.2 A number of nuclear safety significant systems containing pressure will fall within scope of these regulations. PSSR does not make any distinction between low risk equipment and equipment with high risk potential (although examination requirements are likely to be more onerous for higher hazard systems). PSSR repeatedly refers to the 'enforcing authority' which for nuclear sites is ONR for both nuclear and conventional safety.

5.3.1.3 There is a combined Approved Code of Practice (ACOP), guidance and a guide support PSSR (Ref 8). Inspectors are advised to refer to this document when considering any aspect of pressure systems. This section of the TAG offers supplementary guidance, and summarises some of the key points provided in Reference 8, for the benefit of inspectors interpreting PSSR in the context of a nuclear site.

### 5.3.2 Identification of systems containing a Relevant Fluid

5.3.2.1 PSSR does not apply simply due to the existence of a fluid under pressure. Only those parts of a system which are liable to contain a 'relevant fluid' fall within the scope of PSSR. The term 'liable to contain' a relevant fluid is important because on nuclear sites some systems are only there for infrequent or fault events being held normally at atmospheric pressure. Hence, if it is reasonably foreseeable that a system is liable to contain a relevant fluid, albeit infrequently due to fault conditions, then PSSR must apply. Relevant fluid is defined in the regulations as follows:

- Steam at any pressure.
- Gases which exert a pressure in excess of 0.5 bar above atmospheric pressure (barg).
- Mixtures of liquids, gases and vapours where the gas or vapour phase may exert a pressure in excess of 0.5 barg.

5.3.2.2 Inspectors should assume that a system is covered by PSSR if the pressure source is capable of generating pressures greater than 0.5 barg, unless the duty holder is able to demonstrate otherwise. Conversely, except in the case of steam, once the pressure along a line of pipe work drops below 0.5 barg, there is no longer a relevant fluid and that part of the pipe work is not covered by PSSR. Common examples, found on nuclear sites, to illustrate the application of PSSR are as follows:

- *PSSR applies to a blow down vessel which is normally empty but during system blow down contains a relevant fluid and therefore becomes a pressure system.*
- *PSSR might cease to apply where a higher pressure gas expands through a nozzle, the pipe work diameter increases or a phase change occurs such that its pressure drops below 0.5 barg. However, inspectors must be satisfied that a failure in the upstream system cannot foreseeably lead to an increase in this pressure.*

- *The use of a pressure relief system set below 0.5 barg is not normally sufficient to dis-apply PSSR because it is foreseeable that the device could fail and lead to pressures above 0.5 barg.*
- *Despite being under pressure, hydraulic power systems, pressurised cooling water systems and oil coolers are not covered by PSSR because none of these contain relevant fluids.*
- *A gas charged accumulator attached to a hydraulic power system may come under the scope of PSSR due to the presence of the gas charge.*
- *Hot water systems are likely to contain a mixture of water and water vapour. There is no formal definition of where the transition should be made between excluding from PSSR as water or including as a steam system. However, it is widely accepted that hot water below 112° C is not considered to be a relevant fluid. This is because water can exist at 112° C below 0.5 barg (from steam tables) which is the pressure threshold of a relevant fluid. Hence, for practical purposes a hot water system operating above 112° C (and therefore 0.5 barg) is normally considered as a relevant fluid.*
- *CO<sub>2</sub> is normally stored as a liquid under pressure. In this case the vapour pressure above the gas could be greater than 0.5 barg bringing the system under PSSR even though the medium is predominantly a pressurised liquid.*
- *In some storage systems gas is kept in liquid form at very low temperatures in a tank. Providing the pressure above the liquid is below 0.5 barg PSSR does not apply. However, inspectors would need to be satisfied that the safety case considered faults such as refrigeration plant failure, or an external fire leading to pressure increases over 0.5 barg because of temperature increases.*

5.3.2.3 When applying the above conditions, inspectors must bear in mind that a risk of death, personal injury or health effects still exists from escape of certain fluid. These risks will be covered under other statutory provisions rather than PSSR. Examples are, scalding from hot water, toxic gas release, asphyxiation and chemical burns.

