CODE OF PRACTICE 43

THE SAFE FILLING OF GAS CYLINDERS

2012

British Compressed Gases Association

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PREFACE

The British Compressed Gases Association (BCGA) was established in 1971, formed out of the British Acetylene Association, which existed since 1901. BCGA members include gas producers, suppliers of gas handling equipment and users operating in the compressed gas field.

The main objectives of the Association are to further technology, to enhance safe practice, and to prioritise environmental protection in the supply and use of industrial gases, and we produce a host of publications to this end. BCGA also provides advice and makes representations on behalf of its Members to regulatory bodies, including the UK Government.

Policy is determined by a Council elected from Member Companies, with detailed technical studies being undertaken by a Technical Committee and its specialist Sub-Committees appointed for this purpose.

BCGA makes strenuous efforts to ensure the accuracy and current relevance of its publications, which are intended for use by technically competent persons. However this does not remove the need for technical and managerial judgement in practical situations. Nor do they confer any immunity or exemption from relevant legal requirements, including by-laws.

For the assistance of users, references are given, either in the text or Appendices, to publications such as British, European and International Standards and Codes of Practice, and current legislation that may be applicable but no representation or warranty can be given that these references are complete or current.

BCGA publications are reviewed, and revised if necessary, at five-yearly intervals, or sooner where the need is recognised. Readers are advised to check the Association's website to ensure that the copy in their possession is the current version.

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CONTENTS

TERMINOLOGY AND DEFINITIONS

The following terminology and definitions are used throughout this Code of Practice:

HAZOP	A technique to identify and assess potential hazards that might arise during the operation of plant or equipment. A study is normally carried out to assess the potential effects of various malfunctions of the equipment or plant (e.g. reverse flow, excessive temperature or pressure etc.).
May	Indicates an option available to the user of this Code of Practice.
Shall	Indicates a mandatory requirement for compliance with this Code of Practice.
Should	Indicates a preferred requirement but is not mandatory for compliance with this Code of Practice.

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THE SAFE FILLING OF GAS CYLINDERS

1. INTRODUCTION

Each year hundreds of thousands of gas cylinders are filled within the UK, almost entirely free of any incident.

However, the activity has many potential hazards related to the properties of the substance being used; the compatibility with the container it will be filled into; and the pressures involved. It is also subject to a wide range of statutory controls.

Cylinder gases are used in most industries and in a wide variety of environments. To assure the safe filling of gas cylinders it is very important to check that the integrity of the overall package is retained and it is suitable for filling to proceed.

NOTE: Transportable pressure receptacles, or transportable pressure vessels, are legal terms which collectively includes individual cylinders, tubes, pressure drums and bundles of cylinders. To aid clarity this document will refer to all these as gas cylinders.

2. SCOPE

This Code of Practice considers the filling of gas into gas cylinders. With the variety of gases covered, compressed or liquefied, receptacle size, and the number of gas cylinders filled together it is inevitably generic in much of its content.

3. RELEVANT LEGISLATION AND BCGA DOCUMENTS

Many of the documents referenced in Section 6 make specific demands, either explicitly or indirectly, regarding the process of filling gas cylinders. In particular the Management of Health and Safety at Work Regulations (3) and the Pressure Systems Safety Regulations (PSSR) (4) require that the activity is subject to a formal risk assessment, and that the equipment used for the filling process is properly designed, documented and operated. It will also be the subject of a Written Scheme of Examination to ensure continued safety in use.

In addition, any filling and supply of medical gases requires that the filler be in possession of a manufacturer's licence granted by the Medicines and Healthcare products Regulatory Agency (MHRA).

The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG Regulations) (5) implements the European Agreement on the Transport of Dangerous Goods by Road (ADR) (6). ADR (6) requires that the filling of gas cylinders shall only be carried out by specially equipped centres, with qualified staff using appropriate procedures. These procedures should include:

(i) The conformity to regulations of receptacles and accessories.

(ii) Compatibility with the product to be carried.

(iii) The absence of damage which might affect safety.

(iv) Compliance with the degree or pressure of filling, as appropriate.

(v) Markings and identification.

The safe filling of gas cylinders is a complex activity. The BCGA has developed an audit checklist for use in assessing the important processes that shall be applied by any organisation that intends to carry out filling activities (see Appendix 2). Whilst this checklist is primarily intended to assess organisations filling drinks dispense and food gases it is equally applicable to requirements applicable to the filling of general gases and gas mixtures.

4. MANUFACTURING METHODS.

The process of filling a gas into a cylinder follows a series of sequential steps:

4.1 Selection of suitable gas cylinder(s), and filling equipment.

Any gas cylinder being filled in the UK shall comply with the appropriate legislation. The manufacturing standards have to have been approved by the UK Competent Authority, the Department for Transport, and / or meet the requirements of ADR (6). ADR (6) requires that an inspection is carried out on the gas cylinder to ensure it is authorised for the particular product and that the requirements of ADR (6) have been met. ADR (6) further defines the requirements for valves, for the periodic inspection and testing of the gas cylinder, and for many other aspects of the supply of gases.

