Guidance on Safe Isolation of Plant and Equipment

Ref: BG10

CEA
Combustion Engineering Association

Guidance on Safe Isolation of Plant and Equipment (Ref: BG10)

A document by Combustion Engineering Association

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Provision and Use of Work Equipment Regulations 1998
Regulation 22 - Maintenance operations

Every employer shall take appropriate measures to ensure that work equipment is so constructed or adapted that, so far as is reasonably practicable, maintenance operations which involve a risk to health or safety can be carried out while the work equipment is shut down, or in other cases

(a) maintenance operations can be carried out without exposing the person carrying them out to a risk to his health or safety; or

(b) appropriate measures can be taken for the protection of any person carrying out maintenance operations which involve a risk to his health or safety.

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Foreword

This document, Guidance on the Safe Isolation of Plant and Equipment (Ref: BG10) has been developed and written by the Combustion Engineering Association (CEA) in consultation with other stakeholders within the combustion industry to help managers and operators of all types of plant and industrial equipment make health and safety improvements in the industry.

This publication should not be regarded as an authoritative interpretation of the law, nor a mandatory legal requirement. However, if the guidance provided is followed, it will normally be regarded as sufficient to comply with the relevant health and safety duties.

The CEA is an educational charity which promotes the science of combustion engineering in commercial and industrial sectors. The CEA is concerned with industry good practice and the safe and efficient operation of combustion related plant and equipment.

Examples of isolation techniques and procedures in this document have been developed from processes and situations that are common in boiler houses, energy centres and other combustion related installations, but the principles and the legislative references will apply to many other commercial and industrial services, plant and equipment.

Acknowledgments

The CEA acknowledges the contribution of several individuals, Member companies and partner organisations in compiling the information herein.

In this document the following words convey specific meaning:

Should: Compliance with this clause is not essential where supported by risk assessment and/or design calculation.

Shall: Compliance with this clause is required in order to claim compliance with this document.

Must: Compliance with this clause is a legal requirement within the United Kingdom.

Legislation may not be the same for other jurisdictions, but ‘best practice’ principles remain valid throughout industry.

His: The use of his in health and safety legislation includes male and female genders

One possible outcome if maintenance isolations are not properly managed.

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TABLE OF CONTENTS: **PAGE**

1 INTRODUCTION

Most industrial and commercial processes involve the use of services and fluids that are normally contained within pipes, ducts and wires, and they are generally safe to use if the systems that contain them are correctly designed and installed, and properly maintained. However, almost all such installations will require disconnection or dismantling at some stage in their life, sometimes many times over, for activities such as repair, replacement or routine maintenance. Equipment in normal operating mode will usually run safely without any problems, but as soon as the equipment is required to be maintained or repaired it is extremely likely it will need to be isolated from all its sources of energy and any danger.

The common factor is that any commissioning, maintenance or repair activity on those assets must be carried out with all due regard for the safety of people involved and those around them, and every intervention must therefore be preceded by a safe isolation procedure. However, taking equipment apart inevitably requires that it is put back together correctly, necessitating following of a safe process of reinstatement.

Guidance on the Safe Isolation of Plant and Equipment (Ref: BG10) is a document intended to assist managers, operators and maintenance personnel of new and existing industrial and commercial plant installations in addressing the following issues:

- How to assess risks associated with isolating services for repair and maintenance activities on industrial and commercial plant;
- Producing procedures to ensure a safe working environment for those activities;
- Safe methods of managing plant and equipment isolation activities including Permit to Work (PtW) systems.

The Health & Safety Executive (HSE) published HSG253 “The Safe Isolation of Plant and Equipment” in 1997, an informative document on this subject which was updated in 2006; it is still freely available on the HSE website. It was conceived and drafted by experienced industrial plant engineers but focussed on larger installations and somewhat complex industrial processes that rightly require rigorous control measures to be put in place for all operation and maintenance activities. Nevertheless, much of the information in HSG253 is relevant to other plant installations, and short sections are repeated where necessary in this guidance for consistency across industry.

1.1 Who should read this document

The CEA has produced this Guidance Document for managers and operators of small and medium sized installations who would benefit from clear advice on safe local isolation activities, often of short duration, whilst still appreciating that failures during isolation and reinstatement of plant items are one of the main causes of loss-of-containment incidents, and may lead to major accidents.

Examples of isolation procedures and techniques described herein will frequently refer to boiler houses, energy centres and other combustion related processes and services, but the techniques described and the legislative references will apply to many other factory services, plant and equipment.

Root cause analysis of many industrial accidents can be traced to human error being a major contributor. Not knowing or understanding the risks of planned activities and failing to properly prepare for apparently simple and often repetitive maintenance tasks can lead to personal injury and serious harm as well as loss of production and significant unplanned expenditure. Employers with responsibility for plant installations also have a duty to ensure that contractors they employ to work on those installations are competent and properly supervised.

Plant designers, manufacturers and installers also have a role to play; it is incumbent upon them to make safe operation and maintenance activities as straightforward as possible by incorporating effective isolation and disconnection features in their equipment and installations, and by providing accurate and comprehensive operation and maintenance documentation and drawings for all equipment.

> CDM Reg 9 - When preparing or modifying a design the designer must take into account the general principles of prevention and any pre-construction information to eliminate, so far as is reasonably practicable, foreseeable risks to the health or safety of any person maintaining or cleaning a structure, building or fixed plant.

Finally, employers and their managers have many duties in relation to the provision of a safe working environment for their staff and all those who come into contact with their organisation, and the provision of education, training and experience for all staff and contractors is a foundation for improving safe working practices for all involved.

As a duty holder, you must identify the risk reduction measures available and determine the level of risk reduction that can be achieved and the associated cost. Unless the sacrifice involved in implementing the risk reduction measure is grossly disproportionate to the benefits of the risk reduction, then you must implement the measure. Where available measures are not taken, you must justify this decision. (HSG 253 para 14)

Legislation referred to in this document is wide ranging and covers more activities than just maintenance of plant and equipment. The aim of this document is to guide plant managers and duty holders towards the specific requirements of legislation when they are considering plant maintenance activities. Other activities may require reference to other parts of the relevant legislation or to other documents.

2 SCOPE

This document applies to all plant and equipment used in industrial and commercial installations, but particularly in small and medium sized enterprises (SMEs) who may only have relatively small installations at their undertaking.

Almost all industrial equipment has an electrical connection for mains power, and frequently electrical connections for control or safety related systems. Many services include a gas or fluid used for innumerable industrial processes such as:

- compressed air,
- water, potable and process,
- fuels, gaseous and liquid,
- food ingredients, wet and dry,
- steam and condensate,
- chemicals in gaseous form,
- chemicals as liquids (acids, solvents etc.)
- refrigerants (ammonia etc.).

Many different hazards will need to be considered according to:

- the temperature of piped contents;
- the pressure of piped contents;
- the toxicity, flammability or other hazardous nature of the chemicals or associated dusts;
- the voltage and other characteristics of the electrical supply;
- the design of control systems, especially where software routines are embedded;
- the possibility of oxygen depletion, or presence of other toxic gases;
- the means used to normally enclose hazardous substances or activities such as pressure vessels. containers or cages; and
- the access required to achieve safe isolations.

This list is not exhaustive.

This document covers:

- Legal requirements for plant isolations, the relevant legislation and available guidance, and the need for suitable and sufficient risk assessments and method statements;
- The important difference between switching off and Isolation, and methods of securing safe isolation;
- Safe systems of work and work control routines (permit issue and cancellation, shift handover, reinstatement etc.);
- Isolation methods for different services and equipment;
- Records and Documentation;
- Human factors applicable to plant maintenance activities.

Appendices give an abridged list of relevant legislation current at time of publication, examples of risk assessments for certain routine tasks, and permit processes for different activities.

3 LEGAL REQUIREMENTS FOR PLANT ISOLATIONS

Owners of plant and equipment installations of any size have many responsibilities under current UK Legislation. Sometimes it is not the size of the installation that requires greater care to be taken but the risks that installation poses to operators, maintainers and the public.

3.1 Who is responsible

The concept of 'duty holder' is frequently used in health and safety legislation and HSE literature. A duty holder is the person who is ultimately legally responsible for health and safety practices at their place of work and the health and safety of their employees, contractors and visitors. The duty holder usually takes overall responsibility for controlling one or more risks and may appoint an internal or external 'competent person' to help them achieve this goal (but this does not remove their responsibilities as a duty holder). They may also be referred to as the Responsible Person; the person at that time in control of the premises.

The risk may arise from the conduct of the duty holder's undertaking; an 'undertaking' means an 'enterprise' or 'business', so any business owner or the most senior person on site of any organisation regardless of size may be classed as a duty holder or Responsible Person for the purposes of Health & Safety in their place of work; this includes educational establishments, hospitals, military and government work places, retail, leisure and entertainment locations, and a wide range of industries and public offices and services.

The paragraphs below outline key parts of UK legislation that may be relevant to safe isolation of plant and equipment. The list is not exhaustive and specific industries and sectors may be subject to additional measures and guidance. A list of the most frequently used legislation and guidance documents is in the Appendix. It is the reader's responsibility to ensure that they are referring to the latest version of any legislation and guidance, much of which can be found and freely copied from gov.uk or hse.gov.uk web pages.

3.2 The Health & Safety at Work etc. Act (HASAW)

As far as reasonably practicable an employer must provide and maintain:

- Safe plant and systems of work;
- Safe handling, storage and transport of articles and substances;
- Necessary training, instruction and supervision;
- A Safe place of work, with safe access and egress;
- A Safe working environment with adequate welfare facilities;
- A written statement of general policy on Health & Safety;
- The organisation and arrangements necessary to implement that policy (revised and updated when necessary).

Organisation and arrangements shall be provided in sufficient detail to allow employees to comply with them.

An employee must

- take reasonable care for the health and safety of themselves and other persons who may be affected by their acts or omissions, and
- co-operate with their employer in the compliance with relevant statutory provisions.

The term ‘reasonably practicable’ relates to the degree of risk which has to be balanced against

- Time,
- Trouble,
- Cost, and
- Physical difficulty of taking measures to avoid the risk.

> It is generally very hard to find situations where control measures are so troublesome, costly and difficult that reasonable precautions should not or cannot be taken. If the degree of danger means that the only safe solution is to shut the plant down, that will have to be done. If, for example, an industrial process is likely to freeze solid if the flow is interrupted, design of the plant should have taken that into account before the plant was installed; this kind of issue would normally be identified at the planning stage during a Project HAZOP, and alternative arrangements designed in.

Risk assessment starts when the concept of the installation is first discussed and lives with the installation through its lifetime until activities cease and final demolition occurs.

The person doing the work must be competent, having the knowledge and experience to perform the task without creating risk. The person supervising the work must be competent also.

3.3 The Provision and use of Work Equipment Regulations (PUWER)

PUWER is a wide ranging set of Regulations that cover many aspects of equipment use and the supervision of its use. They are an important set of clauses that apply to a wide range of work activities, and a relevant selection is below.

PUWER Reg 3

The requirements imposed by these Regulations on an employer in respect of work equipment shall apply to such equipment provided for use or used by an employee of his at work.

They shall also apply to a self-employed person in respect of work equipment he uses at

Work, and to a person who has control to any extent of work equipment or a person at work who uses or supervises or manages the use of work equipment, or the way in which work equipment is used at work, and to the extent of his control over such use.

PUWER Reg 15

Every employer shall ensure that, where appropriate, work equipment is provided with one or more readily accessible controls, the operation of which will bring the work equipment to a safe condition in a safe manner.

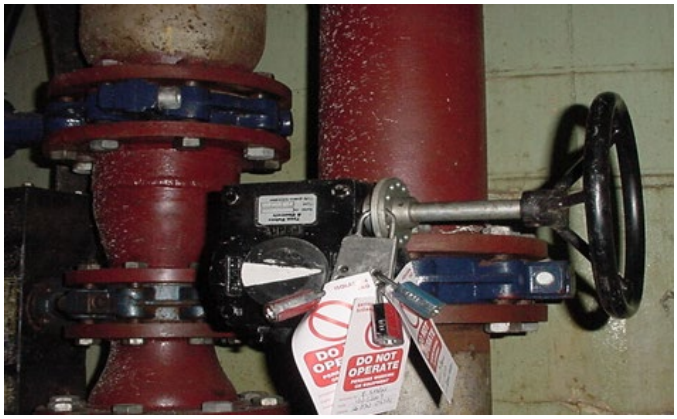
PUWER Reg 16

Every employer shall ensure, where appropriate, work equipment is provided with one or more readily accessible emergency stop controls. There are some exceptions, but where it is appropriate to have one, based on the risk assessment, an emergency stop should be provided at every control point and at other appropriate locations around the equipment so that action can be taken quickly. However, emergency stop controls are not usually suitable as isolating devices for secure isolation.

PUWER Reg 19

Every employer shall ensure that, where appropriate, work equipment is provided with clearly identifiable and readily accessible suitable means to isolate it from all its sources of energy. Isolation means establishing a break in the energy supply in a secure manner, i.e. by ensuring that inadvertent reconnection or reinstatement is not possible.

> Isolation can be as simple as pulling an electrical plug from a socket to carry out a simple local task and then removing the plant item to a workshop for repair, or as complex as dealing with a series of risks and isolations for events such as a complete plant shutdown with vessel entry and intrusive maintenance. But the installation must always be capable of comprehensive and secure isolation at the point of work.



Isolation point locked and labelled

PUWER Reg 21

Every employer shall ensure that suitable and sufficient lighting, which takes account of the operations to be carried out, is provided at any place where a person uses work equipment. Therefore, a planned maintenance activity in an area of the factory that is infrequently used and possibly has poor illumination will probably need temporary additional lighting to enable maintenance work to be performed safely.

