Recommended practice for isolation when working on hydrocarbon systems

FOREWORD

A best practice for isolation when working on hydrocarbon systems was prepared in 2013 by a work group comprising representatives from a number of operator companies on the Norwegian continental shelf (NCS). This work group had been established as part of the hydrocarbon leak reduction project.

The hydrocarbon leak reduction project was revitalised in 2017, and the best practice was revised and updated. It was decided to change its title to "recommended practice", since room for improvement always exists.

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1 INTRODUCTION

1.1 Purpose

This document describes a recommended practice for planning, isolation and reinstatement when working on hydrocarbon systems. The practice provides guidance on the way each company establishes its own procedures and practices. It is also suitable for incorporation in the company's management system.

The practice is directed at the operations phase and normal operation. A company may have other practices for isolation during turnarounds and for major projects.

1.2 Definitions and abbreviations

Area/operations supervisor	The management function responsible for the area or the facility where work is to be done, and who will therefore be involved in approving the work. See Norwegian Oil and Gas guideline 088.
Area technician	The technician responsible for a specific area on a facility. This person will normally have a role in the work permit system.
Blinding	Isolation with the aid of a full-specification spade or blind (blank flange).
Double barrier and bleed	This term is used instead of "double block and bleed (DBB)" in this document, since the latter can be misunderstood.
Performing technician	Technician who will carry out the work activity.
Hydrocarbon system	System which contains or could contain hydrocarbons as defined by the companies themselves.
Isolation	Separating a plant and equipment from any and all energy sources, such as chemicals, pressure, electricity and mechanical energy, in such a way that the separation is secure.
List of break sections	A list of flanges, fittings, etc, affected by a work activity.
NCS	Norwegian continental shelf.
P&ID	Piping and instrumentation diagram.
PSV	Pressure safety valve.
Shall	Verbal form used to indicate a requirement in order to achieve the intention of the action.

Should	Verbal form used to indicate that, among several possibilities, this is the one recommended.
WP	Work permit.

1.3 References

- Norsok L-001, piping and valves, January 2017
- Norsok P-002, process system design, August 2014
- Norwegian Oil and Gas guideline 088 *Recommended guidelines for common model for work permits*
- PSA, *Principles for barrier management in the petroleum industry* – Barriers memorandum 2017
- *Best practice for isolation when working on hydrocarbon equipment: planning, isolation and reinstatement*, report, Norwegian Oil and Gas, May 2013

1.4 Prevention of major accidents

Preventing major accidents is a primary task for the industry, and the principles for this are described in the Norwegian HSE regulations and, in particular, sections 4 and 5 of the management regulations.

Reducing the probability of failures, hazards and accidents is a goal in normal operation. When faults, hazards or accidents occur, it is important to identify them quickly and prevent them escalating into a major accident. Barriers are established to reduce both the probability of hazards and accidents, and their consequences. See figure 1.

