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***The safe isolation of plant and equipment***

DRAFT FOR  
CONSULTATION  
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**FOREWORD**

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This guidance replaces the Oil Industry Advisory Committee' 1997 document *Safe Isolation of Plant and Equipment*.

It has been developed by a joint working group drawn from industry groups, Trades Union and the Health and Safety Executive.

We would like to thank the following individuals, their employers and industry groups for their contribution.

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## 3. INTRODUCTION

### 3.1 SCOPE AND TARGET AUDIENCE

1. This publication provides guidance on the general principles of safe isolations. It describes how to isolate plant and equipment safely, and how to reduce the risk of releasing hazardous substances during intrusive activities such as maintenance and sampling operations.
2. It includes a methodology for selecting 'baseline' process isolation methods and outlines preventive and mitigatory risk reduction measures. **It is intended for use as a reference to assist duty holders to develop, review and enhance their own isolation standards and procedures.**
3. The guidance applies to the following industries:
  - the onshore and offshore oil and gas industry;
  - chemical manufacturing; and
  - pipelines associated with these industries.

The principles also apply more generally to all industries where process isolations need to be made.

4. This guidance is primarily intended for senior operational managers who are responsible for their companies' isolations systems, and for the health and safety professionals who advise them. It should also be of interest to employee representatives and to anyone who monitors, audits and reviews isolations systems. Organisations responsible for the design and modification of plant should use this guidance to ensure that their designs provide adequate isolation facilities.
5. A number of key issues were identified for this second edition. The new focus includes:
  - the critical role of human factors in preventing loss of containment;
  - the importance of good design (for both new plant and modifications);
  - guidance which follows a 'time line' sequence for users (Section 6);
  - a revised and recalibrated selection tool, which has been simplified and includes revised 'ranking' of isolation methods;
  - further guidance on the use of 'variations' from company standards; and
  - discussion of the requirements for own isolations, extended term isolations.

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6. The guidance applies both to existing plant and to the design of new plant and is intended to reflect industry "good practice". It is recognised that older plant may not be able to meet the recommendations entirely. You should then identify a programme of selective upgrades to enable improvements to be made where there is a significant risk to health and safety.

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7. The primary concern of this guidance is with **process isolations** e.g. for intrusive maintenance. The principles are also relevant for non-intrusive isolations controlling long-term process plant configurations. It is **not** intended for emergency situations where loss of containment has occurred and immediate isolation of inventory is required.

8. The main focus is on risks to the safety of people, particularly where activities present potential major accident hazards. Avoiding loss of containment will also improve environmental protection and reduce business interruption.
9. 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. The 'References and further reading' section gives sources of more detailed guidance on such topics.

### 3.2 OVERVIEW OF ISOLATIONS HAZARDS

10. Oil refineries, oil and gas production installations and chemical processing plants are characterised by long lengths of continuously welded pipework and pipelines connecting various types of process vessels, plant and installations. The contents are often hazardous substances, which may be flammable and/ or toxic and are often at high temperatures and/or pressures.
11. Any intrusive activity could allow the escape of hazardous substances. The implementation of adequate isolation practices is critical to avoiding loss of containment. Wherever possible, you should **minimise isolation requirements** by planning intrusive maintenance for shutdown periods. When maintenance work has to be carried out on live plant the associated risks will require a high standard of management.
12. Release of hazardous substances due to inadequate process isolation may cause:
- local immediate effects to people (death or injury) and to the environment. Long-term effects to people and the environment may be equally serious;
  - escalation of the initial release, causing wider damage to plant and other systems (e.g. damage resulting in further releases of inventory).
13. The main hazards associated with the isolation of plant and equipment relate to the release of fluids. However, additional hazards may arise from:
- mechanical (rotating) equipment;
  - electrical equipment;
  - hazardous atmospheres in confined spaces; and
  - special hazards such as radioactive sources and static electricity.
  - these non-process isolation hazards are discussed in Appendix I.
14. Plant reinstatement is an important aspect of any intrusive activity, as incorrect or incomplete reinstatement may result in loss of containment.

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### 3.3 HUMAN FACTORS

15. The potential for human error significantly affects the overall reliability of an isolation method. The performance of isolations depends not only on the integrity of the isolation hardware, but also on the adequacy of the arrangements for identifying each isolation point, securing the isolation, proving/monitoring and maintaining overall control of work. Incident analysis confirms that human failures cause, or are involved in, a large proportion of isolation failures.

16. Human failures are discussed in detail in *Reducing error and influencing behaviour* HSG48<sup>(1)</sup>. Such failures can be grouped into **errors** and **violations**.

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- A human error is an action or decision, which was **not intended**, which involved a deviation from an accepted standard, and which led to an adverse outcome.
- A violation is a **deliberate** deviation from a rule or procedure and usually arises because of a desire to carry out the job **despite** barriers such as work or time pressures, lack of staff, unavailability of the right equipment or tools, extreme weather conditions.

17. Examples of human failures relevant to isolation include:

- failure to complete or reverse isolations fully before starting work or restarting plant,
- failure to prove and monitor isolated valves,
- poor communication (e.g. at shift handover),
- failure to check P&IDs/schematic diagrams against the actual installed plant and equipment.

#### An example

A valve and vent line had been used to verify mechanical isolations made on a 12" gas line during maintenance. The valve had been left in the open position when the system was pressurised. A gas leak resulted.

18. **Competency** is a key contributor to safe isolations. Competent workers are less prone to human failures. However, even experienced and trained staff, familiar with a site, may still make errors. Simply providing further training will not address the root causes of such error. Training and competence for isolation activities are further discussed in section 5.3.
19. Examples of isolation-specific controls that make failures less likely, and help to detect and correct them, include:

#### For errors

- Considering the potential for human error in risk assessments and incident investigations;
- Clear identification of plant and equipment, including valves;
- Establishing and maintaining adequate understanding of hazards and the integrity of isolation arrangements;
- Providing well-designed, clear, concise, available, up-to-date procedures and instructions, including checklists and other job aids, that are accepted and used by the workforce;
- Providing good access (e.g. for valves) and working environment (e.g. lighting), for isolation tasks;
- A clear system for tagging isolated valves, and recording on P&IDs and schematic diagrams;

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- Effective checking (independent where necessary) and supervision for isolation proving and monitoring, and for reinstatement; and
- Good communications (e.g. shift handover arrangements).

**An example**

Two technicians were injured due to a lack of communication after a section of pipework had been isolated using double block valves. On proving the isolation it was found that valves were passing, allowing pressure to build up in the isolated section. At shift changeover this fact was not passed on to the mechanical technicians who were assigned to open up the pipework. On breaking a joint the pressure relieved, resulting in a release of hydrocarbons and the technicians being hurt.

**For violations**

- Establishing a positive safety and organisational culture, including good reporting systems for recognising and acting on work pressures;
- Well designed isolation tasks;
- Good staff understanding of the reason for procedures and instructions and their roles within the system;
- Workforce participation in drawing up procedures and instructions;
- Effective supervision; and
- Compliance checking e.g. procedural compliance audits, performance monitoring (including routine tasks).

**An example**

An operator was carrying out a routine pigging operation. On conclusion of the interlock sequence he opened the tell-tale bleed valve to ensure that the launcher was free of toxic and flammable gases. The gas test was negative. He then realised that he had omitted part of the procedure, requiring the interspace between the kicker line isolation valve and the pipeline isolation valves to be vented to flare. This procedure is normally carried out at the beginning of the operation. He opened the kicker line isolation valves and the pipeline isolation valves without closing the tell-tale door. This caused a gas release from the tell-tale bleed valve.

**3.4 LEGAL CONSIDERATIONS****What 'ALARP' means for isolations**

20. The Health and Safety at Work etc Act 1974, and associated legislation, requires duty holders to reduce risk, **so far as is reasonably practicable**. The qualification **as low as is reasonably practicable** (ALARP) is interpreted in the same way.
21. To show that you have reduced risks to this level, 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.

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22. Where a number of options for risk reduction exist, you must choose the lowest-risk option that is reasonably practicable. Engineering solutions are preferred to procedural controls or to reliance on the use of personal protective equipment.
23. The greater the potential hazard, the more effective, secure and controlled must be the isolation. In some circumstances, the risks of going ahead with the isolation may be **intolerable**. In such cases the **work should not go ahead**. Instead, you will need to find an alternative scenario that does not involve intolerable risk (e.g. plant shutdown). This guidance does not attempt to define a criterion for isolations of intolerable risk. These will be situation-specific.

### Contractors and subcontractors

24. The client company is responsible for operational health and safety, irrespective of where its resources come from – whether its own staff, contract, subcontract or agency staff or self-employed workers.

### Terms 'should', 'may' and 'must'

25. Throughout this publication, verbs with specific meanings are used:
  - should – primary verb for statements of guidance;
  - may – where the guidance suggests options; and
  - must – only where there is a specific legal/statutory requirement for the measures described or where the dangers of taking that course of action are self-evident.
26. Relevant legislation is listed in Appendix 2.

## 4. DESIGN

27. Some intrusive maintenance or internal inspection tasks will always require plant shutdown. Where isolation to enable intrusive activities is appropriate, suitable isolation arrangements on the plant should be clearly specified at the design stage. Good design maximises inherent safety and is fundamental to achieving safe and effective isolation without placing unnecessary constraints on plant operation.
28. The design principles below apply mainly to new plant and equipment, where the opportunity to achieve an inherently safer design is greatest. Wherever reasonably practicable, the same approach should be followed for plant modifications (considerations required before modifications are carried out are discussed in paras 114-115).
29. At an early point in the design process the client should specify the intentions for normal and alternative mode(s) of operation, sparing of equipment, and the equipment maintenance strategy. Where possible, this should anticipate the intended lifecycle of the plant, including foreseeable modifications (for example addition of equipment). This philosophy should be documented in the design basis, which will determine the plant's outline isolation requirements. Any proposed deviation from the agreed design basis once the plant is operational should be justified through risk assessment before alternative isolation arrangements are used.
30. The **potential for human error** should be addressed and, wherever possible, minimised in the design (section 3.3).
31. Within the piping and instrumentation diagrams (P&IDs) and/or other relevant documentation, the following should be noted:
- alternative modes of plant operation using differing flow routes;
  - requirements for intrusive plant operations (for example filter change-out, removal of pipeline pigs from launchers and receivers, or sampling) and requirements for access into equipment for inspection and/or maintenance; and
  - the detail of isolation arrangements, including valve types, spacers/spading points or spectacle blinds, test points and associated vents and drains for venting, flushing and purging.
32. For spared or parallel-operated equipment, isolation arrangements should allow complete segregation from on-line equipment for operational and/or maintenance reasons. The arrangements should also provide for operational/maintenance requirements of associated shared services, including control systems and fluid disposal systems such as flare headers.
33. Design of new plant should include facilities for **positive isolation** (including the valved isolation to install the positive isolation) in the following situations:
- for vessel entry, where a requirement for entry cannot be eliminated by design of the equipment (except as described in para 79)
  - for isolation of high-hazard toxic fluids; or
  - to control segregation of parts of the plant which, in alternative operating modes, might otherwise be exposed to overpressure conditions. This applies where it is not reasonably practicable for the installed safety systems to protect all foreseeable

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operating configurations, for example the separation of a high-pressure plant from its drainage system.

