

IGS

# Laboratory Gas Systems – Pressure Systems Safety

*‘aspire to zero’*

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# Introduction

- What do we mean by a 'safe system'?

Can we define the 'safe system' as:

The equipment and apparatus by means of which we can control, contain and convey gas or gases without risk to health, safety or the environment?

- What does the law say?

# Legislation Key requirements 1

Employers of personnel using gases must:

Be aware of their duties under HASAWA.

If or where applicable follow their duties under COSHH.

Provide information and take necessary precautions.

Provide and maintain the required equipment + PUWER.

If & where applicable follow their duties under DSEAR

If & where applicable follow their duties under PED & PSSR

# Legislation Key requirements 2

Where applicable provide safe means of gas disposal - &, where/if appropriate, by a means that is environmentally sound

Provide any necessary personal protective equipment

Ensure all necessary measures are in place to deal with any possible emergency

Ensure all personnel are properly trained

Carry out 'suitable & sufficient' risk assessments

## Guidance

ACOPS – for each Statutory Instrument (e.g. DSEAR, PSSR, etc.)

Codes of Practice – e.g. BCGA, EIGA & CGA

Technical Guides & Guidance Notes – e.g. SAFED

*CoP's, TG's, etc. inform: design, installation, testing, maintenance, etc.*



## The Pressure Systems Safety Regulations (PSSR), 2000

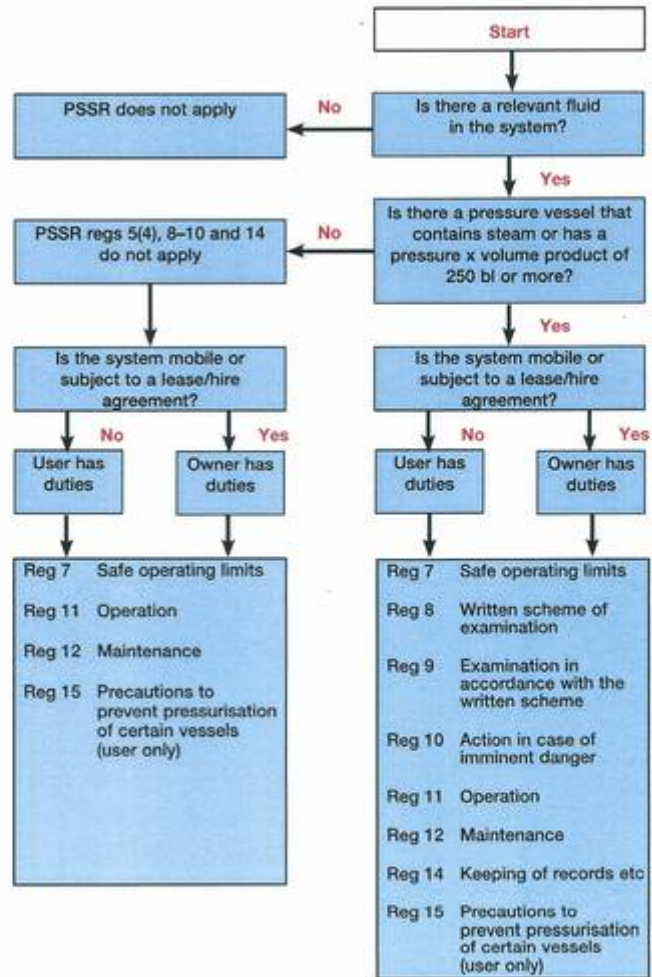
- The hazard of a release of stored energy associated with a relevant fluid\* due to system failure
- Stored energy for vessels =  $P \times V$  ( $P$  = pressure in barG x  $V$  = volume in litres): unit is the barl
- Stored energy for pipes =  $PS \times DN$  ( $PS$  = maximum allowable pressure in barG x  $DN$  = nominal pipework size in mm): unit is the barmm
- PSSR is NOT concerned with fluid properties and associated hazards e.g. if the fluid is flammable, toxic, etc.

*\*Steam under any pressure and gases at  $>$  or  $=$  0.5 barG*

# Catastrophic vessel failure – cold embrittlement



Figure 1 User/owner decision tree: Do the Regulations apply to my pressure system?



Note: This diagram only covers type (a) pressure systems, as defined in regulation 2(1) under 'pressure system', 'one or more pressure vessels of rigid construction, any associated pipework and protective devices.'

It does not cover a type (b) pressure system, 'the pipework with its protective devices to which a transportable pressure receptacle is, or is intended to be, connected,' or a type (c) pressure system, 'a pipeline and its protective devices.' If your pressure system is as defined in (b) or (c), this diagram will not work.

See paragraphs 19-24 for a definition of a 'relevant fluid' in PSSR, as referred to in the decision tree.