A suitable cylinder shall be selected for the intended product. Such selection will be made on criteria including size, material of construction, test period, valve type, and previous service history.

Beverage gas filling involves particular risk of cylinder contamination from the customer process. For this reason the BCGA believes that it is essential that gas cylinders supplied into this market are fitted with residual pressure valves. More information on the supply standard for gas cylinders for use in the beverage industry is contained in BCGA Leaflet L10 (19).

The filling equipment to be used shall be decided. Filling is normally carried out either by pressure or by weight. Pressure filling involves high pressure process equipment, and has the advantage that different sizes of cylinder can be filled at the same time. Liquefied gases are usually filled individually by weight.

4.2 Filling according to written instructions.

The process of filling cylinders should be defined by a series of work instructions / standard operating procedures related to each piece of equipment and the methods being used, based on a risk assessment. The actual filling of the gas product is then carried out in accordance with the written instruction / standard operating procedure. The work instructions / standard operating procedure should have been reviewed and approved by appropriate competent persons. They will include:

(i) Pre-fill inspection of the gas cylinder.

(ii) Filling procedure.

(iii) Post-fill inspection.

Many gases and gas mixtures require very detailed procedures that shall be tailor-made for the product being filled. Such procedures may need to address issues such as material compatibility, cylinder preparation, corrosion, interaction between substances, safe concentration limits, product disposal, product handling and personnel exposure.

The filling of gas mixtures requires particular care. Additional guidance is available from the European Industrial Gases Association (EIGA) Document 39 (22), *The safe preparation of gas mixtures,* which sets out the basic requirements to ensure that gas mixtures are manufactured safely.

For medical gases, EIGA Document 99 (24), *Good manufacturing practice guide for medicinal gases*, is provided for use by manufacturers of medicinal gases and fillers of medicinal gas cylinders. It covers the manufacture and distribution of all medicinal gases on gas company premises and the filling of medicinal gas cylinders to meet the specifications set in the relevant Pharmacopoeia standards and, where required by the national authorities, in the relevant Marketing Authorisations.

Cylinders provided for service in the marine environment should be subject to additional pre-fill checks as detailed in EIGA Document 61 (23), *Safe use of gas cylinders in marine service*.

Recommendations for safe practice in the design and operation of Liquefied Petroleum Gas (LPG) cylinder filling plants is detailed in the UKLPG Code of Practise 12 (38).

Cylinders shall not be filled with a substance different from that which it has previously contained unless the specific operations necessary for a change of gas service have been carried out. Refer to BS EN ISO 11621 (16).

The filler shall ensure that the filled gas cylinder is marked and labelled, and correctly identifies the contents. Marking and labelling shall meet the requirements of ADR (6). Refer also to BS EN ISO 7225 (15) and BCGA Technical Information Sheet (TIS) 6 (20). Where colour coding is applied to the cylinder refer to BS EN 1089-3 (11), ISO 32 (13) for medical gas cylinders and BCGA TIS 6 (20).

4.3 Quality control of the filled gas cylinder(s)

A check shall be carried out to ensure that the filling was completed as intended. This can involve analysis of the finished product to ensure compliance with the desired specification. It can also include pressure checking, leak checking, visual inspection of the gas cylinder and any other specified check.

5. SAFETY ISSUES

Each step identified above involves potential safety issues.

5.1 Training

Cylinders should only be inspected and filled by fully trained and competent personnel, fully conversant with the equipment they are operating. They are to be fully aware of the requirements of the ADR (6), as well as the hazards and dangers of the products, safe handling and emergency response procedures. Training is to be supplemented periodically with refresher training. This competence should be verified periodically and compliance with procedures monitored. Records of the training received are to be kept by the employer and are to be made available to the authorities on request.

5.2 Cylinder Selection:

(i) The design pressure of the cylinder shall be suitable for the filling pressure.

(ii) The material and type of the valve and cylinder shall be suitable for the gas being filled.

These issues will normally be addressed by internal company procedures. The staff who carry out this selection shall be experienced and trained in the process.

5.3 Filling Equipment:

(i) A formal risk assessment should be conducted on the design and operation of the filling equipment to ensure that it is suitable. It shall be designed, operated and maintained in accordance with relevant legislation. The maintenance regime should include consideration of the effects of ageing on the integrity of the equipment.

(ii) The assessment of the filling equipment and operation should include consideration of the 'human factor' issues given in Appendix 1.

(iii) Where hazards are identified which could lead to very serious injury or fatality, the system should be designed to eliminate these hazards as far as possible. Where elimination of the hazard is not possible, the system shall be designed to incorporate physical controls to reduce the risks to a minimum. Reliance on the operator following a procedure shall be used where there is no reasonable alternative, but key stages in the procedure shall be subjected to independent checking by another individual.