34. Select suitable isolation valves for the service fluid and operating conditions (see Appendix 3). Ensure that you can **indicate** and **effectively secure** the position of manually operated valves.

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**An example**

An operator believed that he had completed the isolation necessary for his task, but as he began to remove an instrument drain plug, it blew off. The operator was unfamiliar with the unusual isolation valve type (the valve was open when the handles were turned at 90 degrees to the valve). The gas release led to a plant shut down.

35. Isolation valves downstream of pressure safety valves should be provided for safe isolation from a shared flare or vent system if intrusive maintenance is intended at any time when the remainder of the flare or vent system is in operation. Also, where an isolation valve is downstream from a pressure safety valve, you should be able to secure the isolation valve in the open position at all times when the pressure safety valve is on-line.

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36. Where pressure safety valves are spared and continued plant operation is intended, suitable isolation facilities must also be provided upstream of the pressure safety valves. Appropriate arrangements are required to ensure that the isolation valves do not impair the performance of the pressure safety valves in service, and that closure of the downstream isolation valve does not expose pipework downstream of the off-line pressure safety valve to over-pressure from the live plant.

37. Pipework layout should minimise trapped inventories and allow easy removal of fluid for isolation purposes.

38. Isolation and bleed points should be as close as possible to the plant item (unless risk assessment has shown that an alternative arrangement will be safer). Concentration of maintenance work in one place aids control of the isolation arrangements and minimises the inventory of fluid to be depressurised/drained. For bleeds, ensure that:

- they are arranged so that their discharge cannot harm personnel or plant, and toxic or flammable material can be conveyed to a safe place for disposal; and
- they are easily accessible for checking;
- pipework is of sufficient size and design to minimise the possibility of becoming blocked in service; and
- pipework is robust and able, where appropriate, to cope with the repetitive stresses imposed by vibration, pulsating pressure and temperature cycling<sup>(2)</sup>.

39. For every isolation point, the designer should provide for facilities to test and to monitor the integrity of the isolation, e.g. valved connections for installation of temporary equipment such as pressure gauges.

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40. Any piece of pipework intended for physical disconnection should be easily removable. Pipework supports should be arranged so that they will provide adequate support during disconnection. Provide supports where temporary hoses will be required for bleeding.

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41. Your design should allow suitable access to, and lighting of, all isolation points and associated items. Lifting beams suitable for attachment of portable lifting appliances or access for cranes should be provided at points where spades need to be inserted.
42. A scheme to uniquely identify all process plant, piping, and valves should be drawn up. All items should be permanently labelled on the plant and referenced on the P&IDs.

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## 5 MANAGEMENT OF ISOLATIONS

### 5.1 BASIC PRINCIPLES

43. The basic principles for risk management <sup>(3)</sup> are to:
- avoid risk wherever possible;
  - carry out risk assessment to evaluate risks that cannot be avoided;
  - take action to reduce risks to ALARP levels; and
  - reduce risks at source wherever possible
44. The HSE publication *Successful health and safety management* <sup>(4)</sup> describes the principles and management practice that provide a framework for effective management of health and safety.
45. This guidance sets out expectations for managing isolations activities, i.e. that you:
- set a policy and standards for isolation activities, to reduce risk to ALARP;
  - set procedures/processes, with worker participation, to achieve secure isolations in normal operating conditions and in other foreseeable conditions.
  - assess any proposed deviations from company procedures, authorise these at an appropriate level and record/monitor them;
  - monitor and periodically audit your isolations procedures and use that information in the review of your isolations policy (a checklist for reviewing the adequacy of the overall arrangements is given at Appendix 4);
  - have, for multi-site operations, an element of corporate oversight <sup>(4)</sup> in standard-setting and assurance (for example, central reporting of objective information on the performance of isolations systems).
46. The potential for **human error** during isolations, and its importance, was discussed in paras 15 to 19. It is critical that you both understand and act upon this knowledge. Particularly important aspects of people's role within isolations systems include:
- setting roles and responsibilities for key personnel;
  - training, competence and authorisation; and
  - the management activities of monitoring, audit and review and then **taking action**.

### 5.2 ROLES AND RESPONSIBILITIES

47. Allocate clearly defined roles and responsibilities for drawing up, maintaining, monitoring and improving your isolations system. The responsibilities of key personnel are detailed in figure nn.

<p><b>Fig. 4.</b> Responsibilities of key personnel</p>	<p><b>People in senior management roles</b> are responsible for the company's isolation policy, in particular that they:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> offer visible leadership and commitment;</li> <li><input type="checkbox"/> resource the development, implementation and review of the policy;</li> <li><input type="checkbox"/> review significant (negative and positive) results of audits;</li> <li><input type="checkbox"/> resource necessary remedial actions and plant modifications.</li> </ul>
	<p><b>People in management roles [e.g. plant managers, OIMs]</b> are responsible for ensuring that the company's isolation policy is fully implemented, in particular that:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> they define and populate an organisational structure that delivers the isolations policy;</li> <li><input type="checkbox"/> procedures and systems documentation are created and maintained to deliver the isolations policy;</li> <li><input type="checkbox"/> people are appointed to formally authorise deviations from the isolations procedures;</li> <li><input type="checkbox"/> plant and equipment necessary to comply with the procedures is available;</li> <li><input type="checkbox"/> everyone has the necessary level of competency and there are adequate supervision arrangements;</li> <li><input type="checkbox"/> monitoring, auditing and review is undertaken and specialist advice is sought as and when required;</li> <li><input type="checkbox"/> remedial actions and necessary plant modifications are implemented.</li> </ul>
	<p><b>People in supervisory roles [e.g. lead technicians]</b> are responsible for ensuring that the company's isolation policy is fully implemented at the plant level, in particular that:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> the isolation procedures are fully understood and followed by everyone;</li> <li><input type="checkbox"/> isolations of the appropriate quality are consistently delivered on the plant;</li> <li><input type="checkbox"/> variations from isolation standards are authorised at the appropriate level before proceeding;</li> <li><input type="checkbox"/> isolation and de-isolation work is adequately planned and undertaken via the permit-to-work scheme;</li> <li><input type="checkbox"/> information is effectively communicated between all parties;</li> <li><input type="checkbox"/> systems documentation in use is accurate and current;</li> <li><input type="checkbox"/> tasks are undertaken by competent persons;</li> <li><input type="checkbox"/> they adequately supervise tasks;</li> <li><input type="checkbox"/> planned monitoring of the system is carried out and corrective action is taken.</li> </ul>
	<p><b>People who work on the plant [e.g. operators, maintenance technicians]</b> are responsible for carrying out work in accordance with plant policy on isolation, in particular that they:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> understand and work to the procedures;</li> <li><input type="checkbox"/> work within the permit to work system and the planning documentation;</li> <li><input type="checkbox"/> will not proceed with a variation from normal procedures without proper authorisation;</li> <li><input type="checkbox"/> adequately identify, test and secure isolations;</li> <li><input type="checkbox"/> co-operate with supervisors to ensure that the policy is effectively implemented;</li> <li><input type="checkbox"/> communicate effectively with other parties involved in the work.</li> </ul>

48. These safety-critical activities for isolations, which are an integral part of the roles and responsibilities of teams and individuals, are primarily assured via operating discipline and supervisory arrangements. Define performance standards - for example a requirement that the security of every isolation point is tested and proved before intrusive work goes ahead, or the induction required to ensure contractors' understanding of site isolation standards and procedures.

### 5.3 TRAINING AND COMPETENCE

49. All personnel involved in the isolation of plant and equipment should be competent to carry out their responsibilities. They should:
- understand the purpose, principles and practices of isolation procedures and safety rules – for their own roles, and for others who operate the isolations systems; and
  - be aware of the site’s major accident hazards, i.e. the potential consequences of releases of hazardous substances.
50. Key groups of workers are those who:
- plan isolations;
  - authorise isolations;
  - authorise non-standard isolations;
  - install and remove isolations; and
  - work on the plant.
51. Figure XX shows necessary competences for these roles. A comprehensive, structured training and development programme should be in place to provide both initial and refresher training. You should have a competency assessment process to manage the achievement and maintenance of these competences.
52. Managers who oversee and operate the competence management system play a key role. They should be competent in the areas of management, technical issues and health and safety.
53. Respond to organisational change or to changes in systems of work via training, briefings and reassessment, as appropriate. Periodic refresher training, to maintain competence, will be appropriate, particularly for any safety critical tasks that are done only rarely (for example the use of a non-standard isolation technique). This may take the form of a ‘walkthrough’ rehearsal of the task.
54. The extent of training and assessment should align with the person’s role in isolations and the overarching work control arrangements, especially the site’s permit to work systems. Training and assessment should cover:
- company procedures, and roles and responsibilities;
  - risk assessment, particularly where a variation from the normal level of isolation is proposed for an intrusive activity (section 6.2.5);
  - familiarity with relevant company, industry and regulatory guidance material; and
  - awareness of legal requirements.

<u>COMPETENCE</u>	<u>GROUP OF WORKERS</u>
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	Plan isolations	Authorise the work	Authorise non-standard isolations	Install and remove isolations	Work intrusively on the plant
<b>HAZARDS</b>					
A general awareness of the hazards represented by the plant.	*	*	*	*	*
A detailed understanding of the hazards on the plant and from adjacent plant.	*	*	*	*	
<b>ISOLATION PROCEDURES</b>					
Good working knowledge of isolation and risk assessment procedures for plant.	*	*	*	*	*
Understand the importance of following procedures.					
Know how to check what isolations are in place and that they are the correct isolations required.		*	*	*	*
Know the procedures for installing/removing isolations.		*	*	*	*
Know the procedures for draining, flushing, venting and purging.					
Know how to test and confirm correct installation of isolations.					
Know how to record isolations on an isolation certificate.					
Be able to assess the risks from non-standard isolations.	*	*	*		
<b>PTW</b>					
Understand the system of PTW and isolation certificates in use.	*	*	*	*	*
Know the procedures for issuing PTW and for identifying what isolations are required.	*	*	*	*	
<b>DOCUMENTATION</b>					
Understand the P&IDs, loop diagrams, cause and effect diagrams and power supplies applicable to the isolation.	*	*	*	*	

- 55. Training is likely to include site familiarisation and on-the-job-training. Group training and exercises will help to ensure understanding of the interactions of roles within the overall system. Site-specific training ensures that theoretical knowledge can be successfully applied. You should consider whether safe working also requires further specific training and assessment (e.g. manual handling<sup>(6)</sup>, COSHH<sup>(7)</sup>).
- 56. Keep formal records of all training and assessment. This enables verification and audit of training and competence, and assists in identifying individuals' initial and refresher training needs.