3.4 The Management of Health and Safety Regulations

Regulation 3: Risk Assessment

Employers must carry out suitable and sufficient risk assessments, and employers who have 5 or more employees must record the significant findings.

Risk Assessments must be revised and updated when necessary, especially following a change to the installation or a previous unplanned incident.

Reg 7 H&S assistance

Employers must employ competent persons. They may use outside expertise if necessary e.g. consultants to provide them with the knowledge and information they need to safely manage their installations.

As part of managing the health and safety of your business, you must control the risks in your workplace. To do this you need to think about what might cause harm to people and decide whether you are taking reasonable steps to prevent that harm. HSE INDG163 has some simple advice:

Identify the hazards

One of the most important aspects of your risk assessment is accurately identifying the potential hazards that will arise during the task, before doing anything else;

Decide who might be harmed

Then think how employees, or others who may be present, such as contractors or visitors, might be harmed.

Evaluate the risks

Having identified the hazards, you then have to decide how likely it is that harm will occur, i.e. the level of risk and what to do about it.

Record your significant findings

Make a record of your significant findings – the hazards, how people might be harmed by them, and what you have in place to control the risks, adding additional control measures where necessary.

Regularly review your risk assessment

Few workplaces stay the same. Sooner or later, you will bring in new equipment, substances and procedures that could lead to new hazards.

3.5 The Electricity At Work Regulations (EAWR)

The Electricity at Work Regulations 1989 require those in control of part or all of an electrical system to ensure that it is safe to use and that it is kept in a safe condition.

EAWR Reg 4

Every work activity, including operation, use and maintenance of a system and work near a system, shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger.

> Regulation 4(3) is wide in its application and includes work of a non-electrical nature where there is a risk of electrical injury. A common example is excavation near to live electric power cables and work near live overhead power lines, where the risks can be severe.

EAWR Reg 12

"isolation" means disconnection and separation of electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure.

Electrical danger is contained by:

- Insulation of live parts,
- Protective devices such as fuses and circuit breakers,
- Restriction of access by locked enclosures and 'tool only' removable panels,
- Safety rules and procedures,
- Use of competent personnel,

all achieved by compliance with the Electricity at Work Regulations which require:

- Isolation,
- Prevention of inadvertent re-connection,
- Provision of a positive air gap,
- Preventing unauthorised interference,
- Accessible plant and equipment,
- Labelled plant items.

EAWR Reg 14

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise. The Regulations do go on to qualify this statement by offering a set of test conditions that might be needed in specific industries (such as railway work and street works by distribution companies) but these are not usually relevant to electrical work in most industrial and commercial installations.

If danger may otherwise arise it is always preferable that work on or near electrical equipment should be carried out when that equipment is dead. That includes testing.

3.6 The Gas Safety Installation and Use Regulations (GSIUR)

GSIUR Reg 6(1)

No person shall carry out any work in relation to a gas fitting in such a manner that gas could be released unless steps are taken to prevent the gas so released constituting a danger to any person.

GSIUR Reg 2(1)

For the purpose of the definition of 'work', 'disconnecting' means physically detaching or uncoupling a fitting (i.e. which involves breaking into a gas way), rather than simply isolating it by means of a valve or similar device. Both 'connecting' and 'reconnecting' should be understood accordingly.

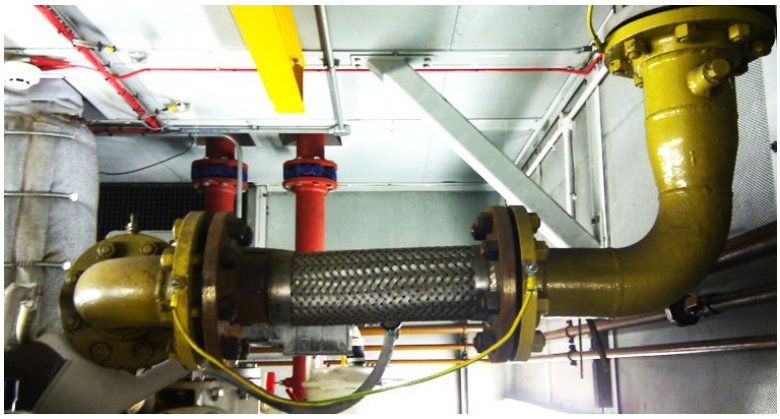
The GSIUR effectively cover the activities of work, isolation and disconnection such that a safe means of working on all gas equipment under the scope of the Regulations must be achieved. It is therefore reasonable to also say that even if work is being carried out on gas fittings that are outside the scope of the Regulations, the principles remain valid and safe isolation should be achieved for every intervention on a gas installation and the appliances connected to it.

> Most of GSIUR do not apply to gas work in factories and other industrial installations. However, even if working at sites that are outside the scope of GSIUR, competence in gas work is required to be demonstrated. For example, someone replacing a section of gas pipework in a factory must still have the necessary education, training and experience needed to make joints in the pipe and support the pipe in compliance with IGEM UP/2, and would need to perform a tightness test afterwards to ensure there was no gas leaking. If they did not, or they did it incorrectly, they could be in breach of GSIUR Section 6.

Reg 10 is important when considering work on gas installations - a temporary continuity bond to the appropriate standard is required when disconnecting and reconnecting pipework where the production of a spark could cause a hazard. Work routines must take this into account.

Reg 23 has details regarding the marking of gas pipework and this must be maintained even when the pipe is temporarily not carrying gas. In commercial premises such as offices, gas pipes accessible to inspection should be colour coded and/or marked in accordance with the appropriate standard.

The responsible person for the premises in which any such part is situated shall ensure that the part continues to be so recognisable so long as it is used for conveying gas.



Cross bonded gas line flexible coupling

3.7 The Control of Substances Hazardous to Health Regulations (COSHH)

COSHH covers most substances that are or can be hazardous to health (except lead, asbestos and radioactive substances which have their own specific regulations). Substances can take many forms and include:

- chemicals,
- products containing chemicals,
- fumes,
- dusts,
- vapours,
- mists,
- nanotechnology,
- gases and asphyxiating gases,
- biological agents (germs); if the packaging has any of the hazard symbols then it is classed as a hazardous substance, and
- germs that cause diseases such as leptospirosis or legionnaires disease and germs used in laboratories.

COSHH Reg 2 (14)

COSHH also covers those gases and vapours which, when present at high concentrations in air at the workplace, act as simple asphyxiants. These can displace the oxygen content to such an extent that life cannot be supported. Many of these asphyxiant gases are odourless, colourless and not readily detectable.

Monitoring the oxygen content of the air is a means of assessing whether their presence poses a risk to the health of employees. Workplace Exposure Limits (WEL) are set for a wide range of potentially harmful chemical substances and compounds.

> Apparently simple tasks that could expose workers to dangers such as fumes or acids are covered by the COSHH regulations. As an example, a maintenance task that requires isolation of a forklift truck battery and its replacement must consider the risks of acid burns and fume inhalation for the operative. Entry into storage hoppers or other enclosed spaces may expose workers to oxygen depletion or to other toxic gases that do not support life, such as carbon monoxide being produced in wood pellet storage facilities along with the risk from a dust explosion, or very rusty surfaces inside boilers or vessels which arise from the available oxygen combining with iron to create iron oxide and thereby possibly deplete the available oxygen.

3.8 The Personal Protective Equipment Regulations (PPE)

PPE Reg 4(1)

Subject to paragraph (1A) every employer shall ensure that suitable personal protective equipment is provided to their workers who may be exposed to a risk to their health or safety while at work except where and to the extent that such risk has been adequately controlled by other means which are equally or more effective.

> PPE is generally regarded as a last resort – if you have to provide PPE for a task, you must have assessed other remedial actions available and found that the residual risk requires such things as gloves, face visors, boots or other PPE. This will be part of the task risk assessment and thereby a pre-requisite for safe isolation.

PPE is to be provided free of charge to workers, and this now includes "limb (b)" workers, those who do casual or irregular work for one or more organisations, receive holiday pay but no other employment rights, only carry out work if they choose to, and are not in business for themselves.

The law says, in terms of who has to be provided with PPE:

> '"worker" means 'an individual who has entered into or works under –
>
> (a) a contract of employment; or
>
> (b) any other contract, whether express or implied and (if it is express) whether oral or in writing, whereby the individual undertakes to do or perform personally any work or services for another party to the contract whose status is not by virtue of the contract that of a client or customer of any profession or business undertaking carried on by the individual.

3.9 The Dangerous Substances and Explosive Atmospheres Regulations (DSEAR)

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) are concerned with preventing or limiting the harmful effects of fires, explosions and similar energy-releasing events and corrosion to metals. DSEAR are goal-setting regulations and are supported by an Approved Code of Practice (ACOP) that provides practical advice on how to comply with them.

Dangerous substances are any substances used or present at work that could, if not properly controlled, cause harm to people as a result of a fire, explosion or similar incident, such as an uncontrolled chemical reaction. They can be found in nearly all workplaces and include such things as solvents, paints, varnishes, flammable gases, liquefied petroleum gas (LPG), dusts from machining and sanding operations, and dusts from foodstuffs.

An explosive atmosphere is a mixture of a dangerous substance or substances (gas, mist, dust or vapour) with the air, which has the potential to catch fire or explode. An explosive atmosphere does not always result in an explosion but, if it does catch fire, the flames travel quickly. If this happens in a restricted space the rapid spread of the flames or rise in pressure could also cause an explosion.

Guidance on Reg 6 from HSE says:

Where plant contains openings such as inlets and outlets, these have the potential to release dangerous substance and employers must ensure:

(a) plant doors, access points or charge/discharge points are provided with interlocks, valves or systems of work to prevent or minimise release;

(b) plant is fitted with isolation valves to minimise leaks after use, to control leaks during use and to enable safe isolation of the plant for maintenance;

(c) where personnel would be exposed to danger when operating valves manually during an emergency, plant is fitted with remotely operated isolation/shut off valves (ROSOVs).

3.10 The Confined Spaces Regulations

Confined Spaces Regulations Reg 1

Under these Regulations a 'confined space' must have both of the following defining features:

(i) it must be a space which is substantially (though not always entirely) enclosed; and

(ii) one or more of the specified risks below must be present or reasonably foreseeable;

(a) serious injury to any person at work arising from a fire or explosion;

(b) without prejudice to paragraph (a) —

(i) the loss of consciousness of any person at work arising from an increase in body temperature;

(ii) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen;

(c) the drowning of any person at work arising from an increase in the level of liquid; or

(d) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid.

Confined spaces, where identified, must be well managed and have entry controlled by robust procedures. As with many other safety related topics, the primary objective would be to 'design out' the need for entry into such spaces and, if that is not possible, ensure that all possible risks are identified and resolved before entry. An alternative solution would be to devise means of carrying out the task effectively and efficiently without requiring anyone to enter the space.

Confined spaces may be created as a result of maintenance work, leaks or other activities. Great care must be taken to properly manage the release of substances as part of a purging activity for instance; allowing a flammable gas or dust to collect in a restricted area may well render the enclosure a confined space and a rigorous set of control measures will then be required.

3.11 The Control of Asbestos Regulations

Asbestos can still be found in pipe ducts, in buildings and roof spaces, around pipework that has been undisturbed for many years, and in insulation and other building materials. Amongst other quite onerous requirements, Reg 11 specifically says that:

Every employer must—

(a) prevent the exposure to asbestos of any employee employed by that employer so far as is reasonably practicable;

(b) where it is not reasonably practicable to prevent such exposure—

(i) take the measures necessary to reduce exposure to asbestos of any such employee to the lowest level reasonably practicable by measures other than the use of respiratory protective equipment, and

(ii) ensure that the number of any such employees exposed to asbestos at any one time is as low as is reasonably practicable.

Reg 10 says:

Every employer must ensure that any employee employed by that employer is given adequate information, instruction and training where that employee—

(a) is or is liable to be exposed to asbestos, or if that employee supervises such employees, so that those employees are aware of—

(i) the properties of asbestos and its effects on health, including its interaction with smoking,

(ii) the types of products or materials likely to contain asbestos,

(iii) the operations which could result in asbestos exposure and the importance of preventive controls to minimise exposure,

(iv) safe work practices, control measures, and protective equipment,

(v) the purpose, choice, limitations, proper use and maintenance of respiratory protective equipment,

(vi) emergency procedures,

(vii) hygiene requirements,

(viii) decontamination procedures,

(ix) waste handling procedures,

(x) examination requirements, and

(xi) the control limit and the need for air monitoring, in order to safeguard themselves and other employees;

All industrial and commercial premises must have a record of the presence or otherwise of Asbestos Containing Materials (ACM) and this information must be available to maintenance staff and contractors. If there is any possibility that ACMs are likely to be in the work area of the services isolation then full compliance with the Control of Asbestos Regs is required by all parties.

Reg 5 therefore says:

An employer must not undertake work in demolition, maintenance, or any other work which exposes or is liable to expose employees of that employer to asbestos in respect of any premises unless either—

(a) that employer has carried out a suitable and sufficient assessment as to whether asbestos, what type of asbestos, contained in what material and in what condition is present or is liable to be present in those premises; or

(b) there is doubt as to whether asbestos is present in those premises that employer—

  (i) assumes that asbestos is present, and that it is not chrysotile alone, and

  (ii) observes the applicable provisions of these Regulations.

The HSE Guide “Asbestos and You – a quick guide for trades” is a useful free reference.

3.12 Environmental Permitting Regulations and Waste Legislation

The primary objective of properly managing isolations and interventions is the safety of personnel; a secondary, and just as important, objective is the protection of the environment.