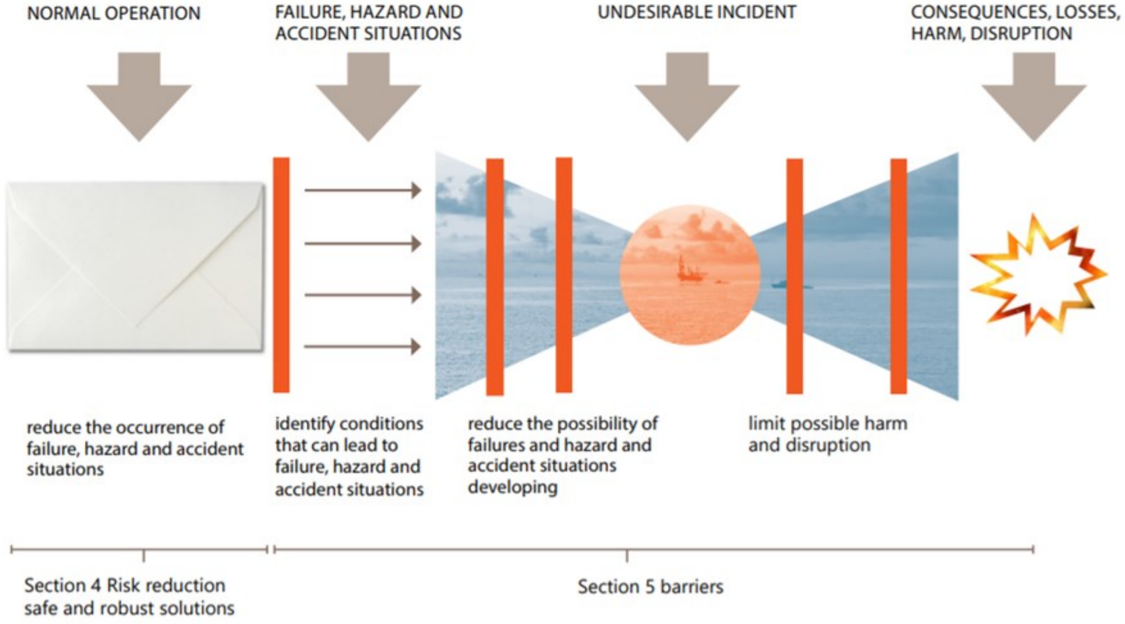

Figure 1 Traditional barrier diagram with barrier functions (in red) intended to deal with failures, hazards and accidents over and above normal operation.

Barriers mean technical, operational and organisational elements on a facility or at a land plant which individually or collectively are intended to reduce the opportunities for specific failures, hazards and accidents occurring, or to limit or prevent damage/ harm. Barriers aim either to prevent a specific chain of events from occurring, or to influence that chain in a way which limits harm and/or losses. Barriers fulfil their functions in the event of failures, hazards or accidents on facilities or at land plants, whether these could harm people, the environment and/or material assets. They can accordingly take the form of measures to prevent, stop and/or limit the spread of acute pollution, but can also include various emergency preparedness measures. See the guidelines to section 5 of the management regulations on barriers.

Attention in this document is concentrated on the way people contribute to the satisfactory functioning of barriers.

Hydrocarbon (HC) leaks have been a contributory factor in a number of major accidents, and preventing such events is an important priority for the petroleum industry in Norway. Analyses of the causes of HC leaks show that isolation failings have made a significant contribution. The number of incidents related to this cause also failed to decline markedly in 2000-15. See figure 2.