57. Training should include assessment of performance against a standard. Demonstration of competence may involve direct and indirect observation, written records, log-books and practical and written tests. Wherever possible, the emphasis should be on workplace assessment (for example, competency assessment for **Isolating Authorities** should involve completion of assigned field assessments in process/mechanical isolation practices and documentation).
58. Everyone who specifies and/or carries out the isolation of plant and equipment should have proven competency within their defined role before being authorised to act as **Isolating Authorities** and signatories to isolation documentation. A 'competent persons' register should be maintained on site.

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#### 5.4 MONITORING, AUDIT AND REVIEW

59. Monitoring, audit and review enables an organisation to confirm that it **actually** does what it **says** it does, and that this is what it **should** do.
60. Effective monitoring, audit and review systems:
- find deficiencies in isolations systems and drive corrective action before these lead to losses and incidents;
  - provide an objective picture of how well isolations are controlled on a site;
  - are not restricted to periodic reviews, but can also **react** to incidents (on site, lessons from relevant industry accidents) and to proposed organisational change;
  - should include workers' views/participation; and
  - drive improvement and facilitate learning lessons and maintaining corporate memory.
61. No single monitoring, audit and review activity can capture the whole picture. In practice, a mixture of different activities is necessary. These should be appropriately resourced, based on the scale, nature, and distribution of hazards of the organisation's isolations activities.
62. Monitoring and audit activity should cover the scope, frequencies, sampling strategy, responsibilities/competences and mechanisms for reporting results. The programme might include:
- weekly compliance checks by an operator and a site manager;
  - specialist audits, which assess, independently of operational management, the implementation of local procedures against corporate standards; and
  - formal periodic review.
63. A full range of isolations should be examined, including:
- isolations controlled by permit and by procedures, including 'own-isolations';
  - routine and non-standard isolations; and
  - activities where the potential for human error could lead to serious consequences.

64. Various degrees of scrutiny may be needed, requiring different defined competences. For example, examination of risk assessment (RA) processes for isolations could include:
- compliance checks that a record of RA is available, signed/authorised at correct seniority; and/ or
  - a technical audit, based on a sample of high consequence isolations, which examines the adequacy of the RA conclusion (i.e. have risks been reduced to ALARP?)
65. Valuable information on the performance of isolations systems can come from other monitoring and audit activity (e.g. PTW system checks, audits of competence assurance programmes).
66. Checklists/forms can be useful tools for:
- planning and initiating remedial action;
  - periodic analysis to identify common issues which reveal underlying weaknesses in the systems.
67. 'Model' checklists which can be tailored to a company's own arrangements are in Appendix 4:
- for site checks ('compliance monitoring') of isolation schemes; and
  - to guide a review of the adequacy of isolations arrangements.

## **5.5 SETTING INDICATORS OF PERFORMANCE FOR ISOLATIONS ACTIVITIES**

68. Setting targets against relevant numerical/other performance indicators may be part of the toolkit for managing H&S performance.
69. Examples of performance indicators include:
- an overall performance standard to reduce the risk of loss of containment (LoC) during isolations activities to ALARP (e.g. N% reduction in LoC attributable to failures in isolations activities?);
  - reporting to senior manager of the number of extended-term isolations in place (rather than modification of plant); and
  - audit outcomes – number of violations against procedures.

## 6 KEY STAGES OF PROCESS ISOLATION

Figure 1 Summary of process isolation

### 1 HAZARD IDENTIFICATION (Section 6.1)

Identification of all hazards that are to be controlled.



### 2 RISK ASSESSMENT AND SELECTION OF ISOLATION SCHEME (Section 6.2)

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 (Section 6.3)

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 (Section 6.4)

An initial isolation may be required to allow installation of the final isolation.



### 5 DRAINING, VENTING, PURGING AND FLUSHING (Section 6.5)

Safe removal of the hazardous substance from the system.



### 6 TESTING AND MONITORING EFFECTIVENESS OF THE ISOLATION (Section 6.6)

Prove the integrity and effectiveness of isolations before intrusive work begins. Isolations must be secured and maintained throughout the intrusive activity.



### 7 CARRYING OUT THE INTRUSIVE ACTIVITY



### 8 REINSTATEMENT OF PLANT (Section 6.7)

Safe removal of isolations and reinstatement of plant integrity.

## 6.1 HAZARD IDENTIFICATION

### 6.1.1 Hazards related to the isolated substance

70. If isolation failure leads to loss of containment, people may be harmed. Escalation to a major accident can occur. Harm may result from a substance's flammable and toxic properties, or where it:
- is present at high pressure;
  - is at high or low temperatures;
  - is reactive
  - can form a hazardous atmosphere, e.g. leading to asphyxiation or drowning;
  - is present as a dust, where explosive mixtures could be formed or it could be inhaled;  
or
  - remains in equipment as a sludge or hard deposit.
71. In the event of a release, the potential for a major accident will depend on a range of factors including:
- the nature and properties of the substance;
  - the quantity of substance released;
  - the escalation potential (i.e. the presence of other plant, including confining structures, and other hazardous inventories); and
  - the populations at risk, their proximity to the plant and the speed with which they may be affected.
72. Release of a **flammable** substance can cause a pool or jet or flash fire, a vapour cloud explosion - or it may disperse without finding a source of ignition. Escalation may occur, especially in congested plant where there are greater risks of, and consequences from, a vapour cloud explosion. The resulting overpressure may damage other plant, with the potential for further loss of containment and additional casualties. Jet flame impingement may also critically damage adjacent plant.
73. Some **toxic** substances (e.g. toxic gases, high hazard toxic liquids) will have longer hazard ranges and greater potential to affect more people. They may be more persistent in the environment. If personnel exposed to a toxic substance become incapable of controlling or safely shutting down the plant, escalation could occur.
74. Storage or processing conditions can be significant. For example:
- flammable substances stored or processed at elevated temperatures may be released above their flashpoints or their auto-ignition temperatures; and
  - gases at ambient temperature are often stored as liquids under pressure. Releases from pressurised storage are more energetic. For a given hole size, release rates tend to be higher.

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75. The nature and scale of an incident will be determined not only by bulk inventory but also by the **rate** at which a hazardous substance is released. This influences the size of the liquid pool or flammable gas cloud formed, or the length and diameter of a jet flame.

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### 6.1.2 Hazards associated with the work task

76. Certain locations or work tasks require specific considerations for isolation systems:

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#### Entry into confined spaces

77. Entry into a confined space should be considered **only** if there is **no reasonably practicable alternative** way to carry out the work. Vessels (e.g. separators, tanks, reactors, distillation columns) are the most obvious form of confined space, but sumps, pig launchers or work inside pipes or machinery modules can present the same dangers.

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78. The hazards from entry include:

- flammable or toxic vapours from process materials;
- toxic vapours evolved from residues or their by-products (for example carbon monoxide may be evolved when a coking vessel is first opened to atmosphere);
- asphyxiation from gases (e.g. nitrogen) used for inerting the confined space or adjacent areas;
- oxygen depletion;
- carbon dioxide build-up; and
- drowning by the ingress of water or free-flowing solid.

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79. A **very high standard** of physical isolation is required, by physical disconnection (spool removal) or the insertion of spades (the **only exception** is where use of positive isolation would **not reduce risk** during vessel entry but would introduce additional potential for human error, e.g. failure to reinstate correctly. The safety valve on a steam boiler is an example of such a situation). Isolation points should be installed as close as possible to the vessel. See *Safe work in confined spaces*<sup>(8)</sup> for further information.

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#### Hot work

80. Eliminate or minimise hot work wherever reasonably practicable (any proposed site weld 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<sup>(9)</sup>.

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81. Consider the impact of hot work on any live systems in the vicinity of the work site. You may need to isolate, depressurise and, if appropriate, drain any systems where hot work could cause fire or inadvertently breach containment of a hazardous fluid.

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#### Pyrophoric iron scale

82. Pyrophoric scale may form in hydrocarbon-processing streams where hydrogen sulphide is present. The scale can spontaneously ignite when exposed to oxygen. Necessary precautions

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include breaking containment in a way to minimise air currents, maintaining an inert atmosphere and/or wetting the scale.

## 6.2 RISK ASSESSMENT AND SELECTION OF ISOLATION SCHEME

### 6.2.1 Setting standards

83. Carry out intrusive work on live plant only if there is no reasonably practicable alternative. You should establish isolation standards, based on the results of hazard and risk assessment. These should specify the 'baseline' or minimum acceptable security of isolation methods, plus any associated risk reduction measures, for the full range of fluids and tasks where isolation is required.
84. Your procedures should specify the requirements for risk assessment of isolation and associated activities. Consider both hazards due to isolation failure, and personal injury hazards (e.g. exposure to substances harmful to health, high temperatures, noise, manual handling, safe access, lifting operations, working at height or over water). Your assessment should include the potential for, and consequences of, human error.

### 6.2.2 Risk assessment of the isolation task

85. Risk assessment should cover all stages of the isolation activity, including:
- preparatory work for the isolation - including depressurisation and release of stored energy, draining/venting, purging and washing out;
  - installation/removal and proving of the isolation;
  - the protection provided by the isolation during intrusive work, and the compatibility of any nearby work or operations on shared systems; and
  - requirements for testing and reinstatement of plant (e.g. pressure/ leak testing, purging, controlled repressurisation/ re-filling).
86. Task-specific risk assessment should identify any need for additional mitigating measures during the intrusive activity, taking into account:
- what could go wrong to lead to a loss of containment;
  - the possible consequences of a loss of containment e.g. fire, human harm, environmental damage;
  - how likely it is and how bad it could be; and
  - anything else that can be done to reduce risk to ALARP levels.
87. The necessary rigour of task-specific risk assessments will depend on the type and severity of the hazards, and the extent to which relevant generic procedures are already in place. Adequate assessment will often require team input, including practical knowledge of both the work task and the isolation methods.

### 6.2.3 Selection of the isolation method

88. Appendix 6 summarises a range of isolation techniques. The level of security provided by your selected isolation method should match the severity of the potential hazard.
89. Your choice of final isolation method should be based on risk assessment. However, where a more secure isolation is available, and where it is reasonably practicable to use it, you should do so unless this would increase the overall risk associated with the isolation (risks should always be reduced to 'ALARP').
90. Use **positive isolations** for confined space entries (see paras 77-79), for 'high hazard' toxic fluids and for extended isolations (Section 7.6), unless your risk assessment shows alternative methods to be safer. Your initial valved isolation, to enable the insertion of positive isolation, should be of an appropriate standard, secure, and provide a tight shut-off.
91. Use physical disconnection wherever reasonably practicable. Ensuring the correct implementation of your isolations is then easier – it is simpler to monitor removal of a spool than to check that a spectacle plate has been correctly installed.
92. **All** isolation methods can fail. The potential for human error is a major factor affecting the overall reliability of an isolation method. The performance of an isolation depends not only on the integrity of the isolation hardware, but also on the adequacy of the arrangements to identify each isolation point, secure the isolation, prove/ monitor the isolation and maintain overall control of the work. When selecting an isolation method, you should consider the potential for both mechanical failure and human error.