(iv) There should be physical segregation within the filling pipework system of chemically incompatible gases. Thus it should be physically impossible to add flammable gases to oxidant gases without disconnecting the cylinder from the filling equipment. Control of the cylinder by analysis or some other appropriate measure defined by the risk assessment should be used to assure safety before taking the next step in the process.

(v) Consideration should be given where practicable to the use of gas specific connectors to prevent filling incompatible gases. Control of the issue and use of filling adaptors is an important preventive measure.

5.4 Filling Process:

(i) Any residual gas contained within the cylinder shall be capable of being safely disposed of, in order to ensure that the cylinder is internally free of any residual or contaminant gas that would affect the filling operation.

(ii) Some gas cylinders are filled by decanting a product from one container to another. The safe decanting of gases is a complex and lengthy procedure, requiring expertise and a high level of technical understanding. This process can be suitable for some circumstances, but involves many safety and quality issues. A detailed description of the relevant concerns is given in BCGA TIS 13 (21).

(iii) The process of filling should only be undertaken by staff with sufficient knowledge, experience and training to enable them to conform exactly to the requirements of the work instructions. The allocation of work should take into account the human factors issues detailed in Appendix 1.

(iv) At any time, at any filling manifold, only one product should be in the process of being filled, albeit more than one cylinder may be filled simultaneously with the same product.

(v) Procedures should exist for dealing with cylinders that have been filled incorrectly.

(vi) Instrumentation and weigh scales where they are used should be calibrated and checked regularly.

5.5 Quality Assurance:

The quality control carried out on finished products can identify when errors have occurred in the whole process resulting in an unsatisfactory product being produced. This should be used as a warning that the process is not fully under control, and could perhaps have resulted in a safety problem. Thus the company should have a formal system of reviewing quality control failures to identify the root cause of the failure.

6. REFERENCES

1.		Health and Safety at Work etc. Act 1974
2.	SI 1998. No. 2306	The Provision and Use of Work Equipment Regulations (PUWER)
3.	SI 1999: No. 3242	The Management of Health and Safety at Work Regulations 1999
4.	SI 2000. No. 128	Pressure Systems Safety Regulations (PSSR) 2000.
5.	SI 2009. No. 1348	Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (as amended)
6.	ECE/TRANS/215	European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)
7.	EC No. 1272/2008	Classification, Labelling and Packaging of Substances and Mixtures (CLP).
8.	HSE HSG 48	Reducing error and influencing behaviour
9.	HSE Human Factors.	Inspectors Toolkit. Human factors in the management of major accident hazards
10.	BS 341	Transportable gas container valves.
11.	BS EN 1089 Part 3	Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour Coding.
12.	BS EN 1968	Transportable gas cylinders. Periodic inspection & testing of seamless steel gas cylinders.

13.	ISO 32	Gas cylinders for medical use - Marking for identification of content.
14.	BS ISO 5145	Cylinder valve outlets for gases and gas mixtures. Selection and dimensioning.
15.	BS EN ISO 7225	Gas cylinders - Precautionary labels.
16.	BS EN ISO 11621	Gas cylinders. Procedures for change of gas service.
17.	BCGA Code of Practice 32	The safe use of N_2, CO_2 and CO_2/N_2 cylinders in the beverage dispense industry.
18.	BCGA Guidance Note 14	Production, storage, transport and supply of gases for use in food.
19.	BCGA Leaflet 10	Profit through quality. Good gas, good business.
20.	BCGA Technical Information Sheet 6	Cylinder identification. Colour coding and labelling requirements.
21.	BCGA Technical Information Sheet 13	Decanting gas cylinders.
22.	EIGA Document 39	The safe preparation of gas mixtures.
23.	EIGA Document 61	Safe use of gas cylinders in marine service.
24.	EIGA Document 99	Good manufacturing practice guide for medicinal gases.
25.	EIGA Safety Info HF 01	Human Factors – An overview.
26.	EIGA Safety Info HF 02	Individual. Training and competence.
27.	EIGA Safety Info HF 03	Organisation. Human factors in incident investigation
28.	EIGA Safety Info HF 04	Task. Design and effectiveness of procedures.

29.	EIGA Safety Info HF 05	Task. Maintenance error.
30.	EIGA Safety Info HF 06	Organisation. Site emergency response.
31.	EIGA Safety Info HF 07	Organisation. Communications on safety.
32.	EIGA Safety Info HF 08	Task. Alarm handling.
33.	EIGA Safety Info HF 09	Task. Fatigue from working patterns - Shiftwork and overtime.
34.	EIGA Safety Info HF 10	Organisation. Managing organisational change.
35.	EIGA Safety Info HF 11	Organisation. Safety culture.
36.	EIGA Safety Info HF 12	Task - Human Factors in Design
37.	EIGA Safety Info HF 13	Organisation. Human reliability.
38.	UKLPG Code of Practise 12	Recommendations for safe practice in the design and operation of LPG cylinder filling plants.