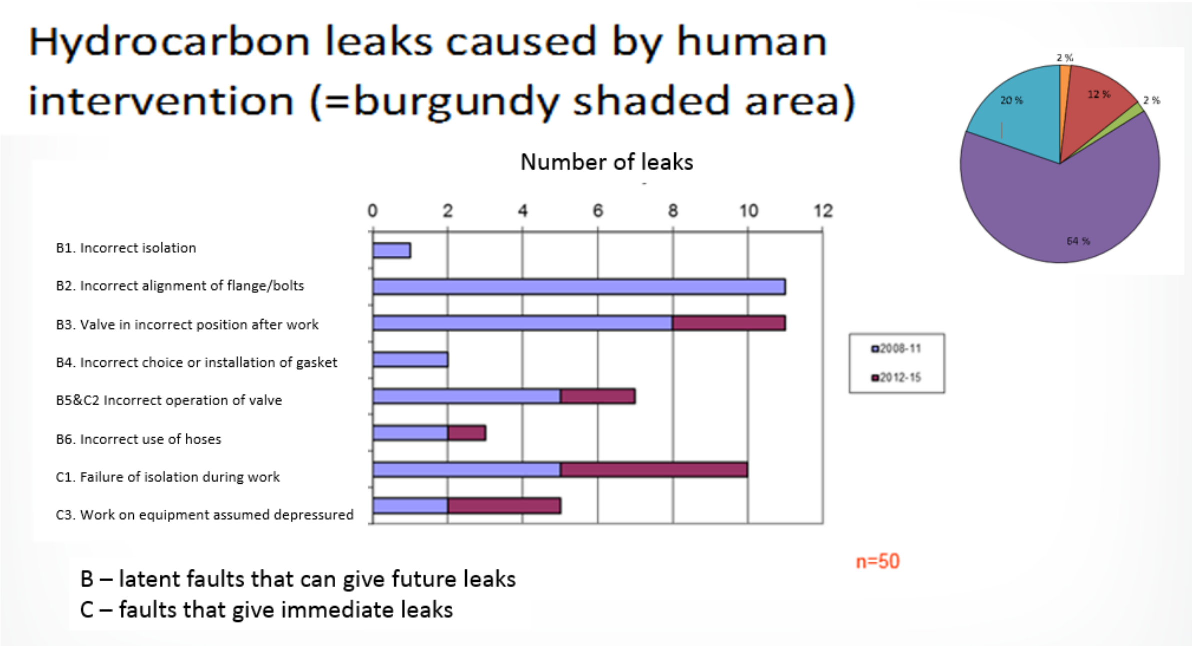

Figure 2 HC leaks in connection with manual intervention.

Norwegian Oil and Gas has analysed the direct causes of HC leaks above 0.1 kilograms per second (kg/s) on the NCS.

- Most HC leaks above 0.1 kg/s occur in normal operation, not turnarounds.
- Most HC leaks occur in connection with work on hydrocarbon systems .

- Technical faults in the equipment account for a significantly lower proportion of the leaks than human intervention.

Figure 3 shows HC leaks divided into five categories. Human intervention has accounted for 60-70 per cent of the leaks, and faulty isolation of hydrocarbon equipment is an important factor in these cases. This proportion has been stable over time.