### 5.3.3 Components forming a pressure system

5.3.3.1 PSSR is only applicable if the definition of a system, provided in Reference 8, is satisfied, i.e for PSSR to apply the system must contain certain key components as follows:

- **One or more pressure vessels of rigid construction, any associated pipework and protective devices.** Pipe work can generally be considered to be all encompassing and therefore in most cases on nuclear sites, any part of the system that is not a pressure vessel or pipeline is likely to be regarded as pipe work including gauges, valves, flexible hoses, fittings, flanges etc. Note that pipe work does not include any protective devices as these are considered separately as described later in this TAG.
- **Pipe work with its protective devices to which a transportable pressure receptacle is, or is intended to be, connected.** For example, certain systems found on nuclear sites don't have a fixed pressure vessel but instead are

connected to Transportable Pressure Receptacles (TPR) or (commonly referred to as a gas cylinder, or gas bottle).

- **A Pipeline and its protective devices.** PSSR defines “pipeline” as a system of pipes, and other associated apparatus for the conveyance of relevant fluid across the boundaries of premises. Pipelines that are excluded from PSSR because they do not contain a relevant fluid may be covered by the Pipelines Safety Regulations 1996.

5.3.3.2 Road tankers are often used at nuclear either for deliveries or in some cases the tank (often on its trailer) remains on site until it is emptied and a new one is then delivered. This situation needs careful consideration by inspectors because there are a few different scenarios as follows:

- Any tanker that carries dangerous goods of any type will come under The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDR) for all aspects of inspection and test which are far more prescriptive than PSSR. (Note that dangerous goods include inert gases above 2 barg so if the tanker is on the road with say compressed air at 2.1 barg then CDR applies and the tanker will have an orange marker board. However if that same tanker is on the road with less than 2 bar compressed air then CDR does not apply but PSSR does).
- Typically non dangerous goods tankers (eg bulk powders) use compressed air to discharge the cargo. In these cases in transit there is no pressure and the pressure is only raised during discharge on site. If this pressure safety valve is set above 0.5 barg then PSSR applies to the tanker.
- In summary – if the tanker displays - orange plates – CDR applies. If there are no orange plates and the safety valve is set above 0.5 barg then PSSR applies. If there are no orange plates and the safety valve is set below 0.5barg then general legislation applies such as Provision and Use of Work Equipment Regulations 1998 (PUWER). The safety case for any process that uses a road tanker in this way should clarify the type of tanker and should indicate which legislation is likely to apply. Any safety claims should reflect the legislative requirements.

#### 5.3.4 Duties under PSSR

5.3.4.1 PSSR categorises systems as either ‘mobile’ being capable of moving between different locations or ‘installed’ being fixed in a permanent location. Installed systems are the responsibility of the user whereas mobile systems in many cases are the responsibility of the owner (often the hirer of the equipment). On nuclear sites, it is likely that there could be a combination of mobile and installed plant and therefore inspectors should be satisfied that the duty holder (e.g. the licensee on nuclear licensed site) has identified where responsibilities lie. The duty holder may appoint employees or even contractors to operate or maintain the equipment but the duty holder is still the legal user and are expected to undertake an ‘intelligent customer role’ such that hired equipment may still require a level of scrutiny by the duty holder.

5.3.4.2 For mobile systems supplied by way of lease or hire, the system owner can agree in writing to be responsible for discharging the legal duty rather than the

user. Inspectors should be satisfied that the user has adequate arrangements in place to cover such agreements and in any case the user would need to provide intelligent customer input. Schedule 2 of PSSR sets out the legal application of such arrangements. Inadequate arrangements can foreseeably lead to components being overlooked during thorough examination.

### 5.3.5 Operating conditions and Operating Instructions

5.3.5.1 Complementing LC 23 and LC 24, PSSR requires the user or owner to establish safe operating limits. This requirement goes much further than just establishing maximum pressure it also should specify other important parameters such as maximum and minimum temperatures, nature of the fluid, volumes, flow rates, nature of contents, operating times, heat input, coolant flow, etc. In all cases the safe operating limits should incorporate a suitable margin of safety.

5.3.5.2 Within the nuclear industry fault scenarios should have been adequately considered in the safety case but nevertheless, inspectors should probe to ensure less obvious faults have been considered. For example, operational experience outside of the nuclear industry has shown that even something as simple as painting a tank a darker colour could be sufficient to lead to the contents absorbing more heat from sun rays leading to an overpressure. Likewise, change of use or rate of filling and emptying can all be factors that can affect the pressure within the vessel leading to undesirable conditions. Similarly, reliability of ancillary plant used for measuring or weighing contents can be lead to overfilling leading to overpressure.