**Regulation 2**

*"installed system" means a pressure system other than a mobile system;*

*"maximum allowable pressure" and "minimum allowable pressure" mean the maximum pressure and minimum pressure respectively for which a pressure vessel is designed;*

*"mobile system" means a pressure system which can be readily moved between and used in different locations but it does not include a pressure system of a locomotive;*

*"owner" in relation to a pressure system means the employer or self-employed person who owns the pressure system or, if he does not have a place of business in Great Britain, his agent in Great Britain or, if there is no such agent, the user;*

*"pipeline" means a pipe or system of pipes used for the conveyance of relevant fluid across the boundaries of premises, together with any apparatus for inducing or facilitating the flow of relevant fluid through, or through a part of, the pipe or system, and any valves, valve chambers, pumps, compressors and similar works which are annexed to, or incorporated in the course of, the pipe or system;*

*"pipework" means a pipe or system of pipes together with associated valves, pumps, compressors and other pressure containing components and includes a hose or bellows but does not include a pipeline or any protective devices;*

*"pressure system" means—*

- (a) *a system comprising one or more pressure vessels of rigid construction, any associated pipework and protective devices;*
- (b) *the pipework with its protective devices to which a transportable pressure receptacle is, or is intended to be, connected;*
- (c) *a pipeline and its protective devices,*

*which contains or is liable to contain a relevant fluid, but does not include a transportable pressure receptacle;*

*"protective devices" means devices designed to protect the pressure system against system failure and devices designed to give warning that system failure might occur, and include bursting discs;*

*"relevant fluid" means—*

- (a) *steam;*
- (b) *any fluid or mixture of fluids which is at a pressure greater than 0.5 bar above atmospheric pressure, and which fluid or mixture of fluids is—*
  - (i) *a gas, or*
  - (ii) *a liquid which would have a vapour pressure greater than 0.5 bar above atmospheric pressure when in equilibrium with its vapour at either the actual temperature of the liquid or 17.5 degrees Celsius;*  
*or*
- (c) *a gas dissolved under pressure in a solvent contained in a porous substance at ambient temperature and which could be released from the solvent without the application of heat;*

*"safe operating limits" means the operating limits (incorporating a suitable margin of safety) beyond which system failure is liable to occur;*

*"scheme of examination" means the written scheme referred to in regulation 8;*

## Consequently:

Laboratory gas manifolds and pipeworks ARE Pressure Systems

They must, therefore, be:

- Properly designed & constructed. (Reg. 4)
- Properly installed with required information & marking provided.

(Reg's 5 & 6)

Further more

- The safe operating limits should be specified (Reg. 7). And,
- A written scheme of examination (WSE) should be prepared (Reg. 8)

# (Reg. 8) The WSE

The written scheme of examination (WSE) sets out the requirement for periodic examination of:

- All protective devices (e.g. safety relief v/v' s, bursting disks, etc.)
- Every pressure vessel (&/or pipeline) in which a defect could give rise to danger
- Those parts of the pipe work in which a defect may give rise to danger (e.g. high pressure hoses or pigtails, etc.)

The WSE will state the frequency of testing and the type of testing required..



A WSE will [typically] include:



THOSE PARTS TO BE EXAMINED

THE IDENTIFICATION OF THESE ITEMS, THE PLANT, etc.

THE NATURE OF THE INSPECTION/TESTING REQ'D

ANY PREPARATION REQUIREMENT BEFORE INSPECTION

(IN SERVICE OR OUT OF SERVICE)

THE MAXIMUM INTERVAL BETWEEN EXAMINATIONS

THE NAME OF THE COMPETENT PERSON RESPONSIBLE FOR THE WSE &

IT'S DATE OF CERTIFICATION

Let's have a look at an example...

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# MANIFOLDS & PIPELINES – ANNUAL INSPECTION

## By the specialist accordance with the WSE:

1. Confirm that any repairs/mod's have been carried out in accordance with the appropriate code
2. That any changes nearby do not affect operation or safety
3. That the pipework is properly marked (colour-code, name of gas, etc.) & is well supported\*
4. That the system is leak free at designated operating pressure
5. Filters are in good condition and aren't blocked
6. That safety relief v/v lifts and re-seats within tolerance and it's vent line is clear of obstructions

NOMINAL SIZE (mm)	SUPPORT SPACING (m)
< or = 15	1.5
22 - 28	2.0
35 - 54	2.5

# SCHEDULED REPLACEMENT OF KEY COMPONENTS

HIGH PRESSURE HOSES – 5 YR.

COPPER/COPPER ALLOY PIGTAILS - > or = 1 YR.

STAINLESS STEEL HOSES – 5 YR.

SAFETY RELIEF V/V – < or = 6 YR.

FLASHBACK ARRESTORS – 5 YR.

REGULATORS – AS DEFINED BY WSE

PIPEWORK – ANNUAL TESTING (see above)



# GAS CYLINDER MANIFOLDS – WEEKLY CHECKS

## - by the users of the 'system'

1. All equipment looks to be in good order, is being used correctly & all necessary equipment is fitted
2. The manifold framework & chains are in good condition
3. The 'pigtailed' are in good condition
4. User operated valves shut-off and re-open correctly
5. The system is correctly identified (service gas name, pressure, etc.)
6. The system is operating normally & no defects have been reported
7. The manifold house/cage is clean & is not being used as a general store

*N.B. JOINING: No soft solder joints, no compression type plumbing fittings\**

*\*cf. [Twin-ferrule] COMPRESSION FITTINGS: 'confined to instrument lines and similar small bore connections up to 15mm'*



Getting it right...