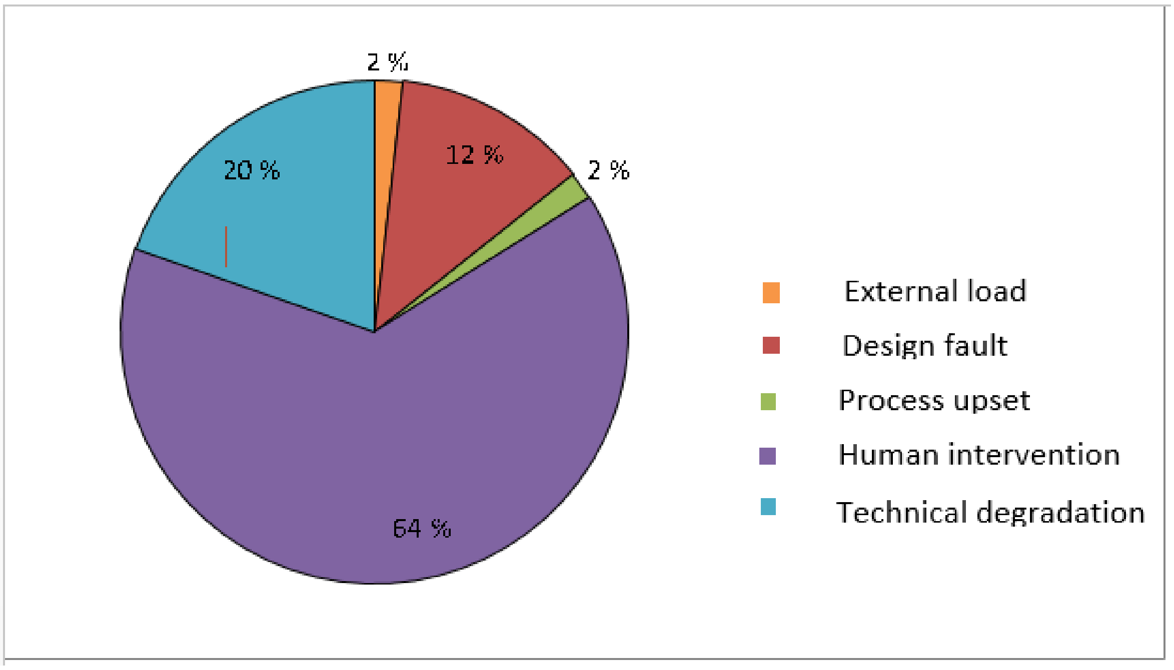

Figure 3 Reasons for hydrocarbon leaks greater than >0.1 kg/s.

2 ISOLATION

Before work can start on hydrocarbon equipment, it shall be isolated, emptied of hydrocarbons and depressurised. Isolation is intended to ensure that hydrocarbons cannot enter the equipment being worked on and get released to the atmosphere, either through leaks or because an isolation has failed – a valve being opened while the work is under way, for example.

When the work is finished, the isolations shall be removed so that the equipment can operate normally.

Isolation in connection with work on hydrocarbon systems can be divided into four main stages: planning, establishing isolation, carrying out the work activity(ies) and reinstating the system. See figure 4. Each main stage can be further subdivided into steps to ensure systematic and predictable execution of the isolation.