5.3.5.3 In addition to any requirements under License Condition LC 11, PSSR places statutory duties on duty holders to provide adequate and suitable instructions for any person operating the system so that it can be operated safely and provides action to be taken in the event of any emergency. PSSR places duties on duty holders to ensure that equipment is not operated except in accordance with the instructions provided.

5.3.5.4 Training of operators is not required under PSSR although it is required by regulation 9 of the Provision and Use of Work Equipment Regulations 1998 and by Licence Condition LC 10.

### 5.3.6 Records of Operating Limits

5.3.6.1 Complementing LC 23 & LC 24, PSSR makes it a statutory requirement that safe operating limits for all parameters including pressure need to be recorded and retained. This information should be readily available to those people who need it, including the competent person responsible for the examinations in accordance with the written scheme

### 5.3.7 Review of Operating Limits

5.3.7.1 Complementing LC 15 – periodic review, it is important to ensure that duty holders keep operating limits for pressure systems up to date by reviewing routinely at the time of examinations under the written scheme. In particular this should be reviewed when significant repairs or modifications are carried out or where there are major changes to the operating conditions, e.g. a change in the relevant fluid contained within the system. If the safe operating limits are altered, the discharge capacity of the pressure-relieving devices should be reviewed to ensure that the system is adequately protected against overpressure at all times.

5.3.7.2 It is preferable for safe operating limits for mobile systems to be marked on the actual plant itself and duty holders should ensure that this data is current. In any case, duty holders should satisfy themselves that they have been provided with the most up to date operating limits for any mobile plant that they use on site.

- 5.3.8 Periodic examination and testing
- 5.3.8.1 It is requirement of PSSR that duty holders shall not operate the system or allow it to be operated without a Written Scheme of Examination (WSE), by a competent person.
- 5.3.8.2 The initial integrity and through life management of pressure systems for nuclear applications will be managed through Licence Conditions as well as PSSR. For example the inspection of the system for through life integrity management would be managed through LC28 as well as the requirements under PSSR Regulations 8 and 9 for examination under the written scheme of examination by a competent person. Inspectors should be satisfied that the duty holder and the competent person both understand their responsibilities, particularly where an independent competent person is employed. Some duty holders distinguish PSSR requirements as 'Statutory' examinations as distinct from examination in accordance with Licence Condition 28 arrangements. Ongoing integrity management may require a unique approach in accordance with duty holders own internal procedures. Further guidance may be found in the list of suggested further reading in section 5.5 of this TAG.
- 5.3.8.3 Duty holders must not place unjustifiable reliance on the inspections undertaken by competent persons compared with their own arrangements. Examinations under PSSR are concerned with the prevention of danger to persons from stored pressure energy and scalding rather than nuclear safety. It is important that the duty holder has arrangements in place to ensure that the competent Persons takes into account detailed and specific knowledge that the duty holder may have on the operation of, and the potential for degradation, in a system.
- 5.3.8.4 The duty holder is responsible for ensuring that the scope of the scheme is appropriate, i.e. which parts of the system are covered (with advice, if necessary, from a competent person or similar). The duty holder should also ensure that the competent person has specified the nature and frequency of examinations and any special measures needed to prepare the system for safe examination.
- 5.3.9 Attributes and role of competent persons
- 5.3.9.1 The term competent person refers not to the individual employee who carries out the examination but to the body that employs them. Hence the legal duty to comply rests with a competent person's employer and not the individual examiner unless that individual is self employed.
- 5.3.9.2 [Ref 8] offers guidance on the level of expertise needed by the competent person dependant on the size and complexity of the system. Three system categories, i.e. minor, intermediate and major are suggested. In practice there are no clear parameters defining the categories, it is merely a judgement based on fluid type, system size, pressure, pressure-volume product or temperature. The higher the equipment category the more onerous it is for the competent person to demonstrate that they are 'competent'. [Ref 8] provides guidance on the basic attributes that a competent person organisation would be expected to demonstrate.
- 5.3.9.3 ONR inspectors may on occasions wish to assess competence. Whether the competent person is the duty holder or third party organisation, they must be able to provide clearly established access to the full range of relevant specialist services in the fields of materials engineering, NDT, design and plant operation as well as demonstrating a formal structure, independence, clear lines of authority and responsibility set out in a written statement. Staff must have the necessary credentials and experience, technical support, legal knowledge, availability of codes of practice, examination and inspection techniques and

understanding of the effects of operation for the system concerned. The persons who carry out examinations need sufficient practical and theoretical knowledge and actual experience of the type of system under examination. They should be capable of identifying defects or weaknesses, making engineering judgments and assessing the significance of those judgements in terms of the integrity and safety of the equipment.