Draining, venting and opening up of services pipework, ductwork and other containment will usually result in the release of the contents. For commercial reasons this will normally be kept to the minimum necessary to allow work to be carried out safely, but a number of environmental regulations may need to be considered when planning the works and issuing permits.

Larger sites may be subject to the Control of Major Accident Hazards (COMAH) regulations and the owners and operators at those sites will be well aware of the risks posed by releases, intentional or otherwise, of their raw materials and finished products, and should have detailed plans for the management of leaks and other emissions during normal activities and in emergency situations.

Many sites will have an Environmental Permit, increasingly as emissions legislation covers more plant types and locations for combustion activities, waste management and other potentially harmful activities. Permits may specifically prohibit releases under any circumstances of materials onto land or into water courses or into the atmosphere, and may also prohibit or restrict fugitive emissions of potentially harmful substances that occur as part of the normal activity on the site. Penalties for failing to comply with the conditions of an Environmental Permit are severe.

The release of unburned natural gas as part of a purging operation, for example, is particularly harmful to the atmosphere, methane being over 80 times more damaging to the environment over a 20 year period than the release of the CO_2 which would occur if that gas were to be flared off instead. Neither are good solutions, but in terms of environmental damage flaring is the lesser evil.

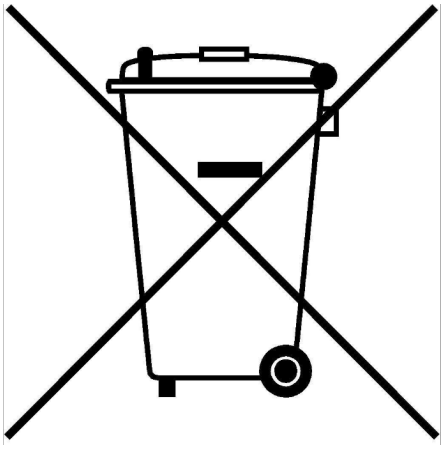
Draining water from steam systems, chiller plant or other 'wet' services can lead to a significant quantity of chemically treated water being released and this must be removed by a licensed waste carrier to a licensed waste treatment facility. It is essential that the contaminants in the water are known in order to deal with the waste correctly. Similarly, the release of refrigerant gases of all types poses significant environmental risks, and their disposal is a closely monitored activity. Many other gases and liquids are used in industrial and commercial installations on a daily basis, and they must be properly managed for every intervention.

Solid wastes arising from the disturbance of pipes and ducts that have been in service for a long period of time may result in quantities of unknown substances. The risks from asbestos used for insulation and electrical arc suppression are well known and well documented, but work on some very old pipework and heating installations may still encounter this material. The residual contents of flues and chimneys may be a significant risk, especially if solid fuels or heavy oils were once burned in an older installation. Waste carriers may insist on a chemical analysis of residues before accepting them for removal.

Some fairly common industrial activities will use chemical substances and mixtures that are quite hazardous to humans and the environment, and the Chemical Data Sheets for those substances need to be consulted before allowing work to commence.

Waste electrical components arising from maintenance or repair activities must be disposed of in accordance with the Waste Electrical and Electronic Equipment Regulations 2013. These Regulations are wide ranging and require all business users to follow detailed processes for disposal of anything classed in the regulations as a 'WEEE' item, from small batteries to the largest electrically operated equipment.

Any isolation activity therefore needs to consider the nature of the service or equipment being worked on, the contents of the pipes, vessels and ducts, and the effect they might have on the environment. Designers of installations can make life much easier for operators and maintainers by providing sufficient isolation points to minimise loss of contents and installing by-pass loops or other duplicate systems where routine interventions are required. Permit issuers must consider the effect of the activity on the environment as well as the people involved in the work



WEEE symbol

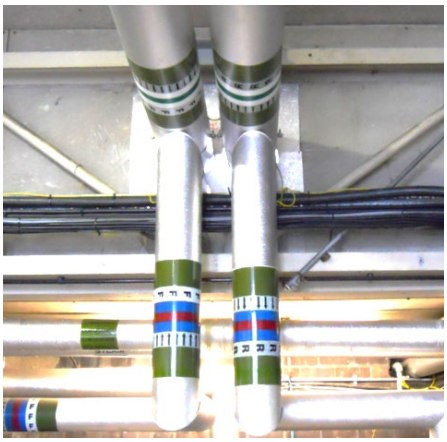
4 SAFE SYSTEMS OF WORK

4.1 Identification and labelling of plant and pipework or cables

It is essential that services to plant and equipment and the equipment items themselves are permanently and correctly labelled and that labelling follows the 'as installed' drawings. Many accidents are caused by incorrect labelling, use of out-of-date drawings, changes to systems that are not recorded properly, or the simple act of not consulting the drawings and assuming the pipe or cable does what you think it does. All labelling should be permanent, well secured, fireproof and robust.

All piped and wired services in every installation should carry some form of identification; for some services this is mandatory (natural gas for example).

All plant items should be numbered and labelled to aid positive identification – isolating the wrong fan or pump because it was assumed to be 'the one on the left' could be a costly and dangerous mistake. It is not possible to write a meaningful and accurate method statement for isolation activities without reference to numbered plant items and properly identified services.



4.2 Signs, labels and tags

A documented procedure for labelling and tagging services installations and isolations is essential. Many organisations will follow the information and recommendations in various British Standards and HSE documents such as:

- BS 1710:1984 Specification for identification of pipelines and services - British Standards Institution
- HSE L64 Safety signs and signals. The Health and Safety Regulations 1996. Guidance on Regulations

Some plant identification requirements are stated in legislation and guidance, and this should always be followed. Organisations may introduce their own labelling standards or plant identification procedures and it is essential that employees and particularly contractors working on the plant have a clear understanding of the safety signs used and the dangers that are being identified for that particular location. Making assumptions about pipe contents or cable routes will lead to dangerous incidents occurring.

Identification tags are frequently re-usable and can be marked with new dates or new information relating to the isolation. Ensure that these are correctly annotated for the task in hand and securely attached to the relevant valve or other isolating device.

4.3 Isolation in an emergency and procedures for hazards arising during works

An emergency situation on plant and machinery can arise at any time. Many installations have 'emergency stop' facilities wired into the control systems of major plant items and these should be routinely checked for correct operation. Note that too many 'stop' and emergency controls can be confusing, so it is essential to make the emergency stop functions clear and unambiguous and locate them in places where they can be seen and safely operated, potentially by untrained persons.

It is also necessary to consider what happens if an emergency should arise whilst work is being carried out under an isolation routine. A properly applied set of isolations and appropriate locks and notices should mean operations can be carried out in complete safety, but the risk assessment should look at what is happening around the work location and who else may be working in the area. An evacuation plan or rescue plan may need to be develop as part of the Risk Assessment and Method Statement (RAMS), and is a requirement under the Confined Spaces Regulations.

Emergency stop and 'isolate here' control devices are not to be used for safe isolation procedures.

4.4 Isolation of system safety devices

Safe isolation of plant and equipment may not mean that every pipe and wire connected to a plant item must be removed or capped before work starts. Due consideration must be given to safety devices on the equipment that should still be able to operate or function normally.

Examples may include:

- Open vents and vent lines for vessels, regulators, purge stacks and other release points;
- Safety valves on vessels and tanks;
- Interlocked control systems that affect other plant items than the item being worked on;
- Drains and tell tales fitted to plant items;
- Fire safety systems such as alarms and extinguishant installations;
- The requirement for electrical continuity to be present when pipe components are removed. Reg 10 of the GSIUR is specific in this regard for gas pipework.

If some services are left operational during an isolation activity they must be clearly identified. However, as an example, if the isolation is to allow welding for a pipework modification and the fire alarm system is left operational, an alternative procedure may need to be considered to avoid spurious alarms.

4.5 Self-isolation, own isolation

Some common and routine plant maintenance activities can easily and safely be carried out by the operative 'self-isolating' the item to be worked on. This activity should be carefully thought through before being authorised, and a written procedure put in place to ensure the work can be completed safely.

A self-isolation or own isolation procedure should cover:

- The competence required of the person doing the work – all isolations and work activities including reinstatement are carried out by the same person in an unbroken sequence;
- The duration – self-isolation procedures should only cover work of short duration that is unlikely to require the operative to leave the task unattended or go far beyond normal shift end times;
- A very clear isolation procedure that involves simple steps such as electrical plug or fuse removal which remains in sight of the work location, or valve closing and locking with double valve isolation nearby, for example, and equally clear reinstatement procedures;
- Clear instruction that the task may not be amended or substituted for a different task or the task be extended in any way;
- Procedures for ensuring all necessary tools and equipment are available before work starts, and that they are accounted for at the end of the task;
- Notification requirements to a supervisor or control room regarding the work and what to do in an emergency.

If the requirements of the self-isolation procedure cannot be met or are likely to be unworkable the task should be re-assessed and a more robust procedure put in place. A simple self-isolation document will focus attention on the risks that may be present and remind the operative that all reasonably practicable steps must be taken; there are examples in the Appendix.

4.6 Permit to work procedures

Where proposed work is identified as having a high risk, stricter controls are required. The work must be carried out against previously agreed safety procedures, often called a 'permit-to-work' system.

A 'permit to work' is a formal, written, safe system of work used to control potentially hazardous activities. The permit details work to be done and precautions to be taken, based on the findings of a risk assessment and production of a method statement (RAMS). Permits should be issued, checked and signed off as being completed by someone competent to do so, and who is not involved in undertaking the work.

Permits to work will also be appropriate in situations such as where contractor's work interfaces with normal production activities, or where work is proposed on plant which must be isolated from electrical supplies and the possible entry of fumes, liquids, steam or gases, or hot work which could cause fire or explosion. It is also highly recommended that a permit is issued if reinstatement of the installation or service requires the issue of a mandatory set of test results such as for gas under GSIUR or for LV electrical alterations under IET Wiring Regulations.

The issue of a permit does not, by itself, make a job safe - that can only be achieved by those preparing for the work, those supervising the work and those carrying it out. In addition to the permit-to-work system, other precautions may need to be taken – e.g. process or electrical isolation, or access barriers - and these will all need to be identified in task risk assessments before any work is undertaken.

Most organisations will benefit from operating a form of permit process. In many cases it does not have to be complex, but it does have to be robust and appropriate for the risks involved.

4.7 Authority to write and issue permits

The permit-to-work requires signed declarations from the people requiring and authorising the work and those carrying out the work. Where necessary it requires a declaration from those involved in shift handover procedures or extensions to the work. Finally, before equipment or machinery is put back into service, it will require a declaration from the permit originator that the reconnected service is ready for returning to normal use.

A hierarchy of authorisation is therefore required for operating a permit procedure. The minimum requirement is 2 people; someone competent shall review the risks, approve the method of work, and write the permit. A second competent person will accept the permit and carry out or directly supervise the work, handing back the permit when work is complete. The original issuer may then check the work, oversee re-instatement and cancel the permit.

More complex or widespread installations may have several different persons involved in a rigorous permit system such as for High Voltage electrical works or specialist functions like medical gases in hospitals.

A typical 'chain of command' from a permit to work procedure might be:

Co-ordinating Authorising Engineer	Reports to senior management and appoints Authorising Engineers
Authorising Engineer	Discipline specific (electrical, mechanical, medical gases etc.) – appoints Authorised Persons and Competent Persons
Authorised Persons	Authorised to write permits and supervise works – discipline specific
Competent Persons	Authorised to accept permits and carry out works – discipline specific
Operatives and contractors	Trained in their discipline, and in the application of the permit system for the designated task

Many organisations such as MOD and NHS and some large industrial undertakings have processes that align with this general arrangement to control works on potentially risky installations.

4.8 Permit issue and receipt

Permits will usually follow a prescribed format that clearly identifies:

- The task;
- The timing and duration expected;
- The location, supplemented by drawings or sketches;
- The risks to workers and other parties;
- The control measures to manage those risks; points of isolation, locks, PPE required, signs, notices, barriers, and any special instructions for reinstatement;
- The names of the persons accepting the permit and those carrying out the work;
- What to do if an emergency arises during the work;
- Handover, completion and cancellation routines.

Permits should always be fully completed – no empty boxes in case important information is missed. Permits should be signed legibly by the issuer and all other parties.

Permits should be displayed at the work location, and in any central control room or similar location where applicable.

4.9 Barriers and enclosures

Any potentially hazardous activity should be clearly segregated from other work or other people nearby. Work carried out under self-isolation rules as well as under a formal permit should be segregated by placing of suitable barriers and notices or other appropriate signage. The requirements should be specified in the permit or the associated procedure.

The use of barriers has the advantage of keeping unauthorised persons away from danger and allowing the operative to work in a clear and uncluttered space. In simple terms, a well-controlled factory environment occupied by a small number of trained personnel would only usually require a simple barrier and reminder to keep clear – isolating and excavating services alongside a public footpath is a completely different matter and will require careful assessment and robust barriers.

4.10 Stopping work, taking breaks, and handover of permits to other workers

Short duration tasks may not need to be interrupted, but when isolations are in place for lengthy periods it is essential that procedures are devised for maintaining the safe state of the work area and ensuring the integrity of the isolations before each work activity.

A procedure is recommended that, as a minimum, requires isolations to be re-checked after every significant work break, preferably at least daily or before the next shift, and whenever a new work team or new trades are involved in the task.

Handover of a permit from one Competent Person to another should be documented, either on the original permit or on a supplementary attached sheet. Supplementary documents must display the PtW reference. It must always be clear who is controlling the permit and therefore who is controlling the work.

If the work is to be stopped and all persons removed from the task for a period of time it may be more prudent to cancel the permit and re-issue it – the Authorised Person in charge of the works should make that decision.