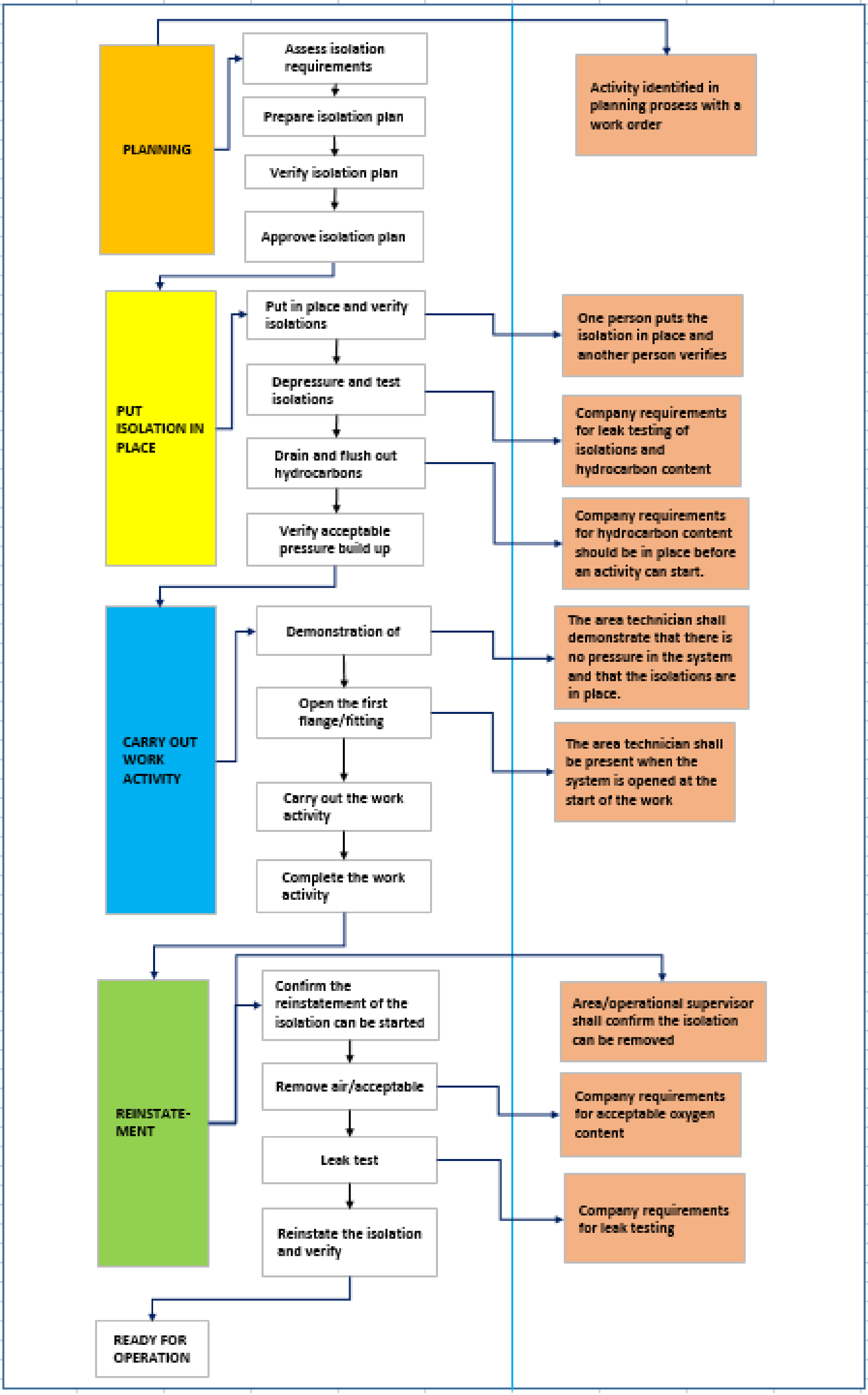

Figure 4 Flow diagram for isolation.

2.1 Planning

The need to isolate in connection with a work activity on a hydrocarbon system will normally arise in connection with the planning process. Where work activities are identified outside the planning process, the area/operations supervisor will be responsible for planning the isolation.

A work order is established which describes what is to be done. The need and requirements for isolation are assessed, and an isolation plan prepared. This plan should normally include a P&ID which shows all the isolations included, such as valves and blinds, the position these isolations shall be in while the work is under way, and how the isolation is secured so it cannot be changed during the work.

Planning should take account of the need for temporary equipment required to establish the isolations, test the system and reinstate isolations.

It should also take account of the possibility of possible operating problems which could arise during isolation and reinstatement – such as hydrates, for example.

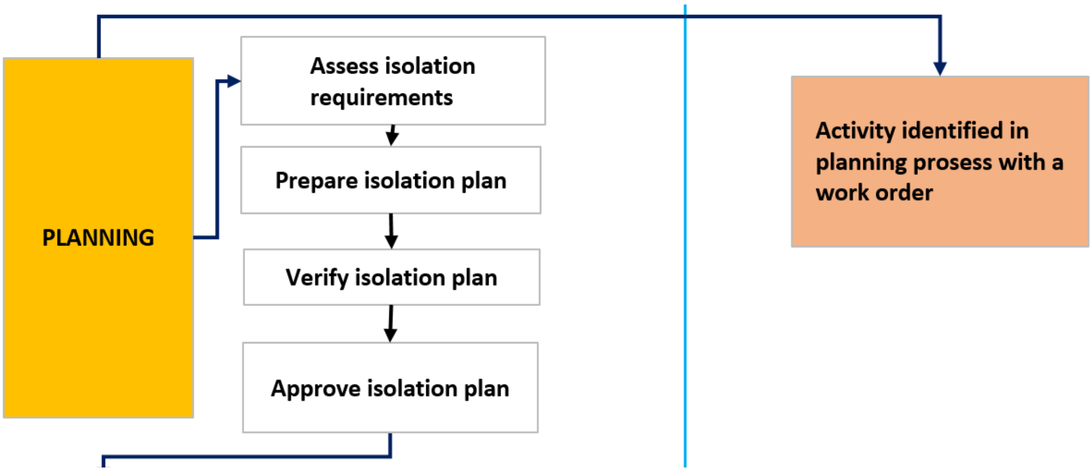

Figure 5 Subsidiary steps in planning.