Further information can be obtained from:

Health and Safety Executive	www.hse.gov.uk
HSE Books	www.hsebooks.co.uk
HMSO	www.hmso.gov.uk
British Standards Institution (BSI)	www.bsigroup.co.uk
International Organization for Standardization (ISO)	www.iso.org
European Industrial Gases Association (EIGA)	www.eiga.eu

British Compressed Gases Association (BCGA)	www.bcga.co.uk
UKLPG Trade Association (UKLPG)	www.uklpg.org

APPENDIX 1

HUMAN FACTORS RELEVANT TO SAFE CYLINDER FILLING

1. INTRODUCTION

Cylinder filling, and in particular gas mixture filling, is a task that is highly dependent upon the diligence and correct application of instructions and procedures by operators. In this respect particular attention shall be paid to those factors that may affect human reliability. In this respect we refer to the term Human Factors where we consider the organisational, job and people related factors that influence behaviour at work.

Additional information on Human Factors is available from EIGA:

EIGA Safety Info HF 01 (25)	Human Factors – An overview.
EIGA Safety Info HF 02 (26)	Individual. Training and competence.
EIGA Safety Info HF 03 (27)	Organisation. Human factors in incident investigation
EIGA Safety Info HF 04 (28)	Task. Design and effectiveness of procedures.
EIGA Safety Info HF 05 (29)	Task. Maintenance error.
EIGA Safety Info HF 06 (30)	Organisation. Site emergency response.
EIGA Safety Info HF 07 (31)	Organisation. Communications on safety.
EIGA Safety Info HF 08 (32)	Task. Alarm handling.
EIGA Safety Info HF 09 (33)	Task. Fatigue from working patterns - Shiftwork and overtime.
EIGA Safety Info HF 10 (34)	Organisation. Managing organisational change.
EIGA Safety Info HF 11 (35)	Organisation. Safety culture.
EIGA Safety Info HF 12 (36)	Task - Human Factors in Design
EIGA Safety Info HF 13 (37)	Organisation. Human reliability.

2. WHY DO INCIDENTS HAPPEN?

If we define anything that goes wrong at work that results in some kind of harm or loss as an incident, then it is possible that many things could contribute to their cause. It is often easy to blame the individual who was most directly involved. However, this is too simplistic and a human factors approach makes it clear that there are often a number of factors which have contributed to the accident. These can include poor design, poor maintenance, attitudes to health and safety in the organisation, inconsistent or inadequate consequence management, inadequate training or supervision, poor work planning and organisation.

3. CONSIDERATION OF HUMAN FACTORS

Human Factors can be grouped into the following three aspects which interlink with each other; these are organisational, task related and the individual.

3.1. Organisation Factors

People's behaviour in the workplace is affected by the collective characteristics of the business or organisation in which they work. Employees respond to the messages and cues they receive from senior management, though not always in the way intended. This reflects the culture of the organisation. To manage health and safety effectively it is important to consider how all the organisational factors listed below influence and affect human behaviour.

(i) Managing organisational change.

(ii) Safety culture.

(iii) Behavioural safety.

(iv) Supervision.

(v) Communications on safety.

(vi) Resource, staffing levels and organisation workload.

(vii) Human reliability – human error and systems failures.

(viii) Human factors in incident investigation.

(ix) Human factors integration.

(x) Emergency response.

3.2. Task factors

The way jobs are designed to interface with equipment and the workplace environment has a direct effect on the health and safety of workers. The timing of shifts, the length and frequency of breaks, the task workload, the physical and mental demands due to the design of the task, equipment and environment are all important Human Factors to consider and can affect both the individual and the integrity of the whole work system. Consideration should be given to the following factors in designing jobs:

(i) Manual handling, repetitive actions and ergonomics.

(ii) Work-related stress.

(iii) Fatigue from working patterns - shift work and overtime.

(iv) Alarm handling.

(v) Interfaces with plant and equipment.

(vi) Design and effectiveness of procedures.

(vii) Routine and non-routine work.

3.3. Individual factors

People vary in many ways, physically, mentally and in their personality, knowledge and experience. The individual's characteristics including their competence, skills, personality, attitude and risk perception, influence behaviour in complex ways. Some characteristics such as personality are fixed; others such as skills and attitudes may be changed or enhanced. Finally, people have different knowledge and experience on which to draw.

The design of the job, the equipment, information and work environment should all take account of the variety of individual capabilities and limitations. People need to have the appropriate knowledge, skills and abilities to be able to carry out their work effectively and safely. They also need to have the appropriate attitudes and awareness of the risks in order to work in a safe manner. It is therefore necessary to ensure they have the appropriate training and personal development if they are to work efficiently and safely. It is easier to develop skills and change attitudes than it is to adapt personality.