- 5.3.9.4 On nuclear sites the duty holder may be the only one with sufficient expertise of the plant and therefore may also act as competent person or may provide technical support and assistance to the competent person undertaking the examination. Furthermore, the duty holder will be responsible for preparation work as necessary in advance of the examination. Where the competent person is embedded within the duty holder's organisation, it is important that the duty holder can demonstrate that the competent person is suitably independent from normal business activities and again [Ref 8] offers guidance on this aspect.
- 5.3.9.5 Many competent persons are represented by the Safety Assessment Federation (SAFed). This federation works in collaboration with other interested stakeholders including operators, inspection bodies (including other 'competent persons') and providers of specialist services. HSE and other trade associations also collaborate with SAFed to develop guidance on matters relating to thorough examination of pressure systems. One such document is identified in [Ref 9] which provides generic industry guidance that ONR inspectors may find helpful although it should not be regarded as an authoritative interpretation of the law.
- 5.3.10 Written schemes of examination
- 5.3.10.1 **Preparation** - PSSR includes specific legal requirements for the content of a written scheme including the nature and frequency of examination and any special measures necessary to prepare the pressure system for safe examination. Further guidance is provided in [Ref 10] which provides generic industry guidance. However, PSSR should be considered as a minimum legal requirement and inspectors should seek evidence of additional requirements added for nuclear applications.
- 5.3.10.2 **Selection** - The duty holder should first establish which parts of the pressure system should be included in the written scheme. Duty holders must carefully select parts for examination taking into account different operating regimes and potential degradation mechanisms, such as stress corrosion cracking, creep fatigue, corrosion, flow assisted cracking, etc. The duty holder must consider where parts will need preparation for examination, for example lagging may need to be removed to inspect pressure vessel integrity and plant may need to be removed or isolated for access. Reference 10 offers guidance that might assist inspectors when considering the adequacy of a scheme. Further guidance is provided in [Ref 12] and should be considered as being applicable to nuclear sites if appropriately applied.
- 5.3.10.3 **Exclusions** - PSSR allows a duty holder to exclude parts from the scope of the written scheme provided they are able to justify their decision. Such decisions need to be supported by advice from persons with an appropriate level of expertise and experience of the particular system. For example they may decide that the particular part of the system could not fail in such a way as to cause serious injury, or that there is no foreseeable degradation method. Inspectors must remember that such exclusions do not necessarily exclude the system from all regulations within PSSR and other legislation may still apply.
- 5.3.10.4 **Precautions** - PSSR requires the written scheme to set out any special safety precautions required to prepare the system for safe examination. On nuclear sites the duty holder normally has the specialist knowledge and it is expected

that this will be documented in duty holder's arrangements. Therefore the requirement for the written scheme to set out any special safety precautions is unlikely to be necessary on nuclear sites provided the work is undertaken in accordance with these arrangements.