Subsidiary steps	Recommended practice	Why
Evaluate isolation needs/requirements	The scope of the work is assessed in order to identify whether it requires a hydrocarbon system to be opened. If so, isolation is required.	The need for isolation shall be assessed for each work activity which could cause an HC leak.
	Type of work shall be assessed in order to determine which isolation methods should be used.	Work involving an ignition source will normally call for a stricter isolation standard.
	Companies shall have clear guidelines on when to use single or double barriers and blinds. These guidelines shall take account of the type of work planned.	Companies can have different requirements for isolation.
	Companies shall have clear guidelines for marking and securing isolations in the field.	Companies can have different requirements for marking and securing.

Prepare an isolation plan	The isolation plan should be formulated as an integrated document so that it is easy to follow. It should be specific on all the details to be observed (all plugs, valves, etc). This is important to ensure correct reinstatement. The plan shall be formulated so that each point is signed for as the isolations are set. That reduces the chance of missing out a point. The technical discipline required to perform each point in the isolation process shall be specified. Whether support is needed from personnel with special expertise shall also be shown. Isolations shall be assessed on the P&ID. Where some work activities are concerned, isolation points may need to be checked in the field. Isolation points shall be entered on a P&ID covering the work area. Whether a special sequence should be followed when establishing isolations and reinstatement shall be assessed. Requirements shall be set that all barriers included in the isolation are tested in the direction of flow they protect against. If the isolation plan is used for a later work activity, it shall be reviewed and verified again. The plan shall be given a new document number if the company uses such a system.	It is important to provide a systematic way of performing the isolation and that an overview exists at all times of which isolations have been set and what remains to be done. A check in the field could be appropriate if information from the P&ID or other documentation is deficient. An important prerequisite for this practice is that P&IDs are updated and that the latest version is used. The company shall prepare its own procedures on the way barriers are tested and what requirements apply for being able to approve the test. Uncritical use of an old isolation plan fails to take account of possible changes since it was last used.

Verify isolation plan	The company shall specify requirements for verification of the isolation plan. This verification shall include a check that the plan is sufficiently detailed and contains, for example, all bleed-off points and all flanges which must be broken. All relevant documentation, such as the P&ID, should be included in the verification. Verification of the isolation plan shall be performed by a competent person. This should not be the same person who has prepared the isolation plan.	Their expertise should accord with the company's internal requirements.
Approve isolation plan	The company shall define who can approve the isolation plan in the planning process. An isolation plan prepared outside the planning process shall be approved by the area/operations supervisor.	