### Selection tool – one means of establishing baseline method

93. Appendix 5 contains a selection tool, based on risk assessment principles and calibrated against industry good practice. This is intended to assist in setting final isolation standards and drawing up the supporting procedures. The selection tool is **not** intended to apply to:
- 'high risk' situations e.g.;
    - **confined space** entries (paras 77-79);
    - where isolation failure could produce a catastrophic outcome, or a situation from which recovery would be very difficult;
  - **pipelines** isolations (Appendix 7); or
  - **extended term** isolations, e.g. for mothballed plant (Section 7.6).
94. Other ways to select isolation methods may be acceptable. A selection tool can complement, but cannot replace, competent technical judgement and common sense.
95. The tool gives a baseline method, **not** a final decision on the most appropriate isolation. This tool's output will be one of the 4 options listed below. Categories I-III are further described in table X:
- Category X consider whether the associated risk is acceptable or whether there is a need to further reduce risk by e.g. plant shutdown, extending the isolation envelope.
  - Category I positive isolation;
  - Category II proved valved isolation; and

- Category III non-proved valved isolation.

**Figure X: Isolation Methods**

Category	Features	Method	Picture
I Positive isolation	Complete separation of the plant/ equipment to be worked on from other parts of the system.  Valved isolation of an appropriate standard is required during the installation of positive isolation.	Physical disconnection	
		Double block, bleed and spade	
		Single block bleed and spade	
II Proved isolation	Valved isolation. Effectiveness of valve closure(s) can be confirmed via vent/ bleed points before intrusive work commences  Within this isolation category the level of mechanical security is greatest for DBB and lowest for SBB.  As a general rule, SBB should <b>not</b> be used with hazardous substances (discussed in paragraph 96)	Double block bleed (DBB)	
		Double seals in a single valve body with a bleed in between	
		Single block and bleed (SBB)	
III Non-proved isolation	Valved isolation. No provision to confirm effectiveness of valve closure prior to breaking into system.  Where possible, double valve isolation should be used rather than single valve.	Double valve	
		Single valve	

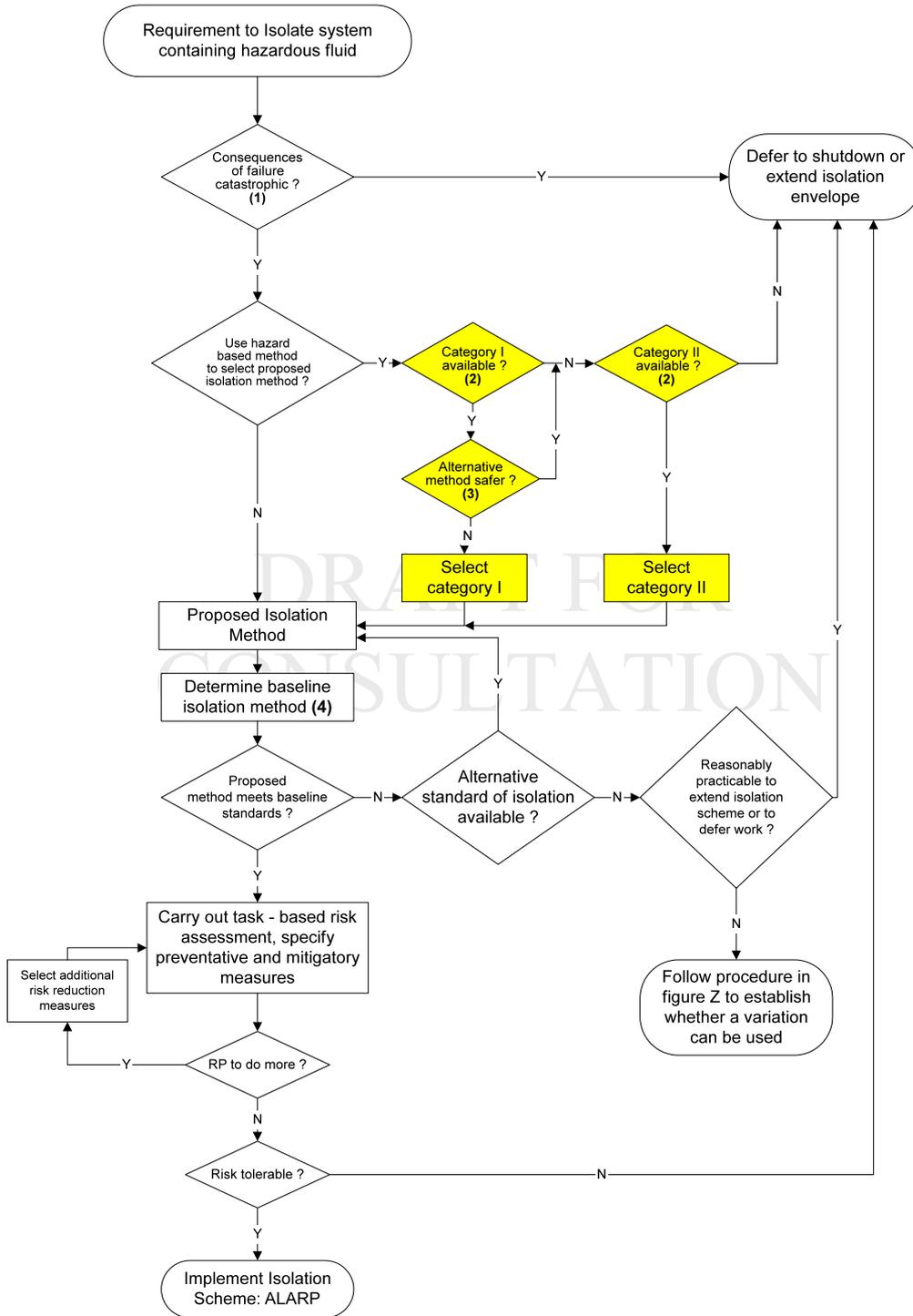
KEY:		
		Live System
		Equipment / Process system to be isolated
		Block valve (closed)
		Vent or bleed (closed and blanked off during normal operations)

		Blank flange or spectacle plate
		Pressure monitoring facility

96. Within each category, the methods listed do **not** all provide an equivalent degree of security. For example, a hierarchy of mechanical security is associated with the three isolation methods shown for category II (proved isolation) - once installed, the reliability of double block and bleed (DBB) is greatest while that for single block and bleed (SBB) is least. **As a general rule you should not use SBB with hazardous substances**, but there may be circumstances where the use of SBB is justified. Your risk assessment should clearly justify any decision to use SBB to isolate a hazardous substance.

#### Selection of 'ALARP' isolation method

97. The flowchart at figure n outlines the selection of an isolation method and risk-reduction measures for an isolation scheme. It includes both hazard-based and risk-based selection of isolation method, where:
- Hazard-based selection directs towards the highest standard of isolation available; and
  - Risk-based selection indicates the 'baseline method'. (The selection tool in Appendix 5 is one means by which this baseline can be established.)
98. After determining the baseline method, you will need to complete your risk assessment to ensure that other risks are minimised. Aspects to consider include e.g.:
- temperature;
  - manual handling considerations;
  - potential for workers to be exposed to substances which may be hazardous to health<sup>(7)</sup>;
  - additional risk reduction measures (Section 6.2.4); and
  - whether it is appropriate to consider use of a 'variation' (Section 6.2.5).
99. Your final considerations should be whether risk levels have been reduced to 'ALARP' and whether the level of risk associated with the proposed isolation is tolerable (section 3.4) – **if not, then the work should not go ahead.**
100. **No individual step should pose an intolerable risk** for those carrying out the work.
101. The risk associated with some proposed isolations will be such that the selection tool (Appendix 5) indicates the need for further consideration before you proceed. You may decide that these isolations **cannot** be carried out on live plant, or that additional precautions will reduce risk to acceptable levels.



**Notes for Figure n:**

- (1) 'Screening' question to address tolerability of risk, based on consequences of failure.
- (2) Category I - positive isolation; category II - proved isolation
- (3) e.g. for short duration work
- (4) The more secure of industry practice + risk-based selection tool (e.g. Appendix 5)

**6.2.4 Risk reduction measures**

102. Consider preventive measures such as:

- reducing pressure;
- reducing inventory;
- detailed planning of the work to minimise the duration of exposure to broken containment and to reduce the duration of the isolation;
- restricting incompatible or non-essential work nearby;
- restricting access around the worksite by barriers;
- reducing the numbers of people working on the plant;
- monitoring the isolation more frequently; and
- increasing supervision.

103. Contingency plans for planned isolation activities should include any necessary additional measures beyond your standard emergency arrangements for loss of containment incidents. You should ensure that any loss of containment can be:

- identified rapidly - by personnel, gas detectors etc;
- stopped rapidly - by identifying upstream valves for securing isolation, in particular valves which may be remotely operated <sup>(10)</sup>; and
- contained - by kerbs, bunds, temporary bunds with sandbags etc.

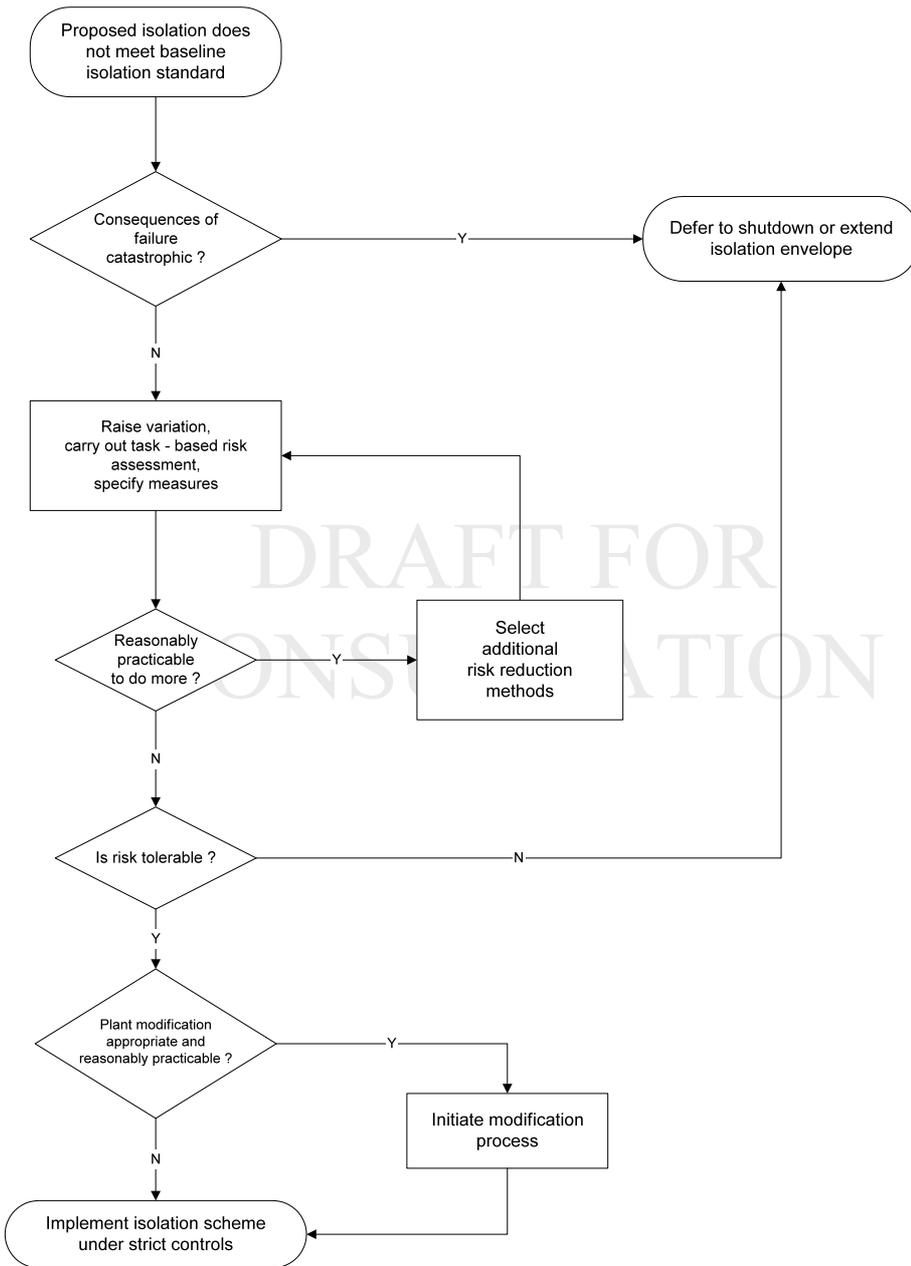
104. Your contingency plans should also include arrangements:

- to allow the work party to escape safely in an emergency;
- to move people away from the potential hazard (arrangements for evacuation, mustering etc); and
- to communicate necessary action to other parties - e.g. shut down of adjacent plants.