- 5.3.10.5 **Periodicity** - There is no statutory periodicity between examinations. However, there are many factors to be considered by the competent person using their judgement and experience to determine the appropriate interval. SAFed have produced guidance [Ref 11] on periodicity for examination which although generic can be applied to nuclear plant by selecting appropriate plant categories etc. Earlier legislation set out maximum examination intervals for some types of equipment and competent persons sometimes use these as a guide. Such practice is perfectly acceptable but ONR inspectors must avoid confusing historic requirements with statutory requirements remembering that PSSR does not specify timescales.
- 5.3.10.6 **Storage** - The written scheme of examination may be kept in hard copy form or stored electronically. Electronic data management systems must be able to reproduce the scheme readily as a written copy, be authenticated by the competent person and be protected from unauthorised alteration.
- 5.3.10.7 **Review** - A review of the written scheme may be carried out at any time but it is good practice to do this when an examination has been completed and before the written report of that examination is issued. The competent person may decide that the period between each examination should be altered and it will, therefore, be necessary to revise the written scheme. For example, as the age of some nuclear plant increases, more detailed examinations may be needed or the frequency of examination could change.
- 5.3.10.8 **Extension** - Duty holders cannot use a review, which alters the frequency of examinations under the written scheme, to extend the date by which the next examination is due to take place. Under PSSR [regulation 9(5)(c)], the competent person will have specified in the last written report the date by which the next examination should take place and after which the system cannot be operated without a further examination. That requirement must be met unless a postponement is made in accordance with regulation 9(7) of PSSR as described below.
- 5.3.10.9 **Reduction in timescale** - The competent person may decide that the risk of danger may be significantly increased if the next examination timescale is in accordance with the current written scheme. In these circumstances, the written scheme should be reviewed and an earlier date set beyond which the system should not be operated without a further examination.
- 5.3.10.10 **Postponement** - PSSR only permits one postponement of the next examination, per examination period and the enforcing authority (i.e ONR) must be notified of this postponement. PSSR does not require ONR to formally agree the postponement once notified. However, if inspectors have concerns, or the duty holder has not satisfied the three conditions below, inspectors may need to take further action. When inspectors receive a postponement notification they should check that this is the only postponement notified for this period. Before an examination can legally be postponed, three conditions need to be satisfied, as follows:
- Agreement in writing with the competent person who made the report and,
  - the postponement does not give rise to danger and

- the duty holder must notify the enforcing authority (i.e ONR) of this change in writing before the date specified in the report.

#### 5.3.11 Examination in accordance with the written scheme

- 5.3.11.1 PSSR places a clear duty on the duty holder to ensure that the equipment is examined properly and in accordance with the written scheme of examination and not operated beyond the date specified in the current examination report. The duty holder shall ensure that the system is not operated until any repairs or modifications specified, have been completed, and the changes in the established safe operating limits have been made. Operating the equipment beyond this date is contrary to PSSR and inspectors should follow ONR guidance in applying the enforcement management model to determine if any enforcement action is appropriate
- 5.3.11.2 PSSR requires duty holders to take all appropriate safety measures to prepare the system for examination, including any such measures as are specified in the scheme of examination. Guidance in [Ref 8] lists typical preparatory works that duty holders must complete before the competent person undertakes the examination.
- 5.3.11.3 Under PSSR duty holders are not directly responsible for the quality of the examination as this is an area of responsibility entrusted to the competent person. However, duty holders will have additional duties under LC28 and therefore they should be assured that the examination has been carried out in a satisfactory manner.
- 5.3.11.4 PSSR requires the competent person to send a report of the thorough examination to the duty holder as soon as is practicable after completing the examination but within 28 days. Where several examinations are concentrated into a short period of time, as they often are on nuclear sites, the competent person should complete the reports and forward them within 28 days of the completion of the final examination in that series. Where the duty holder is also the competent person the same timescale requirements also apply.
- 5.3.11.5 The report should be based on the actual condition of the system as found during the examination. For nuclear plant it is common to perform repairs necessary as a result of the examination before the equipment is put back into service. In this case the report should include details of the fault and the remedial action taken even if the repair works are finished before the examination has been completed. Reference 8 indicates items to include in the report.
- 5.3.11.6 For mobile equipment PSSR requires that the date, by when the equipment should not be used without further examination, is legibly and durably marked on the mobile system and that the mark is clearly visible. Organisations using a mobile system may need to make a greater effort to ensure that examinations are carried out, particularly in the case of plant on long-term hire. A contractual agreement may be needed between the user and the owner to ensure that the competent person has access to the equipment at the appropriate time.
- #### 5.3.12 Action in case of imminent danger
- 5.3.12.1 During a thorough examination a competent person may find a fault that will give rise to imminent danger unless certain repairs or modifications have been carried out or unless suitable changes to the operating conditions have been made. In such circumstances reference 8 identifies the sequence of events for reporting imminent danger.