2.2 Establishing isolation

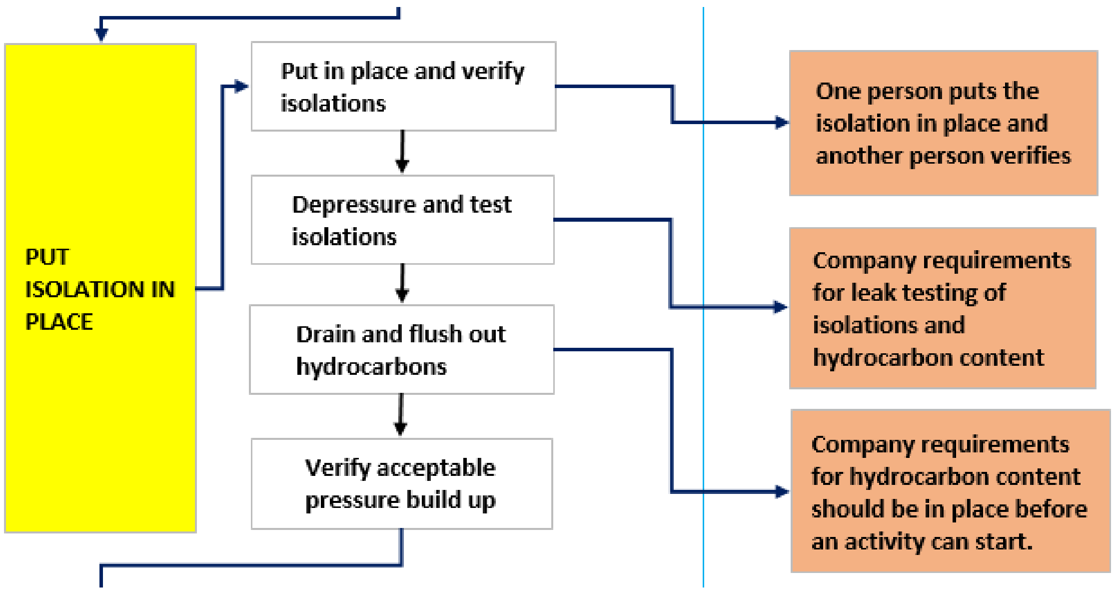

Figure 6 Subsidiary steps for establishing isolation

Subsidiary steps	Recommended practice	Why
Establish and verify isolation	Area/operations supervisor decides when (time) to establish isolation. All isolations should be performed so that they cannot be changed while work is under way.	Two hazards relate to using valves for isolation are. The valve leaks during the work, or it opens during the work. Opening the valve could lead to a major leak. So valves included in the isolation should be

	• A locking pin shall be used on valves. • A barrier shall always be in place to prevent actuator-controlled valves from changing position. With some valves, the valve control shall be disconnected. The isolation method shall be so secure that the loss of power, air and so forth is certain not to cause the valve to change position. A system for labelling isolations shall be in place. Labels are hung on equipment as the isolation proceeds. A system shall exist which ensures that the quantity of labels and the number on each of them corresponds with the isolation plan. This helps to ensure that points in the plan are not overlooked. If flange breaks or plug removals form part of the isolation, the list of break sections should be updated. It should be a living document, which specifies at any given time which points are broken (both flanges and plugs). All isolations shall be verified. The company shall set requirements for how isolations are verified.	secured to prevent them from being opened. The company shall have an overview of which valves can be used for isolation, and how they are used. The company shall establish procedures for how valves forming part of the isolations cannot be operated while the work activity is under way. This involves physical restraints on manual valves, such as locking the handle, and deactivating actuator-controlled valves. Where the latter are concerned, understanding how they work – fail closed, open or stable, for example – is important. Special precautions exist for fail open valves which should be closed during the work activity, and these shall be taken to ensure that the valve does not open during the work activity. The company shall establish a system which describes how isolations are labelled.
Depressurisation and testing isolations.	Pressure in the system shall be bled off before work begins. • Hoses used for depressurisation/ bleeding shall be approved for the purpose and for the pressure the system could experience. • The company shall set requirements for the use of check valves in hoses connected to the hydrocarbon system.	Before work on a hydrocarbon system can begin, hydrocarbons in the system should be removed. Pressure is normally bled off to the flare or drain systems. The system shall be checked for pressure build-up to ensure that the isolation is not leaking. No pressure build-up should normally occur after the system is isolated. The company should establish criteria for an acceptable pressure build-up. If the system has been established and left standing for a while, hydrocarbons could be

	• The company shall specify how the end of the hose is to be fastened so that it does not dance around in the event of a possible leak. • System contents shall be bled off to a safe area. Criteria for what is to be regarded as a safe area for bleeding shall be established for each facility and work activity.	liberated from equipment and piping. In that event, the company shall include frequent checks of pressure in the procedures.
Drain and flush out hydrocarbons	Before work begins, liquid hydrocarbons in the system shall be drained off. The system should be flushed to remove hydrocarbons.	Nitrogen, water or steam are normally used for flushing. The company should establish procedures for the way bleeding and flushing should be carried out. The company should specify requirements for the hydrocarbon content before a work activity can begin. HC content in nitrogen < 1%, for example, HC content in air <5% LEL, HC content in wash water – no visible oil drops. If welding or burning are planned, the use of degreasing agents to remove hydrocarbons from piping/equipment should be considered.
Verify acceptable pressure build-up	When the system is drained and flushed, the absence of pressure build-up which could indicate the continued presences of hydro-carbons in the system shall be verified	Hydrocarbons, particularly condensate, can give off vapour which will lead to pressure build-up even if all isolations are tight.