**6.2.5 Risk assessment of variations**

105. If you cannot meet the baseline isolation standard, the flowchart in Figure Z can help to establish whether use of a "variation" is acceptable.

FIGURE Z: Selection process where proposed isolation does not meet baseline isolation standard



106. You should have a risk assessment and authorisation process to consider any 'variations' (proposals to deviate from baseline isolation methods) and risk-reduction measures. Those authorised to approve such variations should:
- be of an appropriate seniority within your organisation;
  - have the technical competence to review the risk assessment (for example equivalent to the 'technical authority' who set the company standard); and
  - have operational independence from those proposing the isolation scheme.
107. Use of a variation from the baseline standard of isolation should be clearly indicated and explained on the isolation certificate and signed by the person authorising use of the variation.
108. Your risk assessment should systematically identify the isolation failures that could lead to loss of containment. Consider alternative ways of carrying out the overall task and identify the lowest risk option. Take into account:
- the potential consequences in the event of isolation failure to people, the environment and plant and equipment; and
  - the likelihood of failure of each type of isolation.

#### **6.2.5.1 Variations due to physical restriction of plant**

109. The layout or condition of your plant may restrict your ability to safely install or use baseline isolation standards. Plant modification should be considered in these circumstances, as discussed below in paras 114 - 115.

#### **6.2.5.2 Variations from positive isolation requirements for short-duration work**

110. The time needed to install and remove a positive isolation can be substantial. For some short duration work this exceeds the time to carry out the intrusive work and the main loss of containment risk may be associated with the installation and removal of the isolation.
111. You should consider the overall risks of undertaking the activity using positive isolation, including the risks associated with installing and removing this isolation. Compare this to the overall risk if a less secure isolation method is used for the intrusive work and select the lowest risk option.
112. For short-duration work variations:
- completion of the intrusive work should take less time than is needed to install and remove the final isolation;
  - the work should not extend beyond one operating shift;
  - the work instruction should specify the required contingency action if intrusive work does over-run the single shift (reinstate the plant or install a positive isolation);
  - prove each isolation valve to be leak-tight before starting the work, and monitor for leakage during the work activity;

- the work site should not be left unattended. This allows prompt remedial action if a leak develops; and
  - remedial action to bring any leak under control should be understood and necessary equipment available.
113. The most common tasks associated with short duration standards are the removal of instruments for repair or testing, and the changing of e.g. filter elements or control valves. Typical categories of short duration work on pumps are:
- packing of glands;
  - removal of couplings;
  - replacement of mechanical seals; and
  - change of lubricant.

### Considerations where variations are required

114. When a variation from the normal level of isolation is required for work on a plant, you should consider improving the isolation facilities at the next available opportunity. No modification should be carried out until you have assessed the potential consequences (looking at the implications for the plant as a whole, not just at the specific isolation activity) under your change control procedure.
115. Plant modification to enable safe isolation is not always desirable or appropriate. Some situations will always require plant shut down prior to intrusive maintenance. For example, you should assess with great care any proposed modification to permit isolation of protective devices, where no isolation was previously permitted. Modifications should not reduce the inherent safety of the plant.
116. Where modification will reduce risk, it should be carried out unless the costs would be grossly disproportionate to the risk reduction. If work will be carried out on a repeated basis, this will shift the balance of risk reduction and cost towards plant modification.
117. Previous authorisation of a variation does **not** justify its use for future interventions. Repeated use of a variation is acceptable only where your decision not to upgrade to the required standard is based on risk assessment or on reasonable practicability. Record the basis for such decisions. You should review the decision each time the variation is proposed (taking into The use of variations from company standards on a plant should be regularly monitored and audited. Relevant matters to scrutinise include:

### for variations

- the proportion of isolations carried out at lesser security than company policy;
- full compliance with a variation approval process;
- whether an alternative system of work could avoid the use of a less secure isolation method; and
- whether costs/circumstances have altered the validity of the original ALARP decision; and

### for retrofit actions

- that the wider implications of any proposed change are fully assessed prior to implementation;
- that an improvement system/plan drives plant retrofit;
- that there is a phased/prioritised programme of modification; and
- how often an isolation is done at the lesser security before being remedied.

## 6.3 PLANNING AND PREPARATION OF EQUIPMENT

### 118. Adequate planning:

- enables task-specific risk assessments to be made and actioned;
- identifies whether a larger section of the plant might need to be shut down or the work deferred;
- involves sequencing and coordination of intrusive work with other plant operations;
- includes a 'walk the plant' step, to check that the installation matches the P&ID and, especially, that all isolation points have been identified and are accessible/ in operable condition, etc;
- ensures job documentation such as risk assessments, method statements, permits and isolation certificates are prepared and coordinated, for example by the assembly of work 'packs'; and
- enables all necessary tools, equipment, materials, etc (including any additional personal protective equipment required for those installing and removing positive isolations) to be available at the work site at the start of the job.

119. Where operation of other parts of the plant can affect the integrity of an isolation, you should prevent operation of relevant systems as part of the isolation procedure. The effect of such inhibition of plant operation should be clearly understood and communicated to **all** parties operating the plant **before** the isolation is installed.

120. Company standards should set out your arrangements for assessing, authorising and controlling overrides to safety-related systems (e.g. emergency shutdown systems) during isolation activities. Any such overrides, and any additional safety measures required while these systems are shut down, should be justified by risk assessment. You should not disable fire and gas detection systems and emergency shutdown systems simply to prevent spurious shutdowns. Inhibition may be appropriate, for example, where the operation of a fire-fighting system (e.g. use of carbon dioxide or inert gas in a confined space) during isolation/intrusive activity would put workers at risk.

## 6.4 INSTALLATION OF THE ISOLATION

### Stages of isolations

121. Installation of isolations can, in practice, involve two stages:
- an initial isolation; and
  - a final or full isolation
122. The **initial isolation** is a valved isolation of relatively short duration, which enables the insertion of a positive isolation **after** the plant that is downstream of the initial isolation has been depressurised and purged. The valves need to be secure and to provide a tight shut-off. You should consider the safety of this initial isolation scheme when selecting your final isolation method.
123. The **final isolation** secures those carrying out the intrusive work, and those who might otherwise be affected, from a release of substance from the plant during the intrusive activity. Workers breaking into the system to install physical isolation will require suitable personal protective equipment to mitigate against any undetected failure of the initial isolation or trapped pockets of vapour between the valve and the flange.
124. Use suitable blank flanges, plugs, etc to close off any open pipework. These should be appropriately rated and properly installed with the correct gaskets and securing bolts so that they can withstand the system pressure, if required, without leaking. Flange joint bolts should be tightened in accordance with good engineering practice <sup>(1)</sup>. Devices used to seal the ends of open pipework to enable pressure testing, or specialised systems such as pipe freezing to provide local isolation require specialised assessment. These are included in the range of isolation methods described in appendix 6.

### Securing isolations

125. Isolations must remain secure through the duration of the intrusive task. The **degree of security** required for an isolation will be **proportionate to the risks** resulting from its removal.
126. Wherever practicable, use locking arrangements or barriers to physically prevent accidental or unauthorised removal of the isolation. The need for security is greatest where a single action (for example opening a valve) leads to the release of a hazardous fluid.
127. Some valve types are more susceptible to inadvertent opening than others. For example, a ball valve can be knocked open, especially where it is easily accessed. Always physically disable and secure (by removal of handle, padlock, etc) valves which require only a 90° movement between shut and open.
128. Table nnn outlines a range of methods for securing isolations. More complex systems such as trapped key interlocked systems are available, as are systems that allow a number of people in a multi-disciplinary work group to apply individual locks. Your procedures should specify the systems to be used and the arrangements for administering and auditing them.

#### An example

A section of flowline had been isolated from an oilwell using an actuated master valve on the wellhead by shutting the hydraulic control valve on the wellhead panel. While the flowline was being flushed with water, the master valve opened when an operative inadvertently operated the control valve. The low-pressure hose used for flushing burst, resulting in a release of hydrocarbons.

#### An example

During reinstatement of two valves the system was isolated by a single valve isolation. The blanks for one of the valves were removed and no pressure was evident. The joint faces were then cleaned with emery paper before reinstating the valve. When the operator was inspecting the groove in the joint face he had been cleaning, he caught the handle of the isolation valve, causing it to open. A release occurred.

Table nnn: Methods of securing isolations

Level of security	Methods	Typical application	Comments
Most ↑	<input type="checkbox"/> Locking system with secure key control <input type="checkbox"/> Removal of actuating mechanism	<input type="checkbox"/> Offshore <input type="checkbox"/> Onshore high risk activities <input type="checkbox"/> Remote locations	<input type="checkbox"/> Access to keys/actuating mechanism controlled separately to work party, e.g. by a <i>lockout box</i>
↓	<input type="checkbox"/> Locking system, e.g. chains or cables to secure valve, with tagging reference to permit <input type="checkbox"/> Handwheel covers	All locations	<input type="checkbox"/> Work party has access to keys <input type="checkbox"/> Effort by others to defeat the barrier depends on the material (a plastic tie can be more easily cut through than a metal chain)
Least	Tagging only	Where there is tight control of the isolation point/work area and lower process hazards	<input type="checkbox"/> No security – procedural control only <input type="checkbox"/> Requires constant attendance of the work party <input type="checkbox"/> No control of the isolation independent to the work party - may be appropriate for certain 'own-isolation' tasks

129. Where a remotely actuated valve is part of an isolation scheme, the valve should be prevented from inadvertent operation on command. Isolate the control system input **and** physically disable the primary power source for the actuator to an equivalent level of security as for a manual valve in that situation, e.g. removal of the fuse from the supply to a motor driven actuator. Appropriate controls will allow for both:
- the nature of the valve (actuated); and
  - the remoteness of the valve
130. All plant and equipment relating to an isolation should be clearly identified on the work site. Permanently label valves. Fully document all isolation points, including bleeds and spades, and reference these within the work control system to ensure the correct position and sequencing of all the components associated with an isolation scheme (e.g. the position of vents, the removal of physical isolations). This is in addition to full checks at the work-site.