- 5.3.12.2 Competent person reports are a vital diagnostic aid to the safe operation of pressure equipment. Inspectors should not review competent person examination reports on an individual basis but look at a variety of reports on different pressure systems to confirm adequate management of PSSR. Inspectors should endeavour to track reports in accordance with ONR HOW 2 procedures.
- 5.3.13 Maintenance
- 5.3.13.1 For pressure systems used in nuclear applications licensees have a duty under Licence Condition 28 to ensure that the system is properly examined, inspected, maintained and tested, so as to prevent danger. It is likely that maintenance arrangements under LC28 will address this requirement. However, where the pressure systems do not have a nuclear application the requirements of PSSR and more general duties in HSWA and the Provision and Use of Work Equipment Regulations (PUWER) may be more appropriate to ensure adequate maintenance.
- 5.3.14 Modification and repair
- 5.3.14.1 In addition to the requirements of Licence Condition 22, if the licensee modifies or repairs a pressure system, PSSR requires that nothing about the way in which it is modified or repaired gives rise to danger or otherwise impairs the operation of any protective device or inspection facility. Some repairs or modifications may require examination by the competent person before the system is put back into use. Alternatively, the licensee may decide to draw up a comprehensive written method to be followed for certain specified repairs or modifications to some or all of the systems.
- 5.3.15 Keeping of records etc
- 5.3.15.1 In addition to Licence Condition 25: Operational records, PSSR requires the licensee to keep certain documents readily available and these are set out in [Ref 8].
- 5.3.16 Precautions to prevent pressurisation of certain vessels
- 5.3.16.1 Certain vessels may not ordinarily be considered as a pressure system, such as a storage tank for non pressurised liquid. However, if such a vessel could become a pressure vessel, due to its outlet becoming obstructed, then the duty holder has a duty to keep the outlet free from obstructions at all times when the vessel is in use to prevent an unintentional build-up of pressure.
- 5.3.17 Power to grant exemptions
- 5.3.17.1 ONR may, by a certificate in writing, exempt duty holders or any type or class of pressure system from the application of any of the requirements or prohibitions imposed by these regulations. This regulation is intended to cover exceptional circumstances where there are very specific, unusual conditions or duties where an exemption would be appropriate. PSSR offers a comprehensive set of regulations and it is difficult to envisage specific examples in normal operation where ONR might need to grant an exemption. However, in exceptional circumstances, for example to prevent or recover from a nuclear incident it could be envisaged that inspectors might need to exercise this power. Hence, it is important that inspectors are aware of its existence but should seek legal advice and should consult with a Superintending Inspector (SI)/Professional Lead before exercising powers under this regulation. In any case inspectors should be satisfied that the health and safety of persons who are likely to be affected by the exemption will not be prejudiced in consequence of it.

## 5.4 Ageing plant

- 5.4.1 RR509 was produced by HSE to capture research on plant ageing but was never formally published. This document is suggested as further reading material for inspectors wishing to gain more detail with respect on plant ageing and it includes checklist that may assist ONR inspectors. However, inspectors should ensure that the duty holder has systems in place for through life management of plant such that procedures will be in place as the plant ages.

## 5.5 Further Reading

Further reading may be obtained from the following publications:

Safety and Relief Valve Testing and Maintenance Guide - TR-105872	Electric Power Research Institute (EPRI).	www.epri.com
PAS 55-1:2008 – Part 1 – Specification for the optimised management of physical assets.	British Standards Institution (BSI)	www.bsigroup.co.uk
PAS 55-2:2008 – Part 2 – guidelines for the application of PAS55-1.	British Standards Institution (BSI)	www.bsigroup.co.uk
Product Standards – Pressure Equipment – Guidance notes on the UK regulations – URN 05/1074.	UK Department for Business, Enterprise & Regulatory Reform (BERR) formerly Dti.	<a href="https://www.gov.uk/pressure-equipment-manufacturers-and-their-responsibilities">https://www.gov.uk/pressure-equipment-manufacturers-and-their-responsibilities</a>
Equipment reliability process description – AP913	Institute of Nuclear Power Operators.	www.inpo.info
Plant ageing - Management of equipment containing hazardous fluids or pressure – RR509 -	TWI Ltd, ABB Engineering Services, SCS (INTL) Ltd and Allianz Cornhill Engineering for the Health and Safety Executive.	<a href="http://www.hse.gov.uk/research/rrhtm/rr509.htm">http://www.hse.gov.uk/research/rrhtm/rr509.htm</a>