It is also important to ensure that the workplace is designed ergonomically as far as is necessary to support rather than hinder people's task performance. When people are recruited, or change their jobs, it is sensible to check if any adaptations to the workplace would make it easier for them to do the job and reduce the risk of human error, injury or ill-health as well as increasing their efficiency or productivity.

4. SPECIFIC FACTORS RELATED TO CYLINDER FILLING

4.1. Training and competence

This key issue is not discussed in detail here however the guiding principles are:

(i) All staff involved in cylinder filling shall be properly trained and have their competence assessed.

(ii) The training and competence assessment shall be commensurate with risks involved.

(iii) Where safety is dependent upon the strict adherence to procedures and the consequences of error could be serious injury or death, such as flammable-oxidant and other special mixtures, assessment of knowledge, understanding and skill shall be formally undertaken before undertaking any unsupervised filling, and repeated at appropriate intervals.

4.2. Shift handover

Where shiftwork is involved - and remembering that even simple day shifts need consideration e.g. over weekends / from weekend working or because of illness / leave etc - arrangements should be in place for a face to face handover with time allowed on shift for this. Where necessary this should be backed up with a suitable recording system e.g. a shift log.

4.3. Risk assessment for human error

Risk assessment for the identification and control of human error is very important. A detailed risk assessment using a team approach is recommended. For example a suitably modified HAZOP procedure could be used. Given the reliance on correct human actions during cylinder filling operations it is also recommended that there be a rolling programme of further detailed human factors assessments of other safety critical tasks. Operating instructions should contain detailed step-by-step task descriptions that could be the basis for such analyses. A list of error types that could be considered for each task step is given in Annex A to this Appendix. These are suitable when considering errors made by a trained and experienced operator. The assessments should include input from operators and the results should be fed back to all operators who carry out the tasks.

4.4. Mirror image panels

Sometimes control panels may be similar to each other in most respects except that their controls are laid out in a mirror image e.g. left-to-right reversed. In terms of ergonomic design this is not generally desirable as an operator may mistakenly assume they are operating one panel when actually operating another. If the panel design cannot be altered in the short-term then it is suggested that it would be a sensible precaution to carry out a more detailed assessment of the risks of an operator making an error caused by this mirror-image design.

4.5. Assessment of keying errors

Keying errors could be made on computerised weighing machines where gases are being mixed. The consequences of this need to be assessed to see if there are significant risks which may arise from such errors. Such errors can be hard to detect and correct. For example, a single keying error may also have an effect on a batch of cylinders perhaps of different sizes. It is recommended that the consequences of such errors be considered in more detail during risk assessment and that it is established whether existing control measures, which rely on an operator checking the display, are sufficient to control the risk.

4.6. Lock off systems

Where controlled systems for locking off parts of the panels in the gas mixing area are in place, they need to be monitored for effectiveness. The possibility of an operator by-passing these control measures e.g. by locating a separate cylinder of the flammable gas required and transporting it to the panel need to be considered. Site management need to ensure that all operators are fully aware of the risks involved in such rule violations.

4.7. Supervision and fitness for work

Supervisors should ensure that there are no variations from established procedures. Any attempt to short-cut or re-invent work practices shall be immediately prohibited until the change has been risk assessed and authorised. They shall also ensure the continuing fitness for work of their staff, and in particular, take steps to ensure that operators whose behaviour is symptomatic either of fatigue or of being under the influence of drink or drugs are not allowed to work on high risk tasks. Supervision shall be resourced so that this surveillance is effective. Employers should develop suitable policies and practices covering such fitness for work issues with the help of an appropriate expert.

4.8. Job aids

Operating instructions should be clear and detailed. However, though the full instructions will be used for training and reference they may not be used - or readily usable - on a daily basis. It is important therefore that key parts of the instructions, e.g. step by step instructions on specific filling operations, are made more readily and separately available for operators to use. Such simple ‘job aids’ - perhaps in the form of flowcharts or checklists - should be developed for those critical filling tasks which contain a number of sequential steps. In such tasks human errors can arise through mis-ordering steps or omitting one or more steps. Such errors are more likely if there are long waits between task steps where interruptions can distract an operator. Some advice on developing procedures and job aids is given the HSE guidance on human factors (HSG 48 (8)).

4.9. Work planning and scheduling

Staffing levels need to be appropriate to the work carried out and should not involve high levels of overtime. Overtime therefore should be closely monitored. Errors and non-compliance with procedures will of course be more likely if operators are under time pressure and if they are fatigued. Poor work planning can lead to pressure on operators to cut corners to do the required work. Therefore the scheduling of work needs to be appropriate and designed by experienced supervisors with some operator input so that operators on the plant do not feel pressurised by the workload.

4.10. Concentration

Cylinder filling can be highly repetitive which, along with distractions, can lead to lapses in concentration and errors. Critical steps in the filling process shall be carried out correctly every time so factors affecting concentration shall be identified and controlled. Such things as job rotation, appropriate break frequencies, good lighting, low noise levels and supervision will assist here.