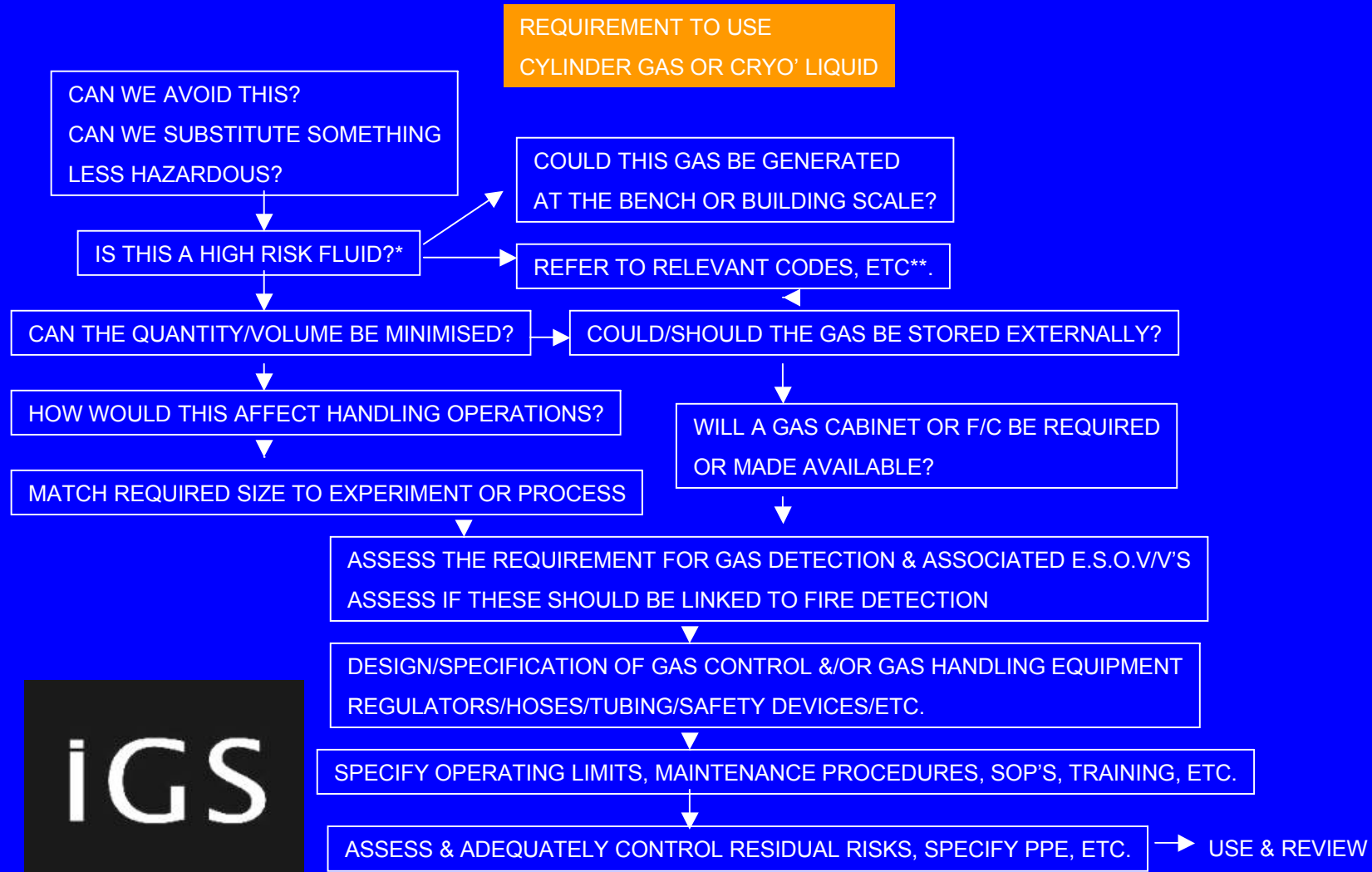


N6.0 grade installation

- Client's specification/clarity – what we need
- Design & component selection – what's do-able within budget & without compromise
- High standards of workmanship

So, there are hazards. There are procedures & precautions too...

Can we define a simple logic for safe system design?



# An explanatory note on this 'simple' logic

- Use of generators for hydrogen or nitrogen
- What is a 'high risk' fluid?
- What are the relevant codes for such fluids?
- Is external storage always desirable?
- Container size / handling / number of handling operations
- Containment by cabinet or fume cupboard – remember DSEAR & ATEX
- Gas detection – requirement (QUANTITATIVE assessment), type(s), functionality, cost of ownership, etc.
- Design, selection, assembly, etc....competencies? Overlooked items? Cost vs. Risk?.
- Testing, maintenance, scheduled replacement, operating procedures, etc.
- PPE requirements
- Authorisation of users
- REVIEW &, if necessary, improve: EVOLVE