## 6. REFERENCES

1. Licence Condition handbook. Office for Nuclear Regulation.  
<http://www.hse.gov.uk/nuclear/silicon.pdf>.
2. Safety Assessment Principles for Nuclear Facilities. .
3. Western European Nuclear Regulators' Association. Reactor Harmonization Group. WENRA Reactor Reference Safety Levels. WENRA. January 2008. [www.wenra.org](http://www.wenra.org).
4. IAEA Safety of Nuclear Power Plants: Design, Specific Safety Requirements SSR-2/1 2012 (which replaces NS-R-1) [www.iaea.org](http://www.iaea.org)
5. IAEA NS-G-2.6, Safety Guide on Maintenance, Surveillance and In-Service Inspection in Nuclear Power Plant. [www.iaea.org](http://www.iaea.org)
6. IAEA International Nuclear Safety Advisory Group series of reports, Report INSAG 19, Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life. [www.iaea.org](http://www.iaea.org).
7. IAEA International Nuclear Safety Advisory Group series of reports, Report INSAG 14, Safe Management of the Operating Lifetimes of Nuclear Power Plant. [www.iaea.org](http://www.iaea.org).
8. Safety of Pressure Systems Pressure Systems Safety Regulations 2000 – Approved Code of practice – L122 – ISBN 0-7176-1767-X. <http://www.hse.gov.uk/pressure-systems/law.htm>.
9. SAFed publication IMG 1 (EEMUA Publication 231) –The mechanical integrity of plant containing hazardous substances - A guide to periodic examination and testing. (<http://safed.co.uk/technical-guides/pressure-equipment/>)
10. SAFed - Pressure Systems – PSG 07 – Guidelines - on the PSSR SI 2000 No. 128 - Working examination requirements in WSE's – (<http://safed.co.uk/technical-guides/pressure-equipment/>).
11. SAFed - Pressure Systems – PSG1 – Guidelines on Periodicity of Examination – (<http://safed.co.uk/technical-guides/pressure-equipment/>).
12. SAFed - Pressure Guidelines – PSG6 – Guidelines - For the examination of pressure systems in accordance with Written Schemes of Examination (WSEs). – (<http://safed.co.uk/technical-guides/pressure-equipment/>).

Note: ONR staff should access the above internal ONR references via the How2 Business Management System.

## 7. GLOSSARY AND ABBREVIATIONS

ALARP	As low as reasonably practicable
HSE	Health and Safety Executive
HSWA	The Health and Safety at Work etc Act 1974
IAEA	International Atomic Energy Agency
UK	United Kingdom
EU	European Union
SAP	Safety Assessment Principle(s)
TAG	Technical Assessment Guide(s)
WENRA	Western European Nuclear Regulators' Association

## 8. APPENDICES

### APPENDIX 1 : WENRA REFERENCE LEVELS

WENRA Reference Level	Applicable Section of this TAG
<p>Issue G: Safety classification of structures, systems and components requires that all Safety structures and components important to safety shall be identified and classified on the basis of their importance to safety. It is important when designing plant to ensure that the appropriate codes and standards in design, manufacturing, construction and inspection. Furthermore, they must be maintained such that their quality and reliability is commensurate with their classification. The selection of materials is also covered by this issue and it is necessary to adopt a qualification procedure to ensure that the Safety Structures and components meet their demands throughout their design life.</p>	All sections
<p>Issue H: Operational limits and Conditions must be developed to ensure that plants are operated in accordance with design assumptions and intentions. The reference level requires that such limits are reviewed and updated as necessary, that modifications are adequately considered and that limits are readily accessible to operators. Limits must cover all plant states and intermediate conditions between states and adequate margins shall be ensured between operational limits and established safety system settings using conservative approach to account for uncertainty.</p>	Section 5.3.5, 5.3.15, 5.3.16, 5.3.20 ,
<p>Issue K: Maintenance, in service inspection and functional testing require the duty holder to prepare and implement documented programmes of maintenance and testing and surveillance. In particular the issue calls for periodic inspections and tests to ensure that they are safe for continued operation. A structured approach is called for to determine the extent and frequency of preventative maintenance, testing, surveillance and inspection. Recording of such activities is also required as is a procedure for adequate implementation and planning of the activities.</p>	Section 5.3.8, 5.3.13, 5.3.14, 5.3.17
<p>Issue Q: Plant modification shall be carefully controlled so that plant is not degraded as a result of modifications. All modifications must be properly designed, reviewed, controlled and implemented. A review process for modifications must also be implemented so that the consequences of any modification can be assessed.</p>	Section 5.3.18