**BRITISH COMPRESSED GASES ASSOCIATION**
Registered office: 4a Mallard Way, Pride Park, Derby, UK. DE24 8GX
Company Number: 71798, England
www.bcga.co.uk

# TECHNICAL INFORMATION SHEET 44

# HUMAN FACTORS

## BACKGROUND

Human factors refer to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety. The focus within this document is on human factors that could affect health and safety whilst at work within the gases industry.

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 the cause. It is often easy to blame the individual who was most directly involved. However, this is usually too simplistic and a human factors approach adds extra insight and potentially identifies other and / or additional elements which contribute to the incident. These elements may 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.

The Health and Safety Executive (HSE) recognises the importance of human factors in helping avoid accidents and ill-health at work. HSE HSG 48, *Reducing error and influencing behaviour*, details HSE's approach to understanding human factors and they publish an '*Inspectors Toolkit'* with lots of other advice on their website: http://www.hse.gov.uk/humanfactors/

The European Industrial Gases Association (EIGA) provide many useful documents on Human Factors which are specifically aligned with work in the gases industry. Refer to the Reference section.

## CONSIDERATION OF HUMAN FACTORS

Human Factors includes three interrelated aspects that need to be considered: the organisation, the task and the individual.

### 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 and peers, though not always in the way intended. These interactions are sometimes seen as characterising the culture of the organisation. To manage health and safety effectively, consider how all the organisational factors listed below influence and affect human behaviour:

- managing organisational change;
- safety culture;

- behavioural safety;
- supervision;
- communications and engagement on safety;
- resource, staffing levels and workload;
- human reliability – human error and systems failures;
- incident investigation (including human factors aspects);
- human factors integration;
- emergency response.

## Task factors

The way jobs are designed to interface with equipment, people 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 job, the equipment used and the 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 when designing jobs:

- manual handling, repetitive actions and ergonomics;
- work-related stress;
- fatigue from working patterns - shift work and overtime;
- alarm handling;
- managing when things go wrong, for example, in emergencies;
- interfaces, for example, with plant, equipment, people, vehicles, etc.;
- design and effectiveness of procedures;
- routine and non-routine work.

## Individual factors

People vary in many ways, physically, mentally and in their life experiences and knowledge gained. The individual's characteristics, such as their competence, skills, aptitude, ability, attitude and risk perception, influence behaviour in complex and sometimes unpredictable ways. Some characteristics may be fixed; others such as skills and attitudes may be influenced, changed or enhanced. Everyone is different and no two people will have the same outlook on work or their wider life styles and choices.

The design of the task, 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. All employees shall have the appropriate competence and personal development if they are to work efficiently and safely. Some human characteristics, of course, are more readily adaptable than others.

Ensure that the workplace is designed ergonomically to support people's task performance. When people:

- are recruited;
- change or vary their tasks;
- age.

Employers should consider adaptations to the workplace which would reduce the risk of human error, injury or ill-health. Such adaptations will improve the work environment, assist motivation and improve productivity.

## EXAMPLE:
## HUMAN FACTORS RELEVANT TO SAFE GAS CYLINDER FILLING

All aspects of work within the gases industry should involve consideration of human factors. An area where the inclusion of human factors is of particular relevance is gas cylinder filling. This example examines how human factors can be incorporated into a safe system of work.

Filling gases into cylinders is a task that is highly dependent upon the diligence and correct application of instructions and procedures by the operators. The process of filling cylinders with a gas is hazardous and the task requires that particular attention is paid to those factors that may affect human reliability. In this respect an assessment of the human factors involved, where we consider the organisational, job and people related factors that influence behaviour at work, is beneficial.

### Competence
The guiding principles are:

- all staff involved in cylinder filling shall be competent. Their competence shall be verified from time to time. BCGA GN 23, *Gas safety. Information, instructions and training*, provides guidance;
- the training and competence assessment shall be commensurate with the risks involved;
- safety is dependent upon the strict adherence to procedures where the consequences of error could be serious injury or death, as such, competence shall be formally assessed in advance. The required level of supervision for individuals shall be ascertained as part of this assessment. Periodic re-assessment of competence shall take place.

### Shift handover

Where shift-work is carried out, which includes consideration of routine day shifts, as well as those over weekends / from weekend working or because of illness / leave etc., then arrangements should be in place for a face to face handover with time allocated on shift. Where necessary this should be backed up with a suitable recording system, for example, a shift log.

### Risk assessment for human error

Risk assessment for the identification and control of human error is very important and a team approach is recommended. A detailed risk assessment can be completed using a methodology similar to a hazard and operability study (HAZOP) where guidewords are used to assess how human error could occur, refer to Annex A.