2.3 Performing the work

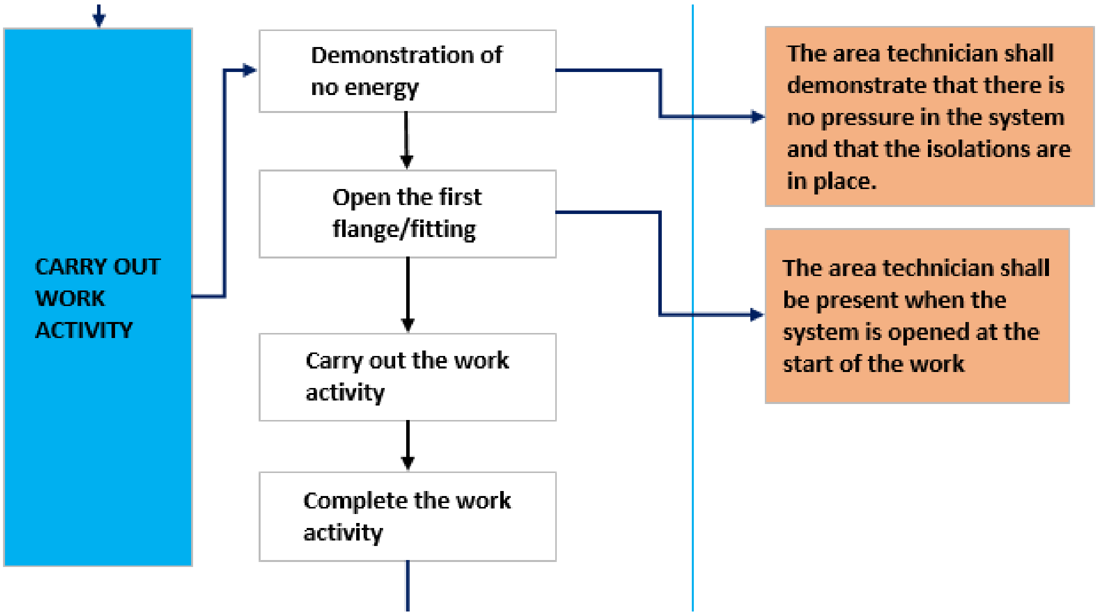

Figure 7 Subsidiary steps for performing the work.

Subsidiary steps	Recommended practice	Why
Demonstrate no energy	Before the work starts, the area technician shall demonstrate to the performing technician that the system is depressurised (no energy in the system). Requirements shall be set to demonstrate no energy at crew changes – between day and night shifts, for example.	Demonstrating no energy could involve, for example, opening a valve to show that the system is depressurised, or attempting to start a pump. Demonstrating no energy with reference to a manometer could be misleading, particularly on a high-pressure system with a coarse gradation in its readings. Crew change involves a pause in the work activity, making it appropriate to demonstrate no energy again before work resumes.
Open first flange/fitting	The area technician shall be present when the system is first opened at the start of the work, such as breaking the first flange. This is an important check to ensure that the performing technician is working on the right system and equipment.	
Execute the work	The work shall be executed in accordance with the relevant procedures and practices which apply in the company, including the company's WP requirements. Should any change be needed to the isolation, it shall be approved by the area/operations supervisor, and the isolation plan shall be updated, verified and approved anew	

Complete the work	When the work activity has been completed, the WP shall be returned in accordance with the company's WP system. The area technician shall verify that the work has been completed, and that all affected flanges and fittings covered by the work order(s) are in place in accordance with the list of break sections.	

2.4 Reinstatement