131. Attach an isolation tag to each component of an isolation scheme, including bleeds and spades. This checks that all necessary isolations are in place and gives a visual indication that a device is in active use as a means of isolation. Tag numbers should match the line diagrams in the isolation documentation.

## 6.5 DRAINING, VENTING, PURGING AND FLUSHING

132. Where systems contain hazardous substances, remove the bulk contents and, as necessary, cool and clean away residual fluids and any solid deposits before breaking containment. Bleeds or vents are pipework connections that allow fluid to be drained or depressurised from the system. They enable safe depressurisation of parts of the plant and are necessary to check the integrity of isolations. Inadequate provision and siting of bleeds or vents may compromise the safety of an isolation.
133. Venting and draining will be required prior to installation and testing of an isolation where:
- a positive isolation is installed/removed. This intrusive work will require prior valved isolation, venting and draining; or
  - the isolation method, e.g. double block and bleed (DBB), requires removal of the fluid to prove integrity of the isolation.
134. Hazardous substances should be removed without:
- overloading the drains and/or vent systems;
  - inadvertent/uncontrolled ingress of air into pipework and equipment;
  - formation of ice/hydrates; or
  - creating a vacuum in vessels not designed for the purpose.
135. Information on the hardware and safe systems of work for draining, venting, purging and flushing (DVPF) is included at appendix 8.
136. The required level of cleanliness determines the necessary extent of purging and flushing. This depends on the substance concerned and the nature of work to be carried out. For example, very stringent control is required where intrusive hot work is to be carried out on systems that have contained flammable substances <sup>(9)</sup>. The hazards from each job will determine the precautions. These are likely to include a combination of:
- depressurise to atmospheric pressure;
  - cool;
  - drain;
  - water flush and/or fill;
  - nitrogen purge;
  - others such as air movement, high pressure water jetting, back flushing, detergent wash; and
  - demonstrating less than 1% LEL internally, immediately before the work starts.

137. Your work control documents should record:
- the hazards related to carrying out DVPF and the necessary risk-reduction controls;
  - the level of isolation necessary to allow DVPF activities; and
  - the required level of cleanliness and how to show/test that this has been reached.
138. Specify arrangements for control, calibration and checking of test equipment in your procedures. Where necessary, ensure that gas-testing equipment is suitable for use after purging (i.e. that measurements will not be adversely affected by the presence of inert gas or depleted levels of oxygen).
139. When testing plant and pipelines to prove that they are totally gas or vapour-free, ensure that a representative sample is taken. For large items of plant, you may need top, middle and bottom samples to ensure that no light or heavy gases remain.
140. Testing of pipelines requires special care, as the point of isolation may be some distance from the sampling point. In such circumstances you should consider installing a sample point closer to the isolation point to verify its gas or vapour-free status.

## 6.6 TESTING AND MONITORING EFFECTIVENESS OF THE ISOLATION

141. Prove the integrity of **all** isolation points of an isolation scheme **before** proceeding with intrusive work:
- each part of the isolation needs to be proved separately, e.g. prove each valve in a double block and bleed scheme;
  - each part should be proved to the highest pressure which can be expected within the system during the work activity. Particular care is required when there is a low differential pressure across valves where the sealing mechanism is activated by pressure; and
  - where possible, each part of the isolation needs to be proved in the direction of the expected pressure differential.
142. For a **positive isolation scheme**, there are 2 stages of testing. Prove both the initial valved isolation and the final isolation.
143. Your procedure for installing the isolation should clearly specify the arrangements for proving the isolation, the test success criteria and, for positive isolations, the pressure to be applied (further discussed in paras 157-161).
144. Do not rely on an isolation that is unproved because the facilities are not present, or where you lack confidence in the test. Extend the isolation boundary or defer the work until shutdown. You should also consider plant modification to install facilities for testing of that isolation point in future (nb the considerations in paragraph 113).
145. The flowchart at figure xx steps through the process of testing and outlines next actions if the isolation point fails the test.

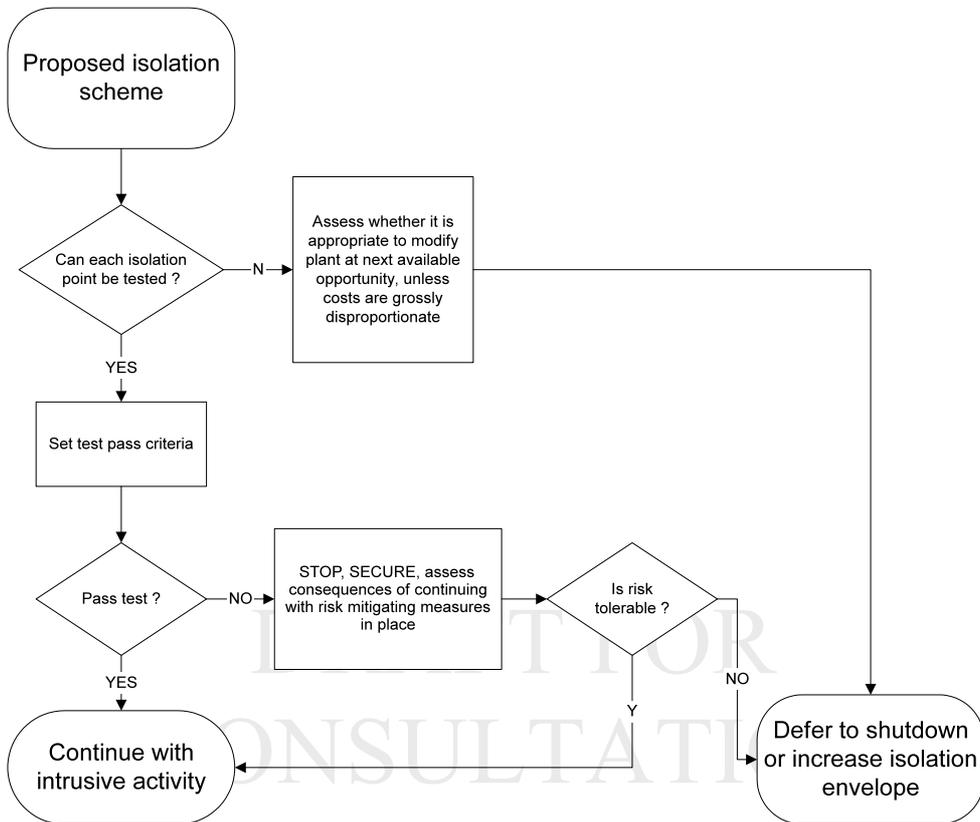


Figure xx: Procedure for testing isolation

146. Fluids which have the potential to foul or plug small bore pipework can lead to false results (for example the use of drain valves to verify depressurisation may give a false result due to blockages in the drain line). You may need to flush small-bore pipework to prove that it is clear. Clearance of blockages is a specialist area and should be attempted only by those who have sufficient expertise.
147. Isolation and proving can be made more difficult by e.g.:
- viscous fluids, particularly if they solidify at temperatures near ambient;
  - 'dirty' services where debris, residues, scale, etc may have settled into drain lines or into valves, preventing seating; and
  - hydrates (certain mixtures of hydrocarbons and water). These can form an ice-like solid at certain pressures and temperatures, blocking valves and pipework. Pressure tests may then give misleading results. Subsequent melting of the hydrates can lead to release of any trapped pressure.
148. Care is needed when you use pressure gauges to confirm the absence of pressure or leaks.

**Pressure gauges**

When using pressure gauges while depressurising plant, consider the following points:

- pressure gauges are reliable indicators of the existence of pressure but not of complete depressurisation. Check an open vent or needle valve for final confirmation of zero pressure before breaking into the system;
- pressure gauges normally give accurate indications only over the middle part of their range and gauges designed to measure high pressures often give poor pressure response at low pressures. If you use pressure gauges to monitor plant blowdown or to check isolation integrity, two gauges with different ranges may be necessary – the procedures should protect a low pressure range gauge; and
- you should prove pressure gauges before use by testing against a pressure source.

149. The integrity of the isolation should be demonstrated to the people carrying out the intrusive work. Immediately prior to breaking containment, a competent person should prove that there is no leakage and pressure build-up within the isolation envelope, for example by gas tests in two places immediately behind the point of intrusion.

**Monitoring**

150. Monitor the integrity of isolations during the work period. Re-prove isolations that will remain in place for longer than one shift or which have been left unattended. Determine the frequency of monitoring and re-proving by risk assessment, and specify this frequency within your procedures.
151. Use bleeds or vents to confirm that there is no leakage past the isolation, by periodically checking for any pressure build-up in the space between the elements of the isolation. For hazardous process fluids, ensure that you route vents and drains to a safe place or safely contain any leakage.
152. Pressure gauges should be fitted where a cavity is bled/vented and may also be needed in other situations. They should have a suitable range and sensitivity to detect pressure build up.
153. Blank flanges should have suitable vents to enable pressure trapped behind them to be detected and safely vented.

**Position of bleed valves etc**

154. Bleed valves connected to a closed live header or drainage system should remain in the **closed** position throughout an isolation, so that:
- the isolated space cannot be pressurised from the live system, should the disposal system become pressurised due to other operations/incidents; and
155. Any leakage through the isolation valves into the space downstream of valves can be Open the bleed valves only to check the continuing integrity of the isolation point. You should then re-close the valves and re-establish the bleed position.
156. **Justify in your risk assessment any other intended position of a bleed valve** (eg kept open to a fixed disposal system, where a known amount of fluid is passing the isolation). Relevant factors include:
- the inherent hazard of the fluid;

- the fluid state;
- the type of collection or disposal system available;
- the location of any open end of the bleed or vent in relation to the work site;
- the ability to detect any leakage; and
- the level of confidence that the isolation valves are not leaking and can withstand overpressures which may develop from other parts of the system.