APPENDIX 1
Annex A

A CLASSIFICATION OF HUMAN FAILURES

The following is a list of typical error categories for routine procedures, carried out by trained operators, as identified in the HSE Human Factors Toolkit (9):

Action errors:

- Operation too long / short.
- Operation mistimed.
- Operation in wrong direction.
- Operation too little / too much.
- Operation too fast / too slow.
- Misalign.
- Right operation on wrong object.
- Wrong operation on right object.
- Operation omitted.
- Operation incomplete.
- Operation too early / late.

Checking errors:

- Check omitted.
- Check incomplete.
- Right check on wrong object.
- Wrong check on right object.
- Check too early / late.

Information retrieval errors:

- Information not obtained.
- Wrong information obtained.
- Information retrieval incomplete.
- Information incorrectly interpreted.

Information communication errors:

- Information not communicated.
- Wrong information communicated.
- Information communication incomplete.
- Information communication unclear.

Selection errors:

- Selection omitted.
- Wrong selection made.

Planning errors:

- Plan omitted.
- Plan incorrect.

Violations:

- Deliberate actions.

APPENDIX 2

AUDIT CHECKLIST

COMPANY:
PREMISES AUDITED:
AUDITOR:
BRIEF DESCRIPTION OF PREMISES AND PRODUCTS FILLED: *Auditors note. Include comment on suitability of plant, premises and general condition.*
DATE OF AUDIT:

Note: In the following tables, the scoring "C" refers to critical and "S" refers to supporting

ITEM	CHECK	COMMENT

TABLE 1 - RECORDS		
1.1	List names of people interviewed during audit, their job title qualifications and experience.	Scoring N/A
1.2	Is there a system in place to control and document cylinder service conversions? Check authority required for this process and establish competency.	If in service conversions are undertaken in house: 1. Look in detail at understanding of developed pressures and material compatibilities. 2. Look for formal approval and control by a competent person and understanding of when a Notified Body may be required. When applicable, then failure to operate an adequate system of control can be taken as a valid reason for rejection. **Scoring:-** 1 = System in place, full compliance with requirements and formal authorisation of conversions by a competent person. 2C = Occasional gaps in records but system in place and competent person available. 3C = No system in place and evidence of service conversions undertaken without authorisation and review.
1.3	For cylinders owned by the company check a specimen sample of records to establish what specification they were purchased to, and the adequacy of the original certification.	If no certification available and no other means of establishing ownership and technical suitability of the container for service then the application shall be rejected. Ref. BCGA CP 32 (17). **Scoring:-** 1 = Full compliance, all records complete and specifications adequate. 2C = Occasional gaps in records but evidence of a system in place. 3C = No system in place and evidence that cylinders are not purchased to adequate requirements.
1.4	Are filling records maintained which detail: (i) Products filled. (ii) Quality control results.	Absence of filling records on its own cannot be a reason for rejection but may be a contributory factor. **Scoring:-** 1 = Full compliance, all records complete and available. 2S = Occasional gaps in system but evidence of a system in place. 3S = No records maintained.

TABLE 2 - PLANT AND EQUIPMENT – Maintenance, Examination & Test		
2.1	Are formal maintenance schedules in place for filling equipment and associated test and measuring equipment?	Formal maintenance shall be evident (Ref. PUWER (2)) e.g. flexible hose and connectors examination. **Scoring:-** 1 = Full compliance, all records complete and available, evidence of satisfactory maintenance of plant and equipment. 2S = Occasional gaps in system e.g. occasional record missing but evidence of a system in place. 3S = No evidence of any system of preventive maintenance.
2.2	Is there a Written Scheme of Examination in compliance with the PSSR (4)? Are formal records kept of the above activities?	A WSE shall be available. Lack of a WSE would be a valid reason for rejection of application. **Scoring:-** 1 = Full compliance, all records complete and a WSE available. 2C = Occasional gaps in system but evidence of a system in place. 3C = No evidence of any system of compliance with PSSR (4), no WSE.
2.3	Is measuring and test equipment, including weighing equipment, included in a formal calibration system and marked accordingly? Check records of such calibration.	Where product is filled or sold by weight e.g. 6.35 kg CO_2, then there should be a formal calibration system in place, there is also a weights and measures requirement (crown stamping of scales). Where lack of calibration control presents a risk to Health and Safety then this may be regarded as a valid reason for rejection of application. **Scoring:-** 1 = Full compliance, all records complete and available. 2C = Occasional gaps in system e.g. calibration label missing but evidence of a system in place. 3C = No evidence of any system of calibration control.