Given the reliance on correct human actions during cylinder filling operations it is recommended that there should be a programme of further detailed human factors assessments to ensure all aspects of cylinder filling are considered, including incorporating any changes that may takes place, for example, in the environment, of equipment, of personnel, of cylinder / valve types, of gas products.

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. These are suitable when considering errors made by a competent operator. The assessments should include input from operators and the results should be fed back to all operators who carry out the tasks.

### Mirror image panels

Unless justified by the application of a careful ergonomic assessment, mirror-image control panel layouts shall not be used.

### Assessment of keying errors

Keying errors into computerised systems are possible, for example, when using digital weighing machines for mixing gases. The consequences of such an error need to be assessed to determine if there are significant risks which may arise. 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 are 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.

### Lock-off systems

At sites where gas mixing takes place, then lock-off systems may be used. Where controlled systems for locking off parts of the panels in the gas mixing area are in place, they should be monitored for effectiveness. The possibility of an operator by-passing these control measures, for example, by obtaining a separate cylinder of one of the gases required and using it at the panel, should be considered. Site management shall ensure that:

- controls are in place to prevent such violations; and
- all operators are fully aware of the risks involved and the correct actions required.

## 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 prohibited. Any such proposals shall be risk assessed and, if acceptable, duly authorised prior to adoption.

Supervisors shall ensure the continuing fitness for work of their staff, and in particular, take steps to ensure that operators whose behaviour is symptomatic of sub-optimum performance, for example, through fatigue or other causes, such as being under the influence of drink or drugs, are removed from the work area. Supervision shall be resourced so that this surveillance is effective. Employers should develop suitable policies and practices covering such fitness for work issues, as necessary with the help of an appropriate specialist.

## Job aids

Operating instructions should be clear and detailed. However, though the full instructions may be used for training, familiarisation and reference they may not be suitable on a daily basis. Key parts of the instructions, for example, condensed or step by step instructions on specific filling operations, should be made available for operators to use. Such simple, easy to understand 'job aids', perhaps in the form of flowcharts or checklists, should be developed especially for those tasks with 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 in HSE HSG 48.

## Work planning and scheduling

Staffing levels need to be appropriate to the work carried out and should not involve high levels of overtime. The use of overtime should be closely monitored. Errors and non-compliance with procedures will be more likely if operators are under time pressure and if they are fatigued. Poor work planning can lead to unnecessary pressure on operators to find short cuts to do the required work. The scheduling of work should be appropriate and designed by experienced schedulers, ideally with some operator knowledge or input.

## Concentration

Cylinder filling can be highly repetitive which may lead to lapses in concentration and errors.

Critical steps in the filling process shall be carried out correctly every time. Factors which may affect the operator's concentration shall be identified and controlled. Such things as job rotation, appropriate break frequencies, good lighting, low noise levels and supervision will assist. Where practical, distractions shall be eliminated.

## REFERENCES

The following documents are referenced or are recommended reading:


| | |
|---|---|
| HSE HSG 48 | Reducing error and influencing behaviour. |
| BCGA Guidance Note 23 | Gas safety. Information, instructions and training. |
| EIGA Safety Information Human Factors 01 | Human Factors – An overview. |

| | |
|---|---|
| EIGA Safety Information Human Factors 02 | Individual. Training and competence. |
| EIGA Safety Information Human Factors 03 | Organisation. Human factors in incident investigation. |
| EIGA Safety Information Human Factors 04 | Task. Design and effectiveness of procedures. |
| EIGA Safety Information Human Factors 05 | Task. Maintenance error. |
| EIGA Safety Information Human Factors 06 | Organisation. Site emergency response. |
| EIGA Safety Information Human Factors 07 | Organisation. Communications on safety. |
| EIGA Safety Information Human Factors 08 | Task. Alarm management. |
| EIGA Safety Information Human Factors 09 | Task. Fatigue from working patterns - Shiftwork and overtime. |
| EIGA Safety Information Human Factors 10 | Organisation. Managing organisational change. |
| EIGA Safety Information Human Factors 11 | Organisation. Safety culture. |
| EIGA Safety Information Human Factors 12 | Task - Human factors in design. |
| EIGA Safety Information Human Factors 13 | Organisation. Human reliability. |
| EIGA Safety Information Transport 07 | Human behaviour within transport operations. |
| EIGA Environmental Newsletter 32 | Human factors in environmental issues relevance to the gases industry. |

**For more information:**

| | |
|---|---|
| Health and Safety Executive (HSE) | http://www.hse.gov.uk/humanfactors/ |
| European Industrial Gases Association (EIGA) | www.eiga.eu |
| British Compressed Gases Association (BCGA) | www.bcga.co.uk |

**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:

**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.