### Proving the isolation

157. The integrity of isolation valves can be proved where appropriate vent/ bleed valves are provided. You should aim to achieve zero leakage past valves by ensuring that they are correctly selected for service and subject to an appropriate maintenance regime.
158. If testing fails to confirm a satisfactory isolation, reinstate the isolation points to a safe condition, secure them and reassess the situation. You may need to shut down a larger section of plant to achieve a satisfactory isolation.
159. Isolation valves do not always provide a leak-tight seal. In such cases, for isolation integrity to be proved, the isolation point must not let past more than a specified quantity of fluid over a defined period of time. The acceptable 'passing' criteria and period of time will depend on the substance concerned and the piping volume available for pressure build up. You should define these criteria within your procedures.
160. Any decision to carry out intrusive work with a known leakage rate is acceptable **only** if it is based upon a specific risk assessment. Your assessment should include the following issues, where relevant. These should be satisfied before work starts:
- the leakage does not impinge on the worksite, or cause additional hazard to either personnel or plant;
  - the leakage can be safely disposed of away from the worksite. Depending on the nature and hazard of the fluid (and on which element of a double valve isolation is leaking), this may include:
    - providing adequate catchment under the open pipe end;
    - fitting a blank capable of retaining full system pressure with venting/bleeding facilities to the open pipe end;
    - ensuring that any interconnecting space (for example between two valves) is vented and drained at appropriate intervals to avoid pressurisation, taking into account risks associated with repeatedly draining the fluid; or
    - special arrangements such as establishing a continuous purge;
  - The leakage rate can be monitored – where an isolation valve shows a small degree of leakage, over time this leakage is likely to increase. It may be appropriate to appoint a person to stand by, who has the authority to stop the work if the leakage rate exceeds pre-determined acceptable levels, and who is independent of the work party;

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- You have a contingency plan to make the equipment safe (e.g. by upstream isolation or remote shutdown of the plant) in the event of a sudden and/or significant increase in leakage rate; and
  - The maintenance team are aware of the potential for sudden release of system fluid and the necessary emergency actions.
161. Use of a single valve isolation which cannot be shown to be leak tight, or a double valve isolation in which both valves are passing, should be proposed only in exceptional circumstances. This is likely to be justifiable only for non-hazardous fluids (for example during repairs on a firewater pump where an isolation valve passes water into a non-confined worksite, it might be better to continue rather than to isolate a portion of the firewater mains system, thus reducing firefighting capability).

## 6.7 REINSTATEMENT OF THE PLANT

162. Recommissioning requires equivalent controls to those used during installation of isolation. Where work has been controlled under multiple permits, dependent on common isolation points, it is critical to define the sequence of plant reinstatement.
163. Controls should include a cross check of all other permits in force and their related isolations (including instrumentation isolations), to confirm the safety of other work following plant reinstatement. Ensure that any plant control and protection systems functions that were overridden for the purposes of the isolations are restored to their normal condition.
164. Take care when removing a positive isolation. Hazardous substances can build up behind the blank or spade if a valve leaks. Always check vents or drains before the spade or blank is removed. If you detect a leak behind the isolation, resecure the vent or drain and stop work until a safe system for the removal is in place.
165. Use isolation certificates to log all disturbed items on a plant and to control their reinstatement. Reinstatement and recommissioning of plant must be properly planned, to include:
- confirmation of plant integrity before removing isolations; and
  - identifying the effects of removing the isolation and restarting plant on other isolations and systems.
166. Systems and procedures that assure the full reinstatement of the plant and the integrity of the process area include:
- control of all disturbed joints; <sup>(1)</sup>
  - blank/ blind register to control removal of blank/ blinds for isolation, purging, flushing, pressure testing etc;
  - purging procedures and records;
  - quality assurance controls on maintenance hand back of intrusive activities during shutdown;
  - full visual system check by operations personnel against the system P&ID and check that no isolation tags remain on the plant;

- system service testing and leak testing records and procedures;
- full visual valve position (open, shut, locked, free) check against plan for start up; and
- additional monitoring after recommissioning.

# DRAFT FOR CONSULTATION

## 7 SAFE SYSTEMS OF WORK FOR ISOLATION ACTIVITIES

### 7.1 WORK-CONTROL SYSTEMS

#### Permit-to-work

167. Permit-to-work (PTW) systems are used to authorise work of a hazardous or non-routine nature on a plant. Comprehensive guidance has been published by OIAC in *Guidance on permit-to-work systems in the petroleum industry* <sup>(12)</sup>. Control of isolations is normally part of a PTW system.

#### Controlling work by procedures

168. Some sites may define categories of less hazardous work of a 'routine' nature and authorise these via operating procedures/work instructions, for example a T-card system.

169. In **highly prescribed** circumstances, this procedurally-controlled work may include isolation activity. This might typically cover repetitive tasks of very short duration work, and the following conditions should be met:

- procedures are in place (derived from risk assessment) which set out standard conditions to be met on every occasion that the work is done;
- all control measures specified in the procedure are in place before start of work, otherwise the task is risk assessed and controlled via the PTW system;
- the work is carried out within the discipline that controls the work, e.g. sample-taking by operators;
- any work by a third party is under PTW control;
- the task does not compromise or conflict with any other activity being carried out in the operating area;
- the work is short duration, i.e. less than one shift, otherwise a handover procedure is required; and
- there is suitable access installed to each isolation point.

170. This type of work control is **not** appropriate where a task cannot be fully defined or where the task impacts on the process, e.g. involves removal of process indication, control, alarm or trip functions.

### 7.2 DOCUMENTATION

#### Sources of information

171. Company standards, procedures and reference information should be accessible to all relevant workers (including short-term contractors) involved in planning and conducting the work.

172. Accurate reference information, kept updated to all plant modifications, is necessary for planning and implementing isolations. This includes:

- piping and instrumentation diagrams (P&IDs);

- process system schematics - unlike a P&ID these provide an overall view of the plant;
- piping general arrangements and/ or piping isometrics
- cause and effect diagrams; and
- loop diagrams.

173. A 'library' of standard isolations schemes for high risk and/or frequently used isolations may be developed and maintained. These schemes should be reviewed on **every** occasion that they are used.

#### Paper 'tools' – certificates, work packs, etc

174. For all but the simplest plant, isolations should be checked against the current P&ID for the plant and marked on a suitable copy of the P&ID. If the current P&ID does not match the installation, the isolation requirements should be reassessed and confirmed on a corrected P&ID, and the schematic should be formally revised and re-issued at the earliest opportunity. Process system schematics can be useful to identify the actual location, within a system, of the areas to be isolated.

175. Isolation certificates should be used in situations where the isolation work required is not detailed on the PTW itself. Certificates should be designed for ease of understanding and use, and to support the main permit. Certificates and permits should be cross-referenced.

#### An example

A compressor was isolated for maintenance. A small blank was removed to prove that it had been depressurised. This blank was not recorded on the compressor isolation certificate. It remained open throughout the job. On reinstatement the blank was missed. A gas release occurred when the compressor was recommissioned.

176. A certificate may show more than one isolation, but it will often be clearer if separate certificates are used for different isolation disciplines (e.g. mechanical, process, electrical, and inhibits of control and safety systems).

177. Isolation certificates should allow for more than one person performing isolations within the same discipline. If separate isolation certificates are issued to cover different disciplines, they should be cross-referenced and closely co-ordinated. This is particularly important where sequencing is safety-critical. Competent people of the relevant disciplines should cross check the certificates to ensure that all isolation requirements and standards are met.

178. Work packs can bring together documentation that relates to the whole work task in a useable form for the work party and for those who are controlling and coordinating the work.

179. Records of work documents (risk assessment records, method statements, permits, isolation certificates, etc) should be maintained on site for a specified time after completion and then archived, to enable effective monitoring, audit and review of the isolations systems.

### 7.3 CONTROLLING INTERACTIONS WITH OTHER WORK/SYSTEMS

180. Effective communication at all levels and between all parties is required, particularly at shift handovers. On most plants, handover will be part of the PTW system and/or shift handover logbooks.
181. Your controls should ensure that isolations are not removed until the plant is in a safe condition. Robust coordination and control of isolations is required when separate work groups rely upon a common isolation, especially where workers are remote from any of the isolation points. This should be administered via the permit to work system and controlled by multi-tagging and multi-securing arrangements.
182. In areas with multiple responsibility, you should ensure adequate control, security, monitoring and communication to maintain the integrity of isolations. This may be relevant:
- where the isolation envelope involves long sections of pipeline and the isolation points are remote from the actual work area and normally controlled by other parties;
  - within a plant, where responsibility for a piece of equipment and for the location of that equipment lie with different departments/ sections

### 7.4 CONTROLLING CHANGES

183. Any change to isolation arrangements should be reviewed, re-assessed and authorised (e.g. a proposal to extend the duration of a permit may warrant a higher level of isolation). The modified scheme should be captured in the work control documents (e.g. isolation certificates and P&ID's) to ensure full reinstatement at the end of the job.
184. Where work is suspended, those with operational control of equipment should ensure either that long-term isolations are put in place or that de-isolation/reinstatement is completed to allow subsequent plant or equipment start up.
185. Reasons for change to the planned isolation scheme include:
- changes imposed by the condition of the plant (e.g. a valve may be stuck open, the specified depressurisation and purging may not be achievable, or the testing of an isolation scheme may not give a satisfactory result);
  - changes to the scope of intrusive work as the work proceeds. The adequacy of the original isolation scheme must then be re-confirmed as part of the re-assessment of the new work scope. This may require suspension of the work and controlling permits until the reassessment is done and the revised isolation scheme installed;
  - inability to complete a job (e.g. due to an increase in the scope of work once it is underway, or the non-availability of spares). The adequacy of the isolation scheme over a longer duration should then be reviewed. Long-term standard isolations should be installed or, if appropriate, the plant or equipment de-isolated and reinstated to allow start up; or
  - a change in the system pressure e.g. where isolation has been applied under shutdown (depressurised) conditions and plant reinstatement is proposed which will increase the system pressure to levels outwith the isolation envelope.

#### Sanction-to-test

186. A sequence of changes in isolation status will arise from various testing requirements. You may temporarily reverse elements of an isolation scheme to confirm that work stages have been correctly completed (e.g. temporary reinstatement of the power supply to a fan motor to confirm correct direction of rotation). Typically, approval for sanction to test process is required at the intermediate stage of a work activity involving equipment function checks and or pre-start tests. Such 'sanction to test' requirements must be implemented via the controlling documentation such as work permits and task risk assessments. You should **not** use/authorise sanction to test where isolation removal would permit reintroduction of the hazardous fluid.

#### Leak/service test

187. Checks on overall plant integrity following major intrusive work (for example plant overhauls) may involve various types of pressure testing to confirm that the plant is 'leak tight'. These tests will involve further temporary changes to the overall isolation scheme. A very high standard of control over the final de-isolation will be required, following the pressure test.

### 7.5 ARRANGEMENTS FOR LARGE-SCALE ISOLATIONS

188. Special arrangements for the isolation of a plant or section of plant may be used for intrusive work when that plant is shutdown. Security of isolation of the plant from adjacent 'live' systems should equal, or exceed, the normal site isolation procedures.
189. '**Boundary isolation**' is the insertion of fully pressure rated spades or spectacle blinds at every point of the plant boundary (the 'battery limits'). Typically, such isolation is used on plant maintenance shutdowns or 'turnarounds' where the inventory of hazardous fluids is removed. Full physical isolation of the boundary prevents re-pressurisation of the system by any adjacent live process systems.
190. After boundary isolation and inventory removal, arrangements for equipment isolation (for each intrusive activity) will include:
- installing a local isolation, to ensure full separation from any residual hazardous material that may be trapped within the plant; and
  - local de-inventory and gas test.
191. In practice, the geographical area of a boundary isolation may contain live pipework (e.g. utility systems which feed adjacent plant). You should ensure that those working in the area are fully aware of the presence and live status of such systems.
192. A staged installation of the boundary isolation can allow fluids to be processed out (for example, flare headers are normally the last system to be isolated as they are the primary route for de-inventorying and gas freeing the plant). Until the full boundary isolation is in place, you should control any intrusive work on an item of equipment under normal site isolation procedures and a fully pressure rated spade should be inserted on that equipment.
193. Additional isolation and de-isolation activity within the shutdown boundary will be needed where temporary connections into systems are required for nitrogen purging, pressure testing, etc. Rigorous arrangements are necessary to assure full reinstatement of all disturbed elements of plant. The integrity of systems within the boundary isolations should be proved prior to removal of the boundary isolation.