TABLE 3 - PREFILL OPERATIONS		
3.1	Does the company have formal pre-fill inspection procedures that clearly lay down acceptability criteria?	If not then application to be rejected. Ref. BCGA CP32 (17). **Scoring:-** 1 = Full compliance, procedure in place. 2C = Occasional gaps in system but evidence of a system in place. 3C = No evidence of any system of pre-fill inspection or general non-compliance with the system in place.
3.2	Does the company ensure that only cylinders complying with an appropriate design standard are filled?	Look for recognised and approved design standard stamped on the cylinder. **Scoring:-** 1 = Full compliance, cylinder fillers are aware of checks required and cylinder stampings are looked at. System in place for cylinder control. 2S = Occasional gaps in system but evidence of a system in place. 3S = No evidence of any system for ensuring the design standards of cylinders filled are adequate.
3.3	Is there a system to ensure that cylinders with no residual pressure or that have been left with their valves open are treated to ensure their suitability for filling?	If no precautions taken then application to be rejected. Ref. BCGA CP 32 (17). **Scoring:-** 1 = Full compliance, methods in place to ensure that cylinders with suspect contamination are not filled. 2C = Occasional gaps in system but evidence of a system in place. 3C = No evidence of any system or evidence of general non-compliance with the system.
3.4	Where residual pressure valves are fitted to cylinders, is there an adequate method for ensuring that the valves function correctly?	**Scoring:-** 1 = Full compliance, RPV function checked each fill. 2S = Occasional gaps in system e.g. some RPV's not checked but evidence of a system in place. 3S = No evidence of any system or evidence of general non-compliance with the system.

3.5	Do the procedures require that cylinders to be filled have valid test status?	**Scoring:-** 1 = Full compliance with procedures in place to ensure that cylinders filled are within current test periods. 2C = Very isolated lapses in system but evidence of a system in place and corrective actions to address any lapses in the system. 3C = No evidence of any system for ensuring that cylinders filled are within test or evidence of general non-compliance with the system.
3.6	Is ownership of cylinders presented for filling established?	**Scoring:-** 1 = Full compliance, all cylinders presented for filling are owned by the company or, if customer owned, there is evidence that ownership is established prior to fill and that filling is approved by the owner. 2S = Occasional gaps in system but evidence of a system in place. 3S = No evidence of any system of establishing ownership.
3.7	Are formal procedures in place for handling cylinders that are outside of the test date?	**Scoring:-** 1 = Full compliance with procedures in place. 2C = Occasional gaps in system but evidence of a system in place. 3C = No evidence of any system for control of cylinders outside test date or evidence of general non-compliance with the system.
3.8	Check how the cylinders are retested, by whom and to what standard.	**Scoring:-** 1 = Full compliance, UK Competent Authority approved cylinder test house working to approved standards e.g. EN 1968 (12). 3C = Evidence that cylinders are either not retested to an approved standard or that the tests done are inadequate.
3.9	How is the next test date identified on the cylinders?	**Scoring:-** 1 = Full compliance, test date rings and hard stamping used. 2C = Not all cylinders are clearly stamped and no test date rings. 3C = No evidence of any method of identifying next test due date or the last test date.
3.10	Check that the cylinders to be filled are suitably rated for the product to be filled.	**Scoring:-** 1 = Full compliance with a formal system for ensuring that the cylinders filled are suitable for the product, mix and filling pressure. 3C = Evidence that cylinders are being filled that are not suitable for the pressure or the products being filled.

3.11	Are cylinders fitted with valve outlets and safety labels in accordance with current standards.	**Scoring:-** 1 = Full compliance, cylinders filled and labeled with correct outlets. 2S = Occasional gaps in system but occasional labels missed, with evidence of a system in place. All valves to have correct outlets. 3S = Evidence of incorrect valve outlets or general absence of labels.

TABLE 4 - FILL & POST-FILL OPERATIONS		
4.1	Are the filling methods and procedures employed suitable to ensure that the integrity of the cylinders filled is not adversely affected.	If a standard manometric (pressure measurement) system is used for mixtures greater than 30 % CO_2, consider the filling pressures and the technical feasibility of the filling system. If in doubt seek further guidance, but application may be rejected if the filling process is technically not capable of safely producing the products offered. Where auto cut off systems are used look for the checks on the system operation. **Scoring:-** 1 = Full compliance, methods suitable and procedures in place. 2C = Occasional gaps in system but evidence of a system in place. 3C = No evidence of any procedures to ensure that cylinder integrity is not adversely affected by the filling method or evidence that the filling methods are unsuitable for the products filled.
4.2	Check the physical condition and suitability of the plant and equipment used to fill cylinders.	The auditor will have to use his judgment and experience to assess the physical condition of the plant in relation to its required duties. Obvious safety risks or inadequate equipment may be contributory factors to rejection but cannot on their own be the only reason as there are limited objective criteria. Check that the equipment looks to be capable of producing product to the applicants specification. **Scoring:-** 1 = Full compliance, plant is suitable for use and in good condition. 2C = Occasional gaps in system, e.g. plant old and some areas not well maintained, but evidence of general capability of plant to produce range of products offered. 3C = Plant in very poor condition or incapable of producing the range of products offered.
4.3	Is there a system in place for the post-filling inspection of cylinders: (i) Leak-checking. (ii) Checking for over-filling.	Absence of a post-fill check shall be considered by the auditor as contributing towards rejection – Ref. BCGA CP 32 (17). **Scoring:-** 1 = Full compliance, post fill checks always done. 2S = Occasional gaps in system, e.g. occasional check missing, but evidence of a system in place and resources to comply with it are available. 3S = No evidence of any post fill inspection.