It is wise to avoid issuing more than one permit on any one task if possible. The co-ordination of multiple permits and various different lock and tag locations can become overly complex, so a single point of responsibility through one permit is preferred.

4.11 Permit cancellation and system reinstatement

Once the work is complete the Competent Person signs it to indicate they have removed all tools and equipment, returned the system to a workable condition, and released all operatives from the task and the area. The permit may then be returned to the Authorised Person.

The Authorised Person then checks the task is complete and authorises reinstatement of the service. It is important to check that no other permits are still in force for the same plant or area, and that no other work has been undertaken, perhaps under the assumption that the plant is dead so a quick repair will “be OK”. It is important to check that others have not taken unauthorised advantage of equipment being offline to make a quick repair.

A useful addition to a permit may be a tool and equipment check list. If the works are completed and tools are left behind, the consequences could be serious, so tasks should be closely managed to prevent incidents occurring. A spanner left inside an electrical enclosure or a bundle of rag inside a pipe would likely cause significant damage and disruption.

Rural distribution transformer with HV temporary earths and LV generator

5 METHODS OF SECURING SAFE ISOLATION

5.1 Isolation principles

Isolation of services generally means that any danger that might arise from the contents of the pipe, vessel, duct, or cable etc. or when accessing the enclosure has been eliminated, so far as is reasonably practicable. For every isolation point, the design should provide for facilities to test and to monitor the integrity of the isolation.

Slightly different definitions appear in some guidance documents, but the overriding principle is that anyone dismantling or working on any plant and equipment can be assured that no danger will arise whilst they carry out the task, to them or to anyone else in the vicinity. Before entering or working on equipment, it is essential that the effectiveness of the isolation is verified by a suitably competent person.

Danger can arise from many sources. Isolating natural gas installation pipework and purging or flaring all the gas to atmosphere must be carefully planned, as the possibility of an explosive mixture must be considered and this may arise some distance from the work site depending upon how the purge is to be achieved. Competent operatives are required to carry out decommission purging of gas lines and other similar hazardous substances, and especially where the purge volume of natural gas is >0.02 m^3 which is approximately equivalent to a 10m length of 50mm ID pipework.

Similarly, releasing a large quantity of reasonably clean water from a cooling system to a drain might seem acceptable, but not if the water drains to a low point where it cannot escape and other plant gets flooded, or the water contains chemical additives such as anti-freeze.

Isolation points should ideally be close to work locations – this prevents excessive loss of product and allows close monitoring of the isolation by the persons most at risk, usually those carrying out the task.

One way of reducing the risk from services that need to be isolated is to reduce the hazardous nature of the pipe contents by methods such as temporarily lowering flow rates, temperatures or pressures if possible. This will relieve stress on other isolation techniques and raise the level of safety provided at the task location. Those authorising isolations should also consider whether the release of pipe contents could result in the work space becoming a confined space.

Another risk that must be taken into account is the access required to achieve the isolation and the subsequent work activity. Services isolation points that are at high level or those that are buried or underground may represent a very high risk. Despite a gradually lowering incidence of workplace fatalities, falls from height are still one of the most frequent causes of death or serious injury being sustained at work and in 2021/22 they accounted for 29 fatalities in the UK, the highest category in that year. People falling into voids and being trapped in collapsed trenches still feature regularly in accident reports.

5.2 The difference between switching off and Isolation

Simply switching off an electrical supply to a plant item is not isolation. Neither is operating a crown valve on a steam boiler and attempting to work on the steam range. And the Gas Regulations make the clear distinction between operating an isolating valve to turn off the gas supply and then disconnecting the gas pipework to the appliance and making the disconnection secure. Just because it is called an isolating valve or an electrical isolator does not mean it provides a secure separation of the live and ‘dead’ services.

It is therefore unacceptable to rely on a user operated valve or control device for secure isolation, and a secure means must be found. Sometimes secure isolation is not achievable at the work location or nearby, and a pipeline or cable must actually be isolated some distance away.

Designers of industrial installations should take this into account when designing plant installations – the cost of fitting a double valve arrangement at critical points in the network may be offset many times over by the subsequent saving in product losses and downtime provided by a simpler isolation activity.

5.3 Safe isolation methods

In simple terms, an isolating valve should be locked shut before the task commences, as should an electrical isolating switch, but there must be a visible and adequate gap between the live and 'dead' sides of the isolation point, and the device must be capable of having a lock fitted to it.

On piped fluids and services such as steam, it is common to provide two valves, often with a detachable spool piece between them (Fig 1), or at least a 'tell-tale' connection in the bottom of the interconnecting pipe which can warn of the presence of liquid. This needs to be tested as 'clear' to operate, as a blocked drain or tell-tale is useless, and this method may not be suitable for fluids that are flammable or have the potential to cause pollution, e.g. oil. Chaining two valve wheels together in the closed position may also be a suitable means of securing the isolation as long as the keys remain with or in the direct control of the person doing the work.

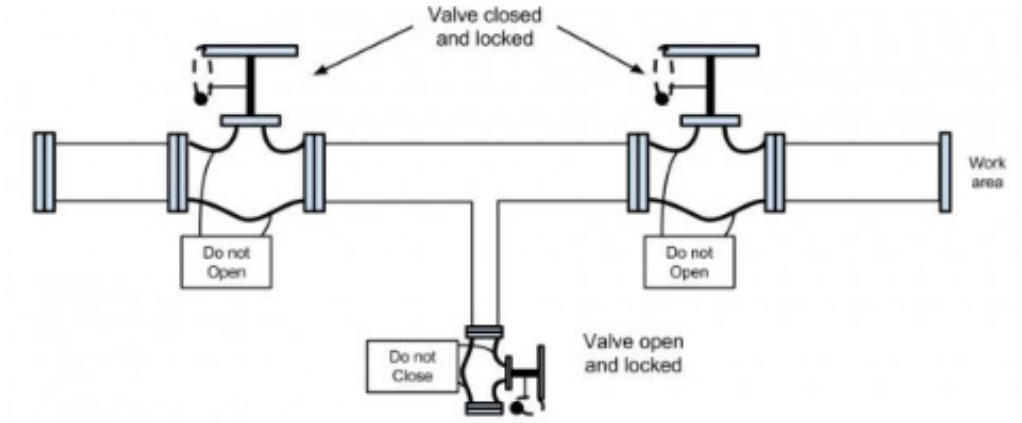


Figure1 - double block and bleed arrangement

Gaseous substances, especially those lighter than air such as natural gas, will usually be vented to atmosphere from an upstream isolation point. The valve may be a single valve upstream of the length of pipework to be isolated whilst the purge takes place, but the isolation is made secure after purging by insertion of a spade or blind in the flanges of the downstream side of the valve or by temporarily bolting on a blank flange or other suitable fitting, with a tell-tale fitted if appropriate.

Great care must be taken when isolating sections of gas lines in multiple use situations to avoid the possibility of gas fittings that were not known to be operating or isolated having their gas supply interrupted, and when gas returns they may present a danger to users.

Removal of final connections such as electrical plugs or gas bayonet connections will only be considered secure if the removed item is prevented from being re-inserted in the supply fitting. Lockable covers and blanking plates may need to be used, or some other secure means of preventing inadvertent or thoughtless re-connection.

Valves on some services installations may be provided with removable handles, especially if they are ball valves or ‘quarter turn’ actuators as used on butterfly valves. Isolation procedures must clearly identify if the handle is to be removed and locked away, or removed and left available for a subsequent operation. A loose handle on a valve could present a danger if it was not immediately available in an emergency, for example.

Electrical isolations must be achieved using devices that have clear contact separation of all poles and are capable of being locked. Some older electrical switches and isolators do not have the necessary gap between live and dead switch elements and are not suitable for secure isolation.

Plugs and other connectors removed from sockets can easily be locked away to prevent unauthorised re-connection.

5.4 Valve proving and blanking

The upstream valve of a double block pair should be plugged or blanked if the intervening spool piece is removed, and the blank may be fitted with a tell-tale to establish the valve has remained fully closed during the task, increasing safety and assisting in safe re-connection. Locking the valve actuators may be required, or the removal of the operating lever or wheel.

The risk assessment will establish whether the downstream valve should be locked closed or not. Valves fitted to drains and tell-tales for example must be locked open. Suitable labelling should be provided at all valve positions.

In circumstances where a single valve is used for isolation and is blanked or plugged on the downstream side, an effective tell-tale will be required to prove secure isolation throughout the task.

The sliding of blanking plates or inserting spectacle blinds in between flange faces is likely to disturb the mating face or any gasket in the joint, so careful consideration of the integrity of the service after re-connection is required if this method is used.

5.5 Not using control devices or interlocking electrical devices for isolation

Control devices, control valves, pushbutton switches and other similar actuators are generally not suitable for isolation purposes and must not be used for safe isolation.

A common plant room accessory is the ‘emergency stop’ facility and these can be provided with locks, but they do not meet EAWR requirements for secure isolation that is prevented from inadvertent re-energisation. Many of the keys are similar and copies are easily made, and the device usually only operates in the control circuit so does not guarantee the mains power to the plant item is isolated securely.

Non return valves in piped systems are not suitable for isolation purposes and should not be included in the isolation process unless they have a full ‘screw down stop’ actuator. Similarly, 2-port and 3-port control valves are usually not designed as isolating valves and should not be used in the isolation scheme.

Dampers in ducts and flues should not be considered suitable for use in a safe isolation scheme. Items such as these will temporarily reduce flow but not usually be capable of sealed shut-off and secure isolation.

Many plant items are controlled by software in stand-alone devices and in computer based controls systems, Building Management Systems and the like. These are also not acceptable for safe isolation routines; software routines must not allow the service to be re-instated by automatically opening valves or operating contactors and relays in electrical circuits for example, and a physical means of secure disconnection and separation must be used instead.

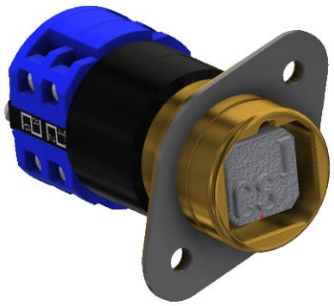
Electrical interlocks (using microswitches, limit switches etc.) are frequently found on gates and cages that prevent unauthorised access to plant and equipment and may send alarm signals; these are not suitable for safe isolation purposes and the service or machine must be correctly and safely isolated before work.

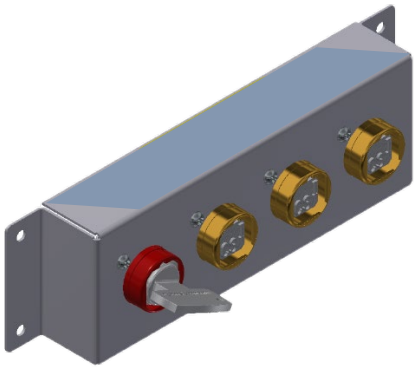
5.6 Locking devices for single and multiple users

A number of proprietary devices are easily available for use in safe isolation routines. A simple padlock with just one key and maybe a length of chain may be sufficient for a valve or an electrical isolator, and many maintenance staff will carry a selection of padlocks and devices to allow them to lock off the service they are working on, and keep the key on their person.

High voltage electrical installations and some other complex industrial plants will often use ‘trapped key interlock’ locking mechanisms that are built into the equipment at the manufacturing stage and allow certain switching or valve operating routines to take place under certain pre-arranged safe conditions. Keys can have equipment specific characters or numbers cut into them that only allow them to work on specified locks.

A number of manufacturers offer off-the-shelf and bespoke solutions. Key exchange boxes can allow complex operations to be carried out safely where multiple access points or system isolations are required. One trapped key to open a door could be released when all three system keys are inserted in the example below, demonstrating that the three services to the enclosure are isolated.





A register of keys and where they are used is an essential safety feature – lost keys must be traced and if keys cannot be found the locks should be replaced. The use of 'master' keys should be avoided, or at least very carefully managed, and cutting a lock off an isolation is usually prohibited, only to be carried out after full investigation of the circumstances and the issuing of a permit for the task.

5.7 Positive isolation, integrity and effectiveness - testing and checking isolations

It is essential that all isolation procedures and techniques are capable of verification, not just at the start of the task but throughout the works. Also, the installation of a 'positive isolation' device such as a blanking plate or spectacle blind has to be possible at the chosen location without adding to the risks, so adequate facilities such as valves and flanges must be considered, preferably at the design stage.

Mechanical isolations may actually be achieved in two stages – the initial isolating activity may allow a purge or the opening of a locked cover to check that the isolation has occurred as expected, and the secondary activity follows immediately to secure that isolation with an approved device such as a blanking plate or plug, or applying a locking device.

Piped fluid services can usually be observed by fitting tell tales and other visual means. Gas detectors or other similar devices may be an alternative way of checking that leaks are not present at the isolation point or work area.

Electrical isolations can be checked by the use of proprietary devices such as a proving unit and test box. It is essential that the proving device is tested before and after the service being checked – the routine is always:

Test the tester, test the circuit, test the tester again.

Proving units must be able to supply a representative voltage to test the test device – the use of multi-meters and 'non-contact' voltage test devices is not recommended for proving electrical circuits are dead, i.e. safe to work on.

HSE Guidance Note GS38:"Electrical test equipment for use on low voltage electrical systems", provides useful information on selection and use of correct electrical test equipment. It is a comprehensive guidance note that is aimed at all people who use electrical test equipment on low voltage electrical systems and equipment. These may include electricians, electrical contractors, test supervisors, technicians, managers or appliance repairers (including trades where electrical testing is not the primary activity, e.g. gas engineers, alarm installers etc.).

Unsuitable electrical test equipment or inappropriate use of test devices can cause serious burns or electric shock. Test probes, clips and leads should conform to the requirements of BS EN 61010-031 or in the case of a 2-pole voltage detector to BS EN 61243-3, and be marked with the rated installation category – CAT II, III, or IV.

Note that use of a proving unit is not a substitute for routine calibration activities and appliance testing on instruments and safety devices.

> Guidance from some organisations promotes use of 'non-contact' voltage checking devices as a means, for example, for a gas fitter to be more confident that an appliance they have isolated is actually 'dead', or that a particular cable in a run of similar cables is actually the one where the power has been isolated. These devices give an indication, and only an indication, that the circuit may be isolated, but positive confirmation of disconnection and separation of contacts is still required to meet EAWR. HSE GS38 says these devices should only be used for identifying live equipment, not for proving it is dead.

6 ISOLATION METHODS FOR DIFFERENT SERVICES

6.1 Piped services such as gas, oil and water

Most piped services will have a number of valves in the installation and they should all be numbered and that numbering system should match that on the PID drawing and valve schedule.

Where isolation of dangerous substances, i.e. ammonia, is necessary to allow repair or modifications of pipework by contractors who may be unfamiliar with the system, clear identification of pipes and valves is required before isolation work is carried out.

Valves should all be pressure rated for the service pressures they are likely to experience but an isolation scheme may sometimes divert the service along an unplanned route and the capacity and rating of valves and pipework must be checked in these circumstances.

An example is where a safety valve with a certain rating and a specific vent pipe size is to be left in use during an isolation and the possible flows or pressures in the isolated section might be higher than the capability of the valve selected to handle them in an emergency.

Traditional valve isolation schemes use double block and bleed techniques where the pipework in between the supply side valve and the service valve can be vented or drained and a tell-tale or other device be used to detect failure of the upstream valve. Beware of trapping pipe contents in bends and sagging lengths of pipework – drains to a fall are essential. “Single valve isolation only” is not recommended unless specifically provided for in the risk assessment or permit and provided with a ‘tell tale’ or other confirmation.

Locking devices are available for lever and wheel operated valves that can be fitted quickly and easily to prevent unauthorised operation, and may also allow several padlocks to be fitted from different workers.

Pipeline freezing is a frequently used isolation technique for water based pipe contents and other fluids that will freeze solid and provide a plug that prevents pipe contents from eascaping during an intervention. The risk assessment for the task must establish whether this is an appropriate technique and whether alternative methods may be more suitable. For instance, can the frozen plug be maintained for the duration of the work plus a safety margin, or will the pipe burst at the point of freezing due to expansion of the contents; does the water or other fluid contain glycol or has it a freezing temperature lower than that of the freezing medium.

For small and flexible pipes containing ambient temperature water this may be a suitable technique, but for other isolations another method may need to be found.

6.2 Mains electricity up to 1000V ac

Low voltage electrical supplies in industrial installations will usually be radial circuits fed from 400V 3 phase distribution boards, and each circuit will normally have a suitably rated isolating switch or circuit breaker with a locking facility.

Close to the plant item (pump, fan, boiler etc.) a local isolator will usually be provided and this too should be lockable with a padlock in the 'off' position.

Low power circuits and single phase supplies may be fed from Miniature Circuit Breakers (MCB) and sometimes these can be fitted with locks. Alternatively, but sometimes less convenient, the whole MCB board may be behind a lockable cover. However, it is not usually possible to verify the contact separation in such devices, so their use in a safe isolation scheme should be limited to initial isolation prior to proving and further disconnection elsewhere to form a secure gap.

Older installations may still have fused supplies from fuse switches and fuse distribution boards, and a common way to secure the isolation was to remove the fuses and keep them with the operative for the duration of the task. This is only really 'fool proof' if no other similar fuses are available (some may be held locally as spares) or some other way is found of locking the distribution board – the removal of fuses provides the disconnection gap but the locking of the electrical equipment is required to provide security against inadvertent re-connection in order to meet EAWR.

Contactors and relays in control panels are not to be considered suitable for a safe isolation scheme.

Live electrical working is generally prohibited. Electrical systems should be designed and installed such that live working is not necessary. The EAWR says that there must be no live working (including any testing or fault finding on live systems or equipment) unless:
– it is unreasonable to work dead; and
– it is reasonable to work live; and
– suitable precautions are taken to prevent injury.

This is a severe test and will usually prohibit any sort of live electrical working or testing. The act of 'proving dead' must be made after sufficient measures have been taken to isolate securely, and the test is to prove the isolation with the expectation that it is secure, but always remembering the possibility that it might not be. Those testing to prove dead must be trained on how to carry this out safely and be provided with suitable testing equipment.

6.3 Mains electricity above 1000V ac

High Voltage electrical installations present a different set of challenges and it is essential that all electrical equipment operating at 1000V and above is locked away in secure plant rooms and only accessible to competent persons. The danger from arcing and explosion of incorrectly operated switchgear still remains in some HV installations, as does the risk of manually dependent switchgear which relies on the speed and skill of the operator to make the connection swiftly and positively. "Manually dependent" gear is no longer supplied in the UK and should be replaced if it is still in operation. The employer has a responsibility to ensure those working on high voltage equipment have received suitable high voltage training and are approved HV workers.

HV systems should always be operated and maintained under a permit system. A strict regime of risk assessment and the associated production of a switching schedule (method statement) is essential for safe working. HV gear may need to be isolated to allow personnel to access areas where they are normally not allowed (non-electrical staff to remove foliage or paint enclosures for example), or to isolate overhead cables for tree cutting or other requirements.

Electrical maintenance will also be needed from time to time and it is common practice to have prepared switching schedules for repeated tasks that allow electrical supplies to be diverted from one cable to another or one transformer to another. Such tasks, although maybe repetitive, will need to be separately assessed and a new permit issued before every intervention.

6.4 Electrical controls, BMS and computer controlled systems, remote controls

Control circuits can still present a danger even at relatively low ac voltages or dc, and the EAWR requirement to securely disconnect from every source of energy is important here. The control circuits and their associated switches and software routines may have the ability to energise plant items at any time in response to outside signals (pressure, temperature etc.) but the isolation of the plant item they control will prevent danger from the mains electricity supply. It is common to find control panels that have more than one live supply coming from a variety of sources, and it is also possible that switching off the main panel isolator will not disconnect all the potential sources of supply.

Consideration needs to be given to isolating control circuits and remote control actuators. Many industrial plants are controlled from relay panels and multi-motor control centres, and other plant items may need to be kept in operation whilst maintenance is being carried out, so a robust means of segregating control circuits and selectively isolating plant items must be devised and implemented. Total isolation of a control panel may result in the loss of service to all plant items and some safety features, so the mechanical design that allowed spare boiler capacity for example now has none because the panel was not segregated. System design should consider future maintenance activity.

Multi-motor control panels present perennial problems where all the contactors, relays and terminals for controlling a series of electrical devices such as fans and pumps are within one enclosure that has a single door-interlocked isolator. Operating this device will remove the main source of energy, and the door can be opened. However, there may be control circuits within, fed from different external sources and still 'live', and the opening of the door to carry out a simple task such as re-setting an overload relay or MCB maybe does not justify the shutdown of a complete section of a production line.

In these cases designers of machinery controls have a clear responsibility to ensure that maintenance activities, however small and possibly insignificant, can be carried out in complete safety and with as little disruption as possible. The default position of leaving the door ajar or permanently defeating the isolator interlock is not acceptable.

6.5 Vents, ducts, drains, test points and ancillary items

It is quite likely that vents and drains on installations were not originally considered as potential sources of danger since their primary function is to release excess product or harmful emissions or to allow over pressurised systems to vent safely. However, plant items such as chimneys with several flues attached or drains with many items piped together may need to be carefully considered for safe isolation of services. When isolating a large boiler for instance, the possibility of products of combustion or other combustion residues coming into the cold boiler from the working chimney must be considered, and blanking plates or other secure means must be found for ensuring the flue to the isolated item is securely blocked off. Dampers in the flue are not a safe means of secure isolation.

If there is a single flue for multiple boilers and some boilers are operational, the flue gases will be hot and the flow of flue gases will be drawing combustion products up the chimney and away from the cold boiler. But this is fortuitous and does not represent a secure means of isolation from all potential sources of danger.

Drains and other piped systems will need to be considered. Chemicals fed to several boilers for water treatment functions must be isolated from the plant to be worked on, as well as the possibility of any 'back feed' from drains and other services. Non return valves on their own are not a secure means of isolation, and some services may need to be disconnected and plugged or blanked.

The presence of good up-to-date drawings of the entire system are of vital importance, especially on a more complex plant item such as a steam boiler or an internal combustion engine (CHP and standby generators for example) so that the permit issuer can be absolutely sure the complete plant item is isolated from all sources of danger, especially where dual supplies are provided.

Any vent, drain or instrument connection that is included in the isolation scheme as a safety device in case of emergency or as part of the purging of line contents for example should be kept free and able to function throughout the work activity.

6.6 Stored energy

Stored energy in plant installations can come from many sources such as batteries, pressure vessels, header tanks, motor driven fans and pumps, lifts and elevators, and many other items.

Stored energy can create hazardous situations in a number of different situations:

- Gas cylinders – LPG, nitrogen, Industrial gases such as CO_2 and H_2, and any other compressed gas – prevent release of the pressurised contents;
- Air – compressed air cylinders on compressors or stand-alone units which can hold extremely high pressures that must be prevented from release; sudden release of air into loose hoses may cause them to 'whip' uncontrollably and air operated valve actuators must be disabled or have the air pressure relieved;
- Vacuum – these systems may also present specific hazards if not safely returned to ambient pressure before a maintenance task;
- Batteries – commonly used in industrial equipment such as fork lift trucks, increasingly in electrically propelled cars and vans (at increasingly high voltages), and as a starting device for engines etc. A risk of short circuiting terminals is always possible, and inadvertent operation or energisation must be prevented;

- Mechanical items such as fans or lifts and elevators – once the driving motor has been disconnected the machine may be free to move under gravity or under the weight of a load; differential air pressures around a fan may arise and cause movement, so means must be found to prevent rotation;
- Mechanical stored energy, as a result of residual pressure or head of fluid for example; can cause significant injuries if the pressure parts are not confirmed to be free of contents before disassembly – blockages in lines and equipment may hide significant potential energy;
- Actuators and handles – some large valves such as gas shut off valves have large handles that can drop when power is lost and cause injury if not segregated or prevented from falling – oil fired systems in plant rooms may have drop valves operated by wires with arms that can fall when power is disconnected, and spring loaded devices can release suddenly and cause injury;
- Capacitance – some electrical installations use quite large capacitors which store electrical energy and they need to have an agreed shut down procedure which may involve lengthy discharge times; in extreme circumstances it is possible for energy to be stored by capacitance arising in cables run close together over long distances – discharging and earthing of the cables is essential;
- In certain situations static electricity can arise and this would be particularly dangerous in a location where a cloud of flammable dust or gas may be present, for example.

A secure means of isolating these items must be devised, and may include:

- Removal of battery connections and locking them to prevent re-connection – lockable covers can be fitted to plugs, sockets and cable terminals;
- Rotating parts chocked or otherwise mechanically held in place to prevent fan rotation or lifts descending for instance;
- Automatic valve handles supported or securely tied to prevent them dropping when power is lost;
- Spring loaded components that can release suddenly and cause injury so need to be secured from unexpected movement.

Pressure vessels such as used for steam and compressed air should have a start-up and shut down procedure that clearly identifies all isolations required to make the pressure vessel safe to work on.

6.7 Parallel or duplicate systems, and new technologies

Plant designs often include the need to allow services to continue uninterrupted to the user, whether that be for heating in a care facility, standby electrical power in a data centre, steam to a factory continuous process, or a simple UPS device in a control system. It is essential that safe isolation procedures identify any possibility of standby or duplicate systems being energised.

Specific dangers include:

- Electrical panels fed from two or more sources of electrical energy, e.g. mains power and standby power from a generator;
- Boilers utilising two or more fuels, either in parallel or separately;
- Control panels with connections to multiple plant items, maybe mixing 3 phase power, single phase power and dc control circuits;

- Duplicate plant items in automated duty/standby mode such as pumps, fans, chillers or boilers where sensing devices in the system can call a standby item into service without warning;
- Renewable energy plant such as solar panels, wind and water turbines, CHP engines and other plants which use unconventional power sources and may start without warning.

Some of these newer technologies will be unfamiliar to conventional plant operators and maintainers, and it is essential that proper training and clear instructions are provided. As examples, batteries in electrically propelled vehicles now operate at quite high voltages and need specific handling techniques to be employed to prevent danger from fire, overheating or explosion, and the advent of hydrogen used in natural gas mains will lead to specific skills being required of maintenance personnel.

6.8 Engine driven plant and machinery

Maintenance activities on engine driven plant and stationary engines such as CHP or standby generators should be carefully planned. Never rely on removing the ignition key or just labelling a starting button for safe isolation. It is essential to understand the various ways engines and other motive power sources can be activated and ensure that the means for the equipment to start is identified and fully disabled to ensure inadvertent reinstatement cannot take place.

Disconnecting battery connections will frequently be the easiest means for disabling the plant but the cables must be secured in such a way that they cannot be easily re-connected.

6.9 Excavations and access

Many services installations are buried in the ground, and some are placed at high level in the street or through factory buildings. Safe access to the isolation point and the work area is essential, and designs of services installations and associated access points should take this into account.

Work at height, and work in excavated ground or ‘below ground’ enclosures is a very high risk activity and every precaution must be taken to ensure safety if services are to be accessed and isolated. The presence or creation of a Confined Space could be a factor that requires careful consideration.

HSG47: “Avoiding danger from underground services” gives sound advice on the risks posed by sometimes very congested services installations under roads and pathways and the techniques needed to make sure such activities are safe, which may well include isolation of the services temporarily whilst work is carried out nearby.

Underground services are widespread. Assume they are present unless you have been shown otherwise. The use of testing devices and the requirement to carefully ‘hand dig’ may be necessary.

6.10 Hot work

Hot work should be eliminated or minimised wherever reasonably practicable. Any proposed site welding or cutting/grinding on or near process equipment should be justified by risk assessment. Where a system contains or has contained a flammable substance, isolation to carry out hot work such as welding or grinding will require additional precautions to mitigate against risks from residual material.

It is also important to consider the impact of hot work on any live systems in the vicinity of the worksite. It may be necessary to isolate, depressurise and, if appropriate, drain or fully vent any systems where hot work could cause fire or inadvertently breach containment of a hazardous fluid.

Following any hot work activity a ‘fire watch’ routine should be instigated and a full inspection of the work area carried out 30 minutes after work ceased to ensure no flammable material has been smouldering.

7 PLANT REINSTATEMENT

Plant reinstatement is a critical aspect of any intrusive activity on plant and equipment installations. Incorrect or incomplete reinstatement is likely to result in loss of containment or an increase in potential danger.

Work carried out under self-isolation procedures would normally mean the person responsible for the work will carry out the isolation and the reinstatement, and they will be responsible for ensuring services are restored to their pre-isolation state. Similarly, work that only involved the opening and closing of valves and isolators for example would not always need a complex reinstatement process. However, where work involved the dismantling of pipework or the disconnection of electrical cables and earthing, or work has been controlled under a permit (or, exceptionally, multiple permits dependent on common isolation points), it is critical to define the sequence of plant reinstatement, and formal procedures and re-certification may be required.

Risk assessment should cover all stages of the isolation activity, including requirements for testing and reinstatement of plant (e.g. pressure/leak testing, purging, controlled re-pressurisation/re-filling, electrical continuity and rotation tests etc.).

It is outside the scope of this document to cover every possible re-instatement activity following an isolation and repair. Rigorous arrangements may be necessary to assure full reinstatement of all disturbed elements of plant. Special consideration should be given to reinstatement of remotely actuated equipment such as valves and circuit breakers that may be located an appreciable distance away from the worksite and may be capable of auto-resetting services.

Particular care is also required to ensure proper reinstatement of relief valves and other safety devices to their required operating status and correct set pressure, for example.

Certain organisations and certain systems will require completion of specified safety documents to record that a full reinstatement sequence has taken place and equipment is safe to use.

A selection of possible reinstatement criteria follows – not all circumstances are discussed and not all proposals will be suitable in every circumstance.

7.1 Piped services such as gas, oil and water

The successful and safe reinstatement of piped services depends on what fluid is being conveyed.

- Natural gas and other gaseous fuels – must follow IGEM guidelines for purging, strength testing and leak testing of all disturbed pipework and components – additional checks for the effectiveness of a flue, the supply of combustion air, the operating pressure, and the overall safe operation of appliances are required by Reg 26(9) of the GSIUR – competent persons should be engaged for these activities;
- Cold water – risks from spillage, flooding and wastage – check drains and vents, and ensure gasketed and other joints are secure – observe any overflow or relief devices for correct operation. Fire mains or sprinkler systems may require additional precautions to be observed. Chilled water systems will probably have additives that need to be checked for strength and effectiveness. Flushing to remove residues may create additional hazards. Large pumps and other fluid systems may need flushing, priming, purging or venting as they refill, taking care to identify any pipework loops or possible ‘U’ bends that act as traps;
- Hot water – as for cold water but with additional precautions for the temperature, and recognising the possibility of the water flashing to steam;

- Steam – adequate time to be allowed for the pipework and cold components to get up to temperature and pressure – traps, drains and vents to be checked for effective operation during and after warm through – may require slow, sequential and careful operation of manual valves; the start-up procedure must be followed as failing to follow the correct process could have severe consequences.
- Piped chemicals (fluids and gases) – extreme care to ensure pipelines and installations are secure before filling – may need to be flushed and either pressure tested or leak tested – an emergency plan to deal with leaks safely is essential for many industrial chemicals – consider possible effects of chemicals reacting with air or being suddenly cooled or depressurised – this may need empty lines to be purged with an inert gas before filling;
- Fuel oil and other oils – treat as a piped chemical installation;
- Food ingredients or food products – depending on the hazard, treat as cold water or piped chemicals. As an example, milk is especially hazardous to the environment if spilt in quantity into watercourses – some dry foodstuffs (sugar, flour etc.) are flammable when in dust form.

7.2 Mains electricity up to 1000V ac

The reinstatement process will require altered or disturbed installations to be tested and this is sometimes carried out under a separate safety document called a 'Sanction to test'.

Tests could include:

- voltage present as expected;
- Phasing of electrical 3 phase circuits;
- Rotation direction of electric motors on pumps, fans etc.;
- Continuity and Earth fault testing of re-wired equipment and circuits (with reference to Minor Works Certificates for Electrical Installations) utilising competent trained personnel and the correct test equipment.

A 'sanction to test' might be included within the scope of the original permit or might be a separate activity depending on the type of work and the skills and equipment required.

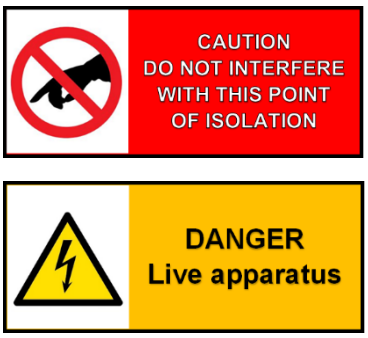
If the testing requires the isolations to be temporarily removed in order to test the affected service, the routine for this should be clearly identified, documented, and rigorously followed.

7.3 Mains electricity above 1000V ac

A Sanction to Test routine will be an integral part of any HV electrical Permit to Work process and will require skilled and competent personnel to carry out rigorous and documented tests on all parts of the HV network that have been disturbed, Tests may include:

- Phasing of cables and joints;
- Phasing of switchgear and transformer connections;
- HV cable integrity by pressure testing etc.;
- The removal or adjustment of temporary earth connections.

Such testing routines will require use of special tools and specialist calibrated equipment for phasing of conductors, insulation resistance, and maybe protective relay operation.



HV Isolation labelling

7.4 Electrical controls, BMS and computer controlled systems, remote controls

Great care must be taken to ensure that any software controls or other remote device actuations are managed and controlled. Persons reinstating services installations and equipment shall be fully aware of the possible means by which a system or specific piece of equipment may be started, and have control over those processes at all times.

Clear liaison with control room staff or other plant operators may be essential to ensure that a pre-determined re-start sequence is correctly followed and that any automatic start or other signals are temporarily inhibited if necessary.

7.5 Vents, ducts, drains, test points and ancillary items

It may be useful to have a list of drains, vents and other installation devices as part of the permit, especially where works are complex and there are more than one or two isolation points. A sketch or diagram of the location may help, with marks at appropriate positions added as the isolations are checked before the permit is issued and then cancelled as the reinstatement takes place.

Whatever system is used, the process of properly identifying all drains, vents and other devices will prevent reinstatement delays and possible loss of containment.

7.6 Mechanical plant (boilers, accumulators), conveyors and elevators

Reinstatement of plant items where stored energy is a risk covers many possible eventualities.

Pressurised systems may have retained their pre-isolation state or may have become de-pressurised, either intentionally as part of the work or by natural leakage. Steam boilers and accumulators, for example, will need to be very slowly brought back up to pressure and temperature observing all the vessel openings for secure re-sealing of doors and gaskets, and managing traps and drains throughout the warm up period.

Any chocks or restraints used to prevent unwanted movement of elevators etc. should be released, BUT if the conveyor or elevator has residual load still in position and movement commences there should be a method for either removing the load safely or restraining the movement until the system is in equilibrium and can be restarted.

8 RECORDS AND DOCUMENTATION

Written records of all activities involving the installation, commissioning, repair and maintenance of industrial plant and equipment should be made and kept securely for five years. Some records such as repair of a steam boiler or other pressure vessel, or routine testing of an electrical installation, may be required by separate legislation or guidance to be available for longer, probably for the whole life of the plant until its disposal or decommissioning.

Installations operating under an environmental permit from a Regulatory Body (such as EA, SEPA) will have pre-determined record keeping requirements in the permit.

Health surveillance records

Certain records relating to the health of employees and others may need to be held for long periods.

A health record is a legal record of the outcome of health surveillance. Employers must keep them for all workers under health surveillance. They must be kept for at least the period specified in the relevant regulations, for example 40 years under the Control of Substances Hazardous to Health Regulations (COSHH). Under The Control of Asbestos Regulations 2012, workers carrying out licenced work must have records kept for 40 years; health surveillance and record keeping for those carrying out other asbestos work or under routine surveillance are for lesser periods – the legislation should be consulted in every case.

Where regulations do not specify how long they should be kept for, the health record should be kept at least while you employ the worker and offered to them on leaving employment.

Health records must contain information about the worker's details, where they work, the hazards they have been exposed to and their fitness to continue to be exposed to those hazards. They should not contain confidential medical information unless you have the worker's written consent.

8.1 Electronic records

Records are increasingly being made and stored electronically. The fundamental principles of having all relevant information available to all persons with a reason to need it must be followed, notwithstanding the requirements of the General Data Protection Regulation. Health & Safety information and other files may be stored electronically but they must be easily and quickly retrievable. They should also be prevented from 'over writing' or other adjustment, and be demonstrated to be the accurate record of the event at the time it occurred. Good document control routines will always ensure that the latest version of the required information is available.

A formal and well managed reporting and recording system will be invaluable in cases of incident and accident investigations and inspections by authorities. Records demonstrate whether or not the decisions and actions taken represented the best option so far as was reasonably practicable at the time, and written contemporaneous log books and other hand written reports will be preferred in many courts as evidence.

All signatures on formal records must be legible and all boxes provided on forms must be completed, even if the required item is 'not applicable' as this demonstrates that the item was considered and rejected.

All formal company procedures and other related documents should be formally reviewed at pre-determined periods and a record of the review and any actions arising be kept.

The following records will need to be retained as part of the safe isolation process:

Company Procedures and safety documentation

All company procedures for all activities should be available to all relevant employees as required. A centrally managed and controlled library of the relevant data is essential for safe working as well as general compliance and good plant management. For isolation activities, especially self- or 'own' isolations, a library of standard procedures may be beneficial, supported by forms or other aids.

Risk assessments and method statements

A copy of the signed risk assessment and the associated method statement that matches the hazards described in the risk assessment must be kept. Risk assessments for activities that are actually not achievable or not followed in practice are not acceptable.

Permits

A copy of the fully signed and properly completed permit with any attachments, sketches, method statements, procedures and other reference material must be kept. Permit documents are usually part of a numbered sequence and all numbered documents should be accounted for, even those that are drafted and not issued, or those that are issued and subsequently cancelled.

Drawings/schedules

Drawings of plant installations are a vital part of effective planning for safe isolation amongst other tasks, and keeping them up to date is an important routine for any size of undertaking. Likewise, schedules of electrical circuits, valves, instrument positions or other plant information are essential and must match the drawings and the actual installation.

Maintenance routines, PPM, test equipment records etc.

Many PPM and other similar maintenance systems are computerised, and records in those systems will follow pre-determined routines for the issue and recording of tasks and any actions arising. It may be necessary to generate a special task for an unusual isolation procedure and this should follow the agreed format for all tasks in the PPM system.

All items of test equipment, including those items issued on a personal basis, must be maintained by a competent person. You should keep records of inspection and testing of the equipment, particularly where faults are found. These records will help decide the frequency of visual inspections or testing that will need to be carried out.

It is important that personnel using test equipment are made aware of the types of defects which may occur in test equipment and that records show the examination, testing and calibration of all test equipment.

Company rules may specify that certain tools and equipment are required for a task and those items are written down at the start of the task and checked back in at the end. Leaving tools in pipes and equipment is not acceptable.

Log books and other records

A plant logbook containing notes relating to all plant room visits and plant interventions is an extremely useful management tool. In boiler houses and HV electrical plant rooms for instance, the logbook records every visitor or employee attendance and brief details of every task carried out, from simple inspection visits to the issue of permits and carrying out of maintenance tasks. It is a valuable source of information about the plant and an essential tool in case an incident occurs.

Personnel records – training and competence

Well trained employees are the best asset the company can have. Every employee should have their own personal training and competence record. Training is expensive, time consuming and vital for the safe and proper operation of plant so it is essential to keep comprehensive records of employee training and competence assessments.

Similar information should be retained for regularly used contractors and regular visitors to site in order to help manage and control permits and other documentation required.

9 HUMAN FACTORS

The effectiveness of an isolation system depends on the adequacy of other arrangements, including work control systems (especially permit-to-work), operating procedures, training and competence, management of change and contingency plans. Many of these are directly affected by the actions, or inactions, of the persons involved.

The potential for human error should be addressed and, wherever possible, minimised in the design process. Plant owners (the duty holder in the undertaking) should ensure that designs they require for their work activities have adequately addressed the requirements for access, maintenance and safe isolation of plant items. Putting in place a properly thought through design is part of the duties under the Construction Design and Management Regulations as well as good engineering practice and a route to safer and less costly maintenance and downtime solutions. Techniques such as a Hazard Operability Study (HAZOP) will be helpful in analysing designs and minimising risks.

9.1 Competency; education, training and experience

Competence is a combination of practical skill, training, knowledge and experience to carry out the job in hand safely, and ensuring the installation is left in a safe condition for use. Knowledge must be kept up to date with changes in the law, technology and safe working practice.

All personnel involved in the isolation of plant and equipment should be competent to effectively conduct their involvement in the isolation process. They should understand the purpose, principles and practices of isolation procedures and company safety rules, for their own role and for others involved, and be aware of the site's major hazards.

Competency in terms of operation and maintenance of industrial installations is often described as a mixture of education, training and experience. Competent workers are less likely to miss key components of the process or make mistakes because they were unaware of the consequences of an action or inaction. They are also more likely to complete the task safely and promptly, using the correct tools, parts and safe methods, and completing the necessary paperwork. It is essential that isolations are carried out either by a competent person or under the supervision of a competent person.

Education is a lifelong process and it is expected that competent staff will be able to understand and interpret instructions given to them in many forms, written, drawn and verbally, as well as being able to understand those instructions in the local language. Workers from other countries and cultures should be assessed for their understanding of the information they need to keep them safe, and measures should be put in place to ensure no-one attempts a task unless they fully understand the requirements. Drawings, photographs, clear plant labelling and local marking up of work locations will all help, and supervisors need to be aware of any possible limitations and how to resolve them.

Training can take many forms, from relatively simple passing down of information from one person to another to full training courses with assessments and examinations. A training course with no knowledge assessment at the end does not demonstrate that the training material has been absorbed and understood, so it is important to select training courses that assess individuals and that the assessments are independent – training someone and then having the same person assessing them is not best practice.

Some activities can be classroom taught, but many people benefit from hands on training on actual equipment and in simulated situations recognisable as places they might undertake work, so practical provision and assessment is an important part of technical training courses. Good training involves hearing, seeing and doing, i.e. what you hear, you forget; what you see, you remember; what you do, you understand.

Experience is often hard won but is as valuable as any other skill. Having seen the way things are done, correctly and maybe occasionally incorrectly, gives the individual significant knowledge to draw upon. Care must be taken that experienced workers pass on the correct methods for safe working, but there is frequently no substitute for the wisdom of years.

9.2 Human error

No-one is immune from a possible error of judgment, the effect of a misread instruction or making an assumption that was flawed. To identify all the possible errors that might occur when isolating and working on a system would be almost impossible, but the risk assessment for the task should cover all reasonably foreseeable eventualities and the method statement should be drafted with full knowledge of the way the plant is installed and the likely hazards and risks that will arise. Following a procedure created and approved by competent persons should reduce the risk of error.

Assumptions that certain tools are readily available, or certain sequences of operation are routine should be avoided. Many incidents occur because the person doing the work 'does not usually do it that way'. And as the complexity of an isolation scheme increases, the opportunities for error also increase.

Human error is different from intentional or deliberate acts. Personnel knowingly deviating from their training or their instructions by not following the company rules or not carrying out certain task sequences correctly are putting themselves, their colleagues and the business of the company at risk. If the permit specifies a sequence of events it must be followed in that order, unless the operative sees a clear danger arising – the action then is to stop the task, make the area safe and report the discrepancy, not carry on regardless. Managers should identify any deliberate acts and have a robust policy and process for ensuring they cannot be repeated.

Failure to check drawings or verify valve numbering for example can lead to dangerous situations arising. Not checking to see that all possible sources of energy have been isolated from a plant item may lead to a fatality, so every effort must be taken to follow instructions rigorously and check work routines carefully. The old metaphor "Measure twice, cut once" can be substituted as "read the instructions twice and do the job correctly first time".

9.3 Communication

The way in which an organisation decides and then disseminates the information its employees need for safe working routines is fundamental for a good safety culture. All organisations should strive to:

- Provide well-designed, clear, concise, available, up-to-date procedures and instructions, including checklists and other aids that are accepted and used by the workforce;
- Establish and maintain adequate understanding of hazards and the integrity of isolation arrangements;
- Have clear identification of plant and equipment, including valves, isolators, vents and drains, pipe contents and other key features;
- Have a clear system for tagging isolated plant items, and for recording activities and changes on drawings and diagrams.

Effective supervision

People in supervisory roles are responsible for ensuring that the company's isolation policy is fully implemented during work activities, and in particular that:

- Safe isolation procedures are fully understood and followed by everyone;
- isolations are appropriate and consistently applied;
- variations from isolation standards are authorised at the appropriate level before proceeding;
- isolation and de-isolation work is adequately planned and undertaken, usually under the permit-to-work scheme;
- information is effectively communicated between all work parties;
- system documentation in use is accurate and current;
- tasks are undertaken by competent persons;
- suitable and appropriate toolbox talks are delivered;
- supervision of the tasks is suitable and sufficient;
- planned monitoring and auditing of the system is carried out and corrective action is taken where it is identified as necessary.

Auditing

Valuable information on the performance of isolations can come from monitoring and audit activity. Monitoring, audit and subsequent review enables an organisation to confirm that it actually does what it says it does, and that this is what it should be doing.

Effective monitoring and audit processes will help find deficiencies in isolation systems and identify corrective actions before these lead to losses and incidents. They should provide an objective picture of how well isolations are controlled on a site and should include workers' views and participation.

Change management

Identifying and accepting the need for change and managing it effectively is a routine activity for well managed organisations. Changes to work procedures, safe working rules and staff training regimes will all play a part in response to the results of any audits and incident investigations, or simply as a result of purchasing new machines or installing new services to the site.

Some activities should be reviewed at set periods, such as risk assessments for routine activities, and some may be reviewed as part of the company policy on managing change and improving working practices. Formal reviews should be planned and documented to demonstrate commitment to improvement by staff at all levels in the organisation.

10 DEFINITIONS

Definitions for some words and phrases used in this document

Asphyxiant:	any material which reduces the amount of available oxygen either by simple dilution or by reaction. Asphyxiation is the effect on the body of inadequate oxygen, usually resulting in loss of consciousness and/or death. This is also known as suffocation or anoxia.
Charged	means that part of the electrical system has acquired a charge either because it is live or because it has become charged by other means, such as static or induction charging, or has retained or regained a charge due to capacitance effects even though it may be disconnected from the rest of the system
dead	A service or process that is proven to no longer contain the required gas, fluid or other constituent (e.g. electrical charge) and is not available for use
double block and bleed (DBB)	an isolation method consisting of an arrangement of two block valves (tight shut-off) with a bleed valve located in between.
Duty Holder	the person who is ultimately legally responsible for health and safety practices at their place of work and the health and safety of their employees, contractors and visitors
HAZOP	Hazard and Operability Study
Isolate	In GSIUR, to temporarily halt the supply of gas to an appliance, normally using a valve supplied for the purpose; In EAWR, the secure disconnection and separation of a plant item from all its sources of electrical energy
live	A service or process that contains the required gas, fluid or other constituent and is available for use. In EAWR it means equipment that is at a voltage by being connected to a source of electricity.
Live work (electrical)	Live work is work on or near conductors that are accessible and 'live' or 'charged'. Note that testing of live exposed conductors using a test instrument is live work. Live working is usually prohibited.
Oxygen depletion	A characteristic of certain elements and compounds to readily react with air and displace or remove the available oxygen.
Permit for Work	A formalised, documented process for safe management of work activities
Proving dead	A process of testing that the service is dead with the expectation that it is but the possibility that it might not be
reasonably practicable	relates to the degree of risk which has to be balanced against time, trouble, cost, and physical difficulty of taking measures to avoid the risk
Self isolation	Also called own isolation – one competent employee solely in charge of a single task of short duration with isolation points in close proximity, working to a standard documented procedure.
undertaking	Any enterprise or business with employees 'at work'
voltage	High voltage is a voltage in excess of 1000 V ac or 1500 V dc (direct current). Low voltage is a voltage up to and including 1000 V ac or 1500 V dc.
WEEE	Waste Electrical and Electronic Equipment

APPENDIX 1 - REFERENCES

The following is a list of applicable documents current at the time of preparation of this publication. Please note:

- This is an indicative, not comprehensive list. Users should ensure they are working with the latest information available.
- Free copies of all legislation and many HSE documents are available from gov.uk.
- Legislation marked with an asterisk is supported by Approved Codes of Practice and Guidance (ACoP) published by the HSE.
- Legislation marked with a double asterisk is supported by more than a single ACoP.
- The Electricity at Work Regulations (EAWR) 1989 are supported by a Memorandum of guidance published by the HSE.

1. Health and Safety at Work etc Act 1974.
2. Management of Health and Safety at Work Regulations (MHSWR) 1998 SI 1999/3242.
3. Provision and Use of Work Equipment Regulations (PUWER) 1998* SI 1998/2306.
4. Electricity At Work Regulations 1989 - SI 1989/635.
5. Confined Spaces Regulations 1997* - SI 1997/1713.
6. Control of Substances Hazardous to Health Regulations (COSHH) 2002* SI 2002/2667.
7. Waste Electric and Electronic Equipment (WEEE) Regulations 2013
8. Dangerous Substances and Explosive Atmosphere Regulations (DSEAR)** SI 2002/2776.
9. Control of Noise at Work Regulations 2005 - SI 2005/1643.
10. Control of Asbestos at Work Regulations 2012
11. Construction Design and Management Regulations (CDM) 2015* - SI 2015/51.
12. Supply of Machinery (Safety) Regulations (SMSR) 2008 - SI 2008/1597.
13. Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016 - SI 2016/1107.
14. Pressure Equipment (Safety) Regulations (PER) SI 2016/1105.
15. Pressure System Safety Regulations (PSSR) 2000* - SI 2000/128.
16. Work at Height Regulations 2005 SI 2005/735.
17. The Regulatory Reform (Fire Safety) Order 2005 – SI 2005/1541.
18. The Gas Safety (Installation and Use) (Amendment) Regulations (GSIUR) 2018 * SI 1998/2451.
19. The Environmental Permitting (England and Wales)(Amendment) Regulations 2018 SI2018/110 (MCPD).
20. L5 The Control of Substances Hazardous to Health Regulations 2002. Approved Code of Practice and guidance.
21. L22 Safe use of work equipment Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance.
22. L101 Safe work in confined spaces. Confined Spaces Regulations 1997. Approved Code of Practice, Regulations and guidance.

23. L108 Controlling noise at work The Control of Noise at Work Regulations 2005 Guidance on Regulations.
24. L122 Safety of pressure systems. Pressure Systems Safety Regulations 2000. Approved Code of Practice.
25. L138 Dangerous Substances and Explosive Atmospheres Regulations 2002. Approved Code of Practice and guidance.
26. L153 Managing health and safety in construction. Construction (Design and Management) Regulations 2015. Guidance on Regulations.
27. HSE GS38: Electrical test equipment for use on low voltage electrical systems
28. HSG47: Avoiding danger from underground services
29. HSG250: Guidance on permit-to-work systems: A guide for the petroleum, chemical and allied industries
30. HSG253: The safe isolation of plant and equipment.
31. HSE INDG98 Permit-to-work systems.
32. HSE Pressure Systems website http://www.hse.gov.uk/pressure-systems/index.htm
33. BEIS Pressure Equipment (Safety) Regulations 2016: Guidance
34. HSE INDG436: Safe management of industrial steam and hot water boilers.
35. BG01 Guidance on Safe Operation of Steam Boilers. (CEA)
36. BG02 Guidance on Safe Operation of Hot Water Boilers. (CEA)
37. BG03 Guidance on Steam Boiler Blowdown Systems. (CEA)
38. BG04 Guidance on Boiler Water Treatment. (CEA)
39. BG05 Guidance on Design and Operation of Biomass Systems. (CEA)
40. BG06 De-aerators and Hot Wells - Guidance for Industrial Installations. (CEA)
41. BG08 Guidance on Temporary Steam and Hot Water Boiler Plant. (CEA)
42. BG11.Guidance on the Safe Operation of Water Tube boilers (CEA)
43. IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems.
44. Institution of Gas Engineers and Managers Utilisation Procedure IGE/UP/1A - Strength/tightness testing and direct purging (Small I&C) and IGEM/UP/1C - Strength/tightness testing and direct purging (Meters).
45. Institution of Gas Engineers and Managers Utilisation Procedure IGEM/UP/2 - Installation pipework.
46. Institution of Gas Engineers and Managers Utilisation Procedure IGEM/UP/10 Installation of gas appliances in industrial and commercial premises.
47. Institution of Gas Engineers and Managers IGEM/UP/12 Application of burners and controls to gas fired process plant.
48. Institution of Gas Engineers and Managers IGEM/UP/16 Design for Natural Gas installations on industrial and commercial premises with respect to hazardous area classification and preparation of risk assessments.
49. Institution of Gas Engineers and Managers IGEM/SR/25 - Hazardous area classification of Natural Gas installations.

APPENDIX 2 - SAMPLE PERMIT CHECKLIST FOR THE PREPARATION OF A STEAM BOILER FOR ANNUAL COLD EXAMINATION

Site:		Boiler No	
Authorised Person	Name	Sign	

The above named boiler has been prepared for inspection of the water side as follows on (date)

…… AP to initial each item before issuing the permit

1	The boiler and immediate surroundings are certified free of asbestos	
2	Boiler pressure has been reduced to point where boiler vent valve has been opened. The boiler is completely drained and the shell is at ambient temperature – water removed by licensed waste carrier	
3	All fuel supplies are effectively isolated, disconnected and locked/blanked off	
4	There are no open connections to the flues of adjacent boilers – blanking plates fitted as appropriate	
5	The steam outlet is effectively isolated from the range by double isolation and tell tale or spade/blanking flange	
6	The feed water supply and any associated pump is isolated and disconnected from the boiler and the pump electrically disabled	
7	There is no possibility of blowdown from adjacent boilers entering the space (non return valves are not sufficient isolation)	
8	All the boiler openings, manway doors, mud holes etc. are removed, and fresh ambient air ventilation is applied to the boiler	
9	All electrical supplies including relevant controls and alarms are effectively and securely isolated	
10	The area inside and around the boiler has been checked and any combustible or hazardous materials removed to appropriate waste facility	
11	The boiler and associated components have been checked for residues in the combustion chamber, waterways and flue bases, especially rust deposits	
12	There is no likelihood of fumes from adjacent engine driven plant or vehicles, including from outside the plant room	
13	Boiler fittings and mountings have all been removed, including water treatment chemicals dosing lines and any direct condense injection points	
14	Fire and gas detection and other security systems have been selectively isolated if required and any control room personnel advised.	
15	There is NO work to be carried out on the boiler other than entry for inspection (no repairs, welding etc.)	
16	There is a First Aider and a First Aid kit available nearby/on site	
17	The boiler Inspector has supplied a copy of his company's risk assessment and method statement for the work	
18	The Inspector has agreed he is fit to work inside the boiler on the day of the inspection	
19	The Inspector has completed a list of all the tools, PPE and equipment he will be taking into the boiler	

APPENDIX 3 - EXAMPLE SELF-ISOLATION DOCUMENT TO BE COMPLETED BEFORE WORK STARTS.

Self-Isolation procedure		Job reference	
Date/time work is to be carried out		Name of competent operative	
Task description	**Isolate gas supply to no 1 boiler for filter cleaning**		
Operative complete details		**Time of activity**	**Comments/readings**
Production warned of possible steam interruption			
Tools and equipment available at point of work – place barriers around work location			
Gas supply to be isolated at Valve 17 and valve 23 – lock and label – apply electrical bond			
Electrical supply to burner to be isolated at main switch marked ‘no1 boiler’ – lock and label			
Fit temporary purge hose to outside air and Purge gas to air at burner valve 12 - gas to be flared off to lessen environmental impact			
Disconnect filter and clean mesh and internal parts – fit new gasket and reconnect when complete. Torque bolts to specification			
Remove temporary purge hose to outside air and Purge air to gas at burner valve 12			
Check all gas connections secure and remove isolations at valves 17 & 23 and remove electrical bonds			
Remove electrical isolations and any barriers, and return to service – inform production works complete			
Complete boiler house log book and PPM schedule			

Notes:

1. No other work to be completed under this self-solation.
2. Only competent gas trained operatives to carry out the activity
3. If work cannot be completed or an emergency arises call production manager on internal number 45367
4. Document created 12/7/19 – revision 2

APPENDIX 4 - SAMPLE PERMIT FOR WORK

Display a copy of this permit at the work location at all times it is in force - Complete all unshaded boxes

Company logo/address etc			Serial number	
Task description – brief description; add details overleaf if necessary	No other work to be carried out			
Location of work	Add sketch for clarity if required			
Planned date for the work		Time and duration of work	Start Time:	
			Finish Time:	
Risk Assessment and control measures – brief list of significant risks with control measures supported by attached risk assessment	See attached risk assessment ref no ……..			
Method of working – brief description supported by attached method statement	See attached method statement ref no ……			
Isolation points – the equipment is isolated at:	List isolation points and types of isolation or refer to a sketch or drawing attached			
Notices posted at:				
Person issuing this permit	I confirm that the equipment to be worked on is securely isolated and the area around it is clearly marked and segregated			
	Print name	Date/time	Signature	
On behalf of	Company name			
Person accepting this permit	I confirm that work will proceed in strict accordance with the permit and no other work will be carried out			
	Print name	Date/time	Signature	
On behalf of	Company name			
Person cancelling this permit	I confirm that the work is complete or has been left in a safe condition, all workers and tools are withdrawn, and the permit is now cancelled			
	Print Name	Date/time	Signature	
On behalf of	Company name			

Fully completed and cancelled permits to be filed with the contract safety information.

APPENDIX 5 - REINSTATEMENT PROCEDURE FOR SERVICES AND EQUIPMENT

In general terms it will be necessary to carry out all of the following activities in order to safely return the installation or equipment back into normal service. The precise sequence of events will depend on the type of service being restored, the nature of the work, and the extent of the isolated area. Some reinstatement activities will be relatively straightforward and some will in effect require a complete re-commissioning of a system.

Check that repair or replacement is complete, by physical checks and inspections, and where necessary, by testing the installation and the affected equipment and issuing the required documentation	
Re-check torque settings (where applicable) on mechanical parts such as flange bolts, and on major electrical connections – flush any systems as required by the contents or the downstream equipment	
Check lagging is replaced correctly and that any barriers or guards are secure	
Ensure all tools, spare parts, waste materials and personnel are removed from the area of work	
Advise any production staff or other affected persons that services are about to be restored	
Consider having an emergency procedure for dealing with unexpected occurrences after reinstatement commences – spill kits and drain covers will be useful for many fluids	
Return any drains or vents to their normal operating position – remove any electrical bonding	
Check the status and operability of any safety devices such as pressure switches, non-return valves, trip switches and limit switches – restore any isolated safety systems such as fire alarms	
Sequentially remove locks and other isolation devices in the reverse order to how they were applied, or to a documented sequence	
Observe the affected area for leaks, smells, smoke, sparking, unintended movement or other unexpected occurrence and be prepared to stop work at any point	
Re-fill or re-energise the equipment and check the work area again for unintended occurrences – some services such as steam may require considerable time to be allowed for full reinstatement; then carry out necessary safety checks, ie evaporation test	
Check all system gauges and indicators for correct readings	
Check any safety interlocks or safety relief devices where appropriate	
Cancel permits	
Advise operators, control rooms or other relevant personnel that the equipment is now returned to service and appears to be operating normally	

APPENDIX 6 - KEY STAGES OF PROCESS ISOLATION - CHECKLIST

1 HAZARD IDENTIFICATION
Identification of all hazards that are to be controlled.

2 RISK ASSESSMENT AND SELECTION OF ISOLATION SCHEME
Assessment of the failures that can occur during the isolation activity, the likelihood of these failures, and their consequences, then the selection of the appropriate type and level of controls.

3 PLANNING AND PREPARATION OF EQUIPMENT
Includes identification and preparation of the equipment involved in the task, and any other areas of plant that may be affected. The effects of the isolation must be clearly understood and communicated.

4 INSTALLATION OF ISOLATION
Installation of each point of the isolation scheme. An initial isolation may be required to allow installation of the final isolation.

5 DRAINING, VENTING, PURGING AND FLUSHING
Safe removal of the hazardous substance from the system.

6 TESTING AND MONITORING EFFECTIVENESS OF THE ISOLATION
Prove the integrity and effectiveness of isolations before intrusive work begins. Isolations must be secured, monitored and maintained throughout the intrusive activity.

7 CARRYING OUT THE INTRUSIVE ACTIVITY
It is necessary to maintain isolation integrity throughout this step.

8 REINSTATEMENT OF PLANT
Safe removal of isolations, carrying out any testing, and reinstatement of plant integrity.

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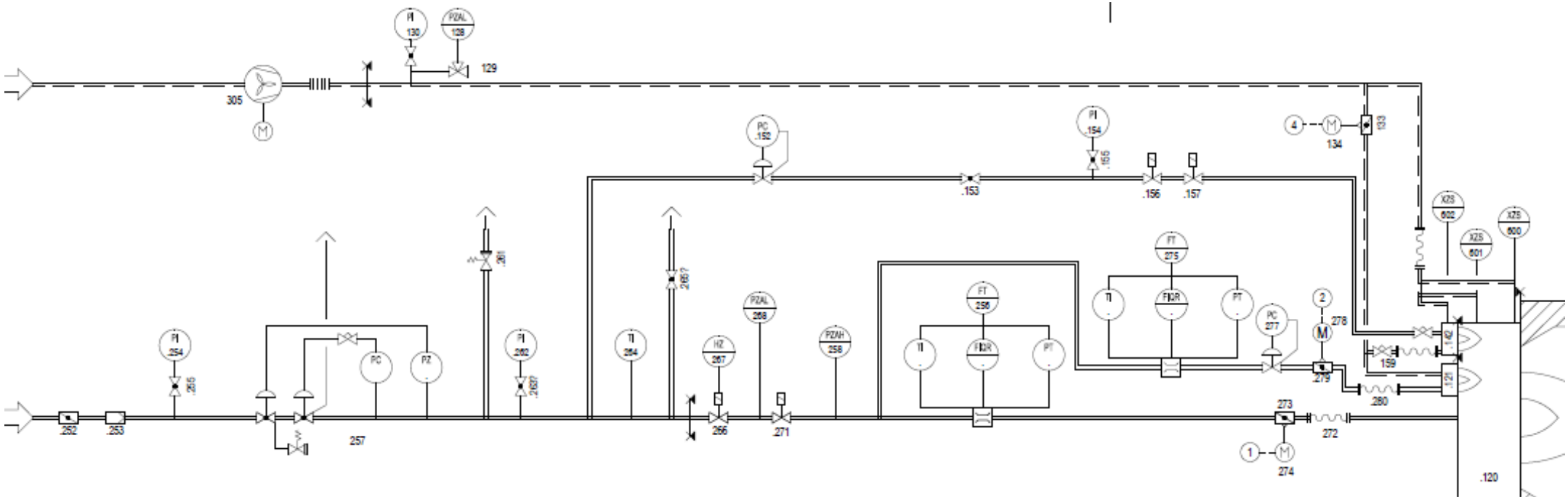
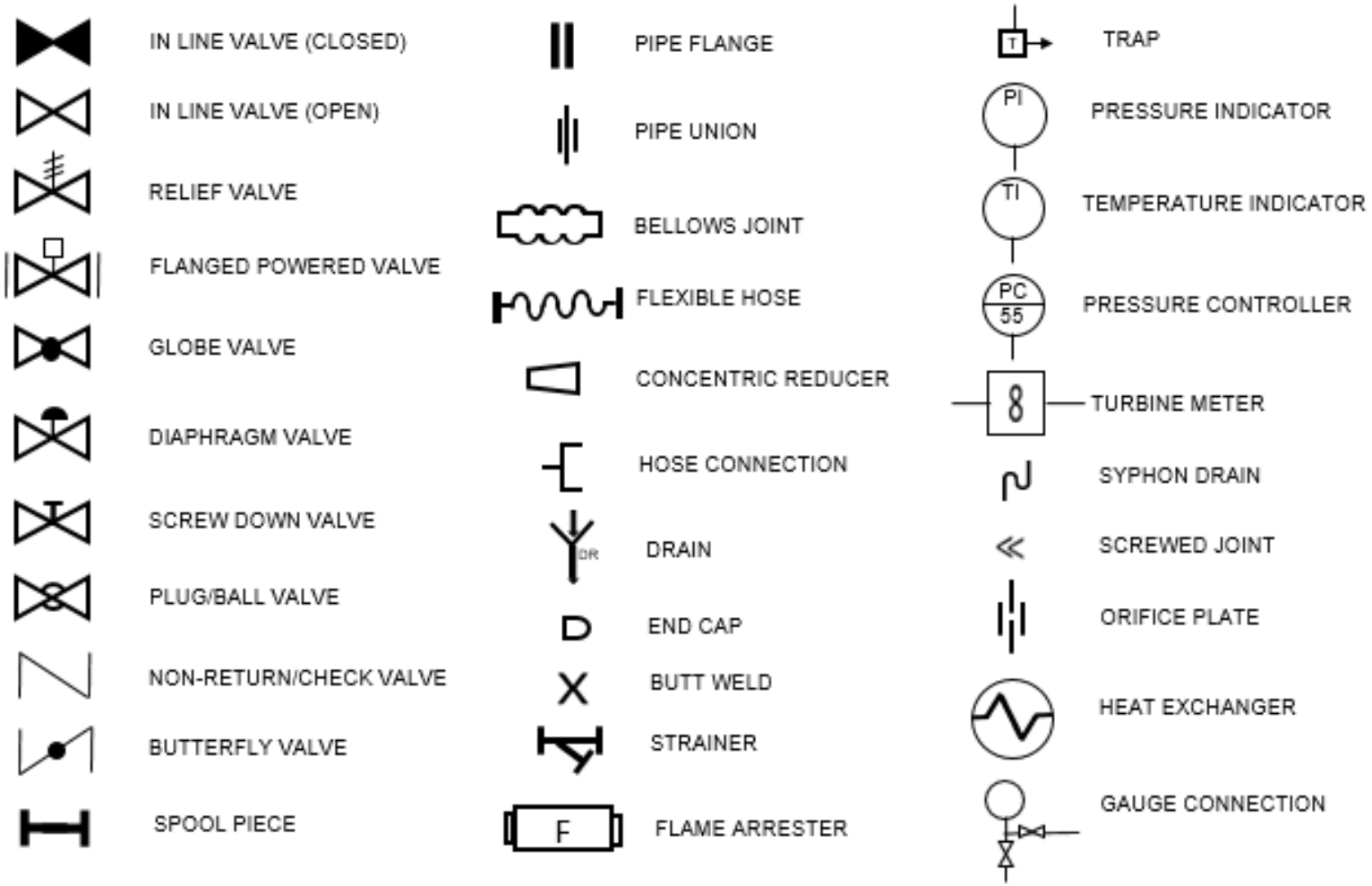
APPENDIX 7 - MECHANICAL PLANT PIPING AND INSTRUMENTATION DIAGRAMS (PID)



Gas and primary air supply to a natural gas burner – typical PID

Legend for PID

Standard symbols exist for many mechanical processes and the selection below pertains primarily to piped services such as gas, water and steam.



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This document will be formally reviewed periodically, although amendments and revisions may be made more frequently as required.

Users of this document should ensure they are working to the latest edition of this document and the related legislation and guidance.

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