### 7.6 EXTENDED TERM ISOLATIONS

194. Record within the PTW system, or an equivalent record of plant status, any isolations which are to remain on the plant after work is complete.
195. 'Extended term' isolations (e.g. parts of plant which have been mothballed) should be marked on the P&IDs for the plant. These should be positively isolated. Consider the need for measures such as nitrogen purging and for additional controls such as:
- a register which identifies all such isolations and the reasons for isolation;
  - a system to periodically check the status and integrity of each isolation; and
  - periodic review of the status of each item to decide if the isolation is still appropriate, whether the equipment should be permanently removed etc.

## 7.7 OWN ISOLATIONS

196. PTW arrangements usually assure the **separation** of isolation activity and intrusive work. For strictly controlled and prescribed categories of work, which are low risk and present limited release potential, alternative arrangements may be put in place, where the **same person** makes the isolations and performs the work ('own isolation'). Typically, this applies to repetitive tasks of very short duration work.
197. It may be necessary to independently check the isolations and subsequent reinstatement, to prevent inadvertent error where the consequences of error may be safety critical.
198. Own isolations normally fall into the following types:
- Routine plant operator activities, for example;
  - removing, cleaning and reinstating filters from pressure envelopes;
  - process sampling.
  - **Third party maintenance** of specialist vendor kit; and
  - Isolation of **instrument systems** for maintenance where these are designed to be isolated from process plant streams (Appendix 9). Typically this might include transmitters, impulse lines, sight-glasses, analytical instruments and gauges.
199. Own isolations may be carried out under PTW or may be procedurally controlled. Work which affects process control and/ or safety systems (e.g. involves removal of process indication, control, alarm or trip functions) should **always** be carried out under PTW. Work control by procedure is also inappropriate where a task cannot be fully defined.
200. Own isolations require that:
- isolation, intrusive work and reinstatement are carried out by the same person;
  - that person is competent to perform the isolation, to undertake the task and to reinstate the equipment;
  - the isolation is under the control of the competent person, who is continuously present at the work site while the pressure envelope is breached;

- the isolation points are identified and secured unless they are all within sight/reach of the 'own-isolator' (who must then remain in attendance for the duration of the work); and
- communication with control room or operating unit is available throughout the task (e.g. by radio).

201. In addition, for own isolations performed by competent Instrument Technicians:

- the permit-to-work will identify any potential residual risks and specify the appropriate control measures, including mitigation measures in case of loss of containment.
- relevant control room operators should be involved in PTW authorisation for work on systems which impact on safe control of the plant e.g. instrumented safety-related functions and many process control functions; and
- independent checking of reinstatement is necessary where failure to reopen an isolation valve after completion of instrument work might defeat a safety related function, and this may not be self-revealing.

**An example**

During preventative maintenance an instrument technician carried out some local isolations to remove a number of pressure gauges. He took these to the instrument workshop. Approximately 1 hour later an operator noticed a smell of gas. The instrument technician had failed to cap the open end of the pipework. It is assumed that there had been a blockage in the pipework that subsequently cleared.

# CONSULTATION

## APPENDICES

### Appendix I Non-process isolations hazards

1. Any inadvertent movement of machinery or sudden release of potential energy in mechanical, electrical or pressure form is a hazard to workers.
2. You should ensure coordination and sequencing of all the necessary forms of isolations. The electrical isolation of equipment is closely linked with its process/mechanical isolations. These may be applied by different workers/ disciplines.

#### Hazards associated with mechanical machinery

3. Isolate hydraulic, pneumatic and process powered machinery by closing the appropriate isolation valves. Prevent any possibility of movement of the machinery by disconnecting the supply and return pipes, or otherwise making safe.
4. Isolate engine driven machinery by shutting off the engine fuel supply and then isolating all the starting systems. For electrically driven machinery, switch off the power supply to the motor and ensure that the equipment is securely disconnected and separated from all sources of electrical energy.
5. Any residual mechanical, electrical or pressure energy which may be locked within any part of the machinery mechanism should be safely released as follows:
  - a. **mechanical** – high and low speed rotating elements need to be run down and springs released;
  - b. **electrical** – capacitors should be discharged and batteries disconnected and/or removed;
  - c. **hydraulic** – accumulators and pressurised pipework should be depressurised;
  - d. **pneumatic** – air from the system should be depressurised;
  - e. **services** - steam, gas or fuel may need to be depressurised, vented, purged or drained.
6. Even after disconnection of machinery power systems, or prevention of engines/motors from starting, there may still be a risk for people working on the machinery if it were to move (e.g. due to gravity). If so, fit a device such as a properly engineered *chock* or a *scotch* to lock the machinery in a safe position.

#### Hazards associated with electrical equipment

7. Hazards to workers include electric shock, electrical burns, and electrical arcing resulting in the ignition of flammable gas, vapours or materials. The provision of a safe system of work is fundamental to the effective control of risks. See *Memorandum of Guidance on Electricity at Work Regulations 1989*<sup>(13)</sup>, and *Electricity at Work: Safe working practices*<sup>(14)</sup>.
8. The main power circuit of the electrical equipment, plus any associated auxiliary circuits which constitute a hazard, should be electrically isolated. Disconnect and separate the electrical equipment from **every** source of electrical energy. Discharge any stored energy in the electrical circuits, taking particular care with batteries and capacitors.

9. Devices suitable for isolation include (see BS EN 60947 series of standards<sup>(15)</sup> for definitions):
- circuit breakers with the required contact separation and locking facilities;
  - disconnectors (commonly referred to as *isolators*) with locking facilities;
  - switch disconnectors with locking facilities;
  - plug and socket outlets;
  - fuse links; and
  - removable links.
10. You are advised to verify that all switching devices used for electrical isolation provide adequate separation of contacts, as some older devices do not provide for the proper separation.
11. You are strongly advised **not** to use miniature circuit breakers (MCB) as disconnectors because confirming a positive contact separation is generally not possible. In such cases, you should take alternative and/or extra measures to establish a positive air gap, e.g. disconnecting the circuit conductors, but only **after** you have proved them to be dead.
12. The opening of switches in the control circuits for circuit breakers, contactors and other electro-mechanical devices is **not** adequate to achieve electrical isolation. You should **not** use semi-conductor devices as a means of electrical isolation.
13. Secure the means of electrical isolation by locking in the 'off' position. Your control procedures should ensure that fuses or links that have been removed are held secure.

#### Radioactive sources

14. Radioactive sources are used for inspection and measurement purposes in various instruments. The source can normally be withdrawn into a shroud or housing in the instruments and this should be confirmed prior to carrying out nearby work by checking radiation dose rates. For extensive work, it may be necessary to remove the device to a secure source store to prevent it being damaged. See *The protection of persons against ionising radiation arising from any work activity*<sup>(16)</sup>.
15. Some onshore and offshore process plant and piping may contain low specific activity (LSA) scale. Build-up of scale can give rise to significant external radiation and if allowed to dry out may pose a risk of release and inhalation during intrusive work on that equipment.

#### Static electricity

16. Vessel cleaning using high pressure water, solvent or steam jetting can create static electricity hazards. The British Standard *Code of Practice for control of undesirable static electricity*<sup>(18)</sup> provides useful advice for jetting and other activities that might give rise to static.

## Appendix 2 Legal requirements

### Universal application

- Health and Safety at Work etc Act 1974
- Management of Health and Safety at Work Regulations 1999
- Provision and Use of Work Equipment Regulations 1998
- Control of Substances Hazardous to Health Regulations 1999
- Personal Protective Equipment at Work Regulations 1992
- Manual Handling Operations Regulations 1992
- Health and Safety (Consultation with Employees) Regulations 1996

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### Offshore

- Offshore Installations (Prevention of Fire and Explosion, and Emergency Response) Regulations 1995
- Lifting Operations and Lifting Equipment Regulations 1998 (part)
- Dangerous Substances and Explosive Atmospheres Regulations, 2002 (part)
- Offshore Installations and Pipeline Works (Management and Administration) Regulations 1995

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### Onshore

- Pressure Systems Safety Regulations 2000
- Lifting Operations and Lifting Equipment Regulations 1998
- Confined Spaces Regulations 1997
- Dangerous Substances and Explosive Atmospheres Regulations, 2002
- Workplace (Health, Safety and Welfare) Regulations 1992

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### On-shore major hazards

- Control of Major Accident Hazards Regulations, 1999

### Pipelines

- Pipelines Safety Regulations 1996

### Appendix 3 Valve types and issues

1. Select isolation valves carefully to ensure successful performance in service. Key factors are:
  - sealing ability;
  - security (potential for accidental or deliberate re-opening); and
  - reliability (potential for partial or total loss of seal).

The table at figure A outlines the characteristics of common valve types. Valve selection should always be determined by isolation circumstances.

2. Limitations on the use of valves with other primary functions for isolation purposes include:
  - Control or choke valves should not be used for isolation where there is a likelihood of wear leading to internal leakage.
  - Emergency isolation valves may be used for plant isolation, provided they are of a suitable type for the fluid and conditions being isolated
  - Relief valves may be used only if there is a purpose-designed method of securing the valve in the closed position **and** if it is possible to pressure test the valve to the maximum anticipated differential pressure in the direction of the applied pressure.
3. Valves will provide a tight seal 'on demand' only where you select:
  - an appropriate type of valve; and
  - trim materials compatible with the process fluid conditions (e.g. can withstand an abrasive fluid).

Valve selection should take account of accumulated experience of a particular valve/trim combination performing satisfactorily under specific process conditions.

4. Use commissioning tests to confirm the initial sealing performance of the installed valve.
5. Prove the leak tightness of a valve **every** time it is used for isolation.
6. A valve providing an isolation needs to be reliable. A high degree of confidence is required that, **once proven**, the isolation will remain tight for the required duration. Once a valve is proven to be leak tight, the likelihood of a small leak developing during the course of the isolation is low unless the isolation period is particularly long, e.g. several months.
7. Careful consideration is required before using valves which provide a double seal in a single valve body with a bleed in between (e.g. double wedge gate, parallel expanding gate or double seal ball valves) for isolation. In some applications, both barriers cannot be easily tested. Also, the security of the isolation depends upon the immobilisation of a single valve operating stem. Such valves should be used in preference to a double block and bleed isolation method **only after full consideration of these increased risks.**