TABLE 5 - TRAINING		
5.1	Check a sample of training records to establish what standard exists with regard to cylinder filling activities. Establish if a suitable method is used to decide when a trainee has become competent and if there is a system to periodically recheck that employees remain competent in key filling and testing activities. Check for the use of suitable induction training program for new personnel, including casual staff.	Absence of evidence that training has taken place, records (required if > 5 employees), may be a reason for rejection. Ref. BCGA GN 14 (18) and HASAWA (1). CAUTION: This is a management function and will vary from applicant to applicant. Specifically check if casual labour is used in the operating areas. **Scoring:-** 1 = Full compliance, a comprehensive training system is in place and training records are available. 2C = Occasional gaps in system but clear evidence of a system in place. 3C = No evidence of a training system and maintenance of training records, or evidence of general non-compliance with the system.
5.2	From discussion with randomly selected operations staff, is there evidence to indicate that the actual level of knowledge is sufficient for the operations being undertaken?	The auditor should select staff himself at random and assess the understanding of the staff. **Scoring:-** 1 = Full compliance, a wide range of staff understand their tasks. 2C = A few gaps in knowledge, but most have a good level of knowledge of what they are doing. 3C = Many staff have poor understanding of the tasks they are supposed to do.
5.3	Are there formal working instructions for sorting and filling operations? Check for currency of the work instructions and their availability to personnel.	Work instructions to be available and known to operators. If the operators are unaware of the working instructions then the auditor needs to establish how operators are trained and what work standards apply. If there is no formal system of work then this is a valid reason for rejection of the application. **Scoring:-** 1 = Full compliance, all instructions, adequate, and available. 2C = Occasional gaps in the system, e.g. occasional work instruction not available but evidence of a system in place. 3C = No formal instructions.

TABLE 6 - SAMPLE CYLINDER CHECK						
	Select a suitable number of cylinders (minimum of 3), at random, and confirm compliance with the attributes in Table 6. Use additional sheets, as required. Details of any non-conformance to be recorded as an appendix to the report. If a non-conformance is found then check at least 5 further cylinders. All non-conformances to be reviewed with the applicant and recorded in a separate Appendix. More than one non-conformance from any of following means rejection of the application but the auditor shall satisfy himself by inspection that this is not just an isolated instance but is indicative of the general operations.					
	ATTRIBUTE **√ = compliance** **X = non-con-compliance**	**CYLINDER REFERENCES**				
		1.	**2.**	**3.**	**4.**	**5.**
6.1	Check from cylinder stamping that the cylinders meet the requirements of the ADR Regulations (6).					
6.2	Check that cylinders are only being filled when they are clearly identified as being within their test period.					
6.3	Do cylinders carry some means of identifying the next due test.					
6.4	Cylinders should be fitted with valves in good condition with valve outlets complying with BS 341 (<250 bar) (10) or NEVOC (>250 bar) (14). For food gases check if residual pressure types are in use for mixed gas.					
6.5	Cylinders shall carry identification markings on the shoulder in order to establish the manufacturing standard, the safe filling pressure, the test pressure, the date of the last test and test station identification where appropriate, the tare weight and a unique serial number.					
6.6	Cylinders shall be labeled in accordance with the requirements of the ADR Regulations (6) and CLP (7).					
6.7	Check the external condition of the cylinder and valve to ensure that a reasonable minimum standard is being achieved.					

TABLE 7 - CONCLUSIONS

Question Reference	Critical check	Score	Comments
1.1		N/A	
1.2	Yes		
1.3	Yes		
1.4			
2.1			
2.2	Yes		
2.3	Yes		
3.1	Yes		
3.2			
3.3	Yes		
3.4			
3.5	Yes		
3.6			
3.7	Yes		
3.8	Yes		
3.9	Yes		
3.10	Yes		
3.11			
4.1	Yes		
4.2	Yes		
4.3			
5.1	Yes		
5.2	Yes		
5.3	Yes		

For Auditor use - Summary

TOTAL 3C		*Any score above zero here means rejection.*
TOTAL 2C		*Divide this score by 3 and add to total below.*
TOTAL 3S		*Add this score to total below.*
Add: *3S + ⅓ 2C*		*Total of 3S & a third of 2C – if 3 or above then rejection.*

British Compressed Gases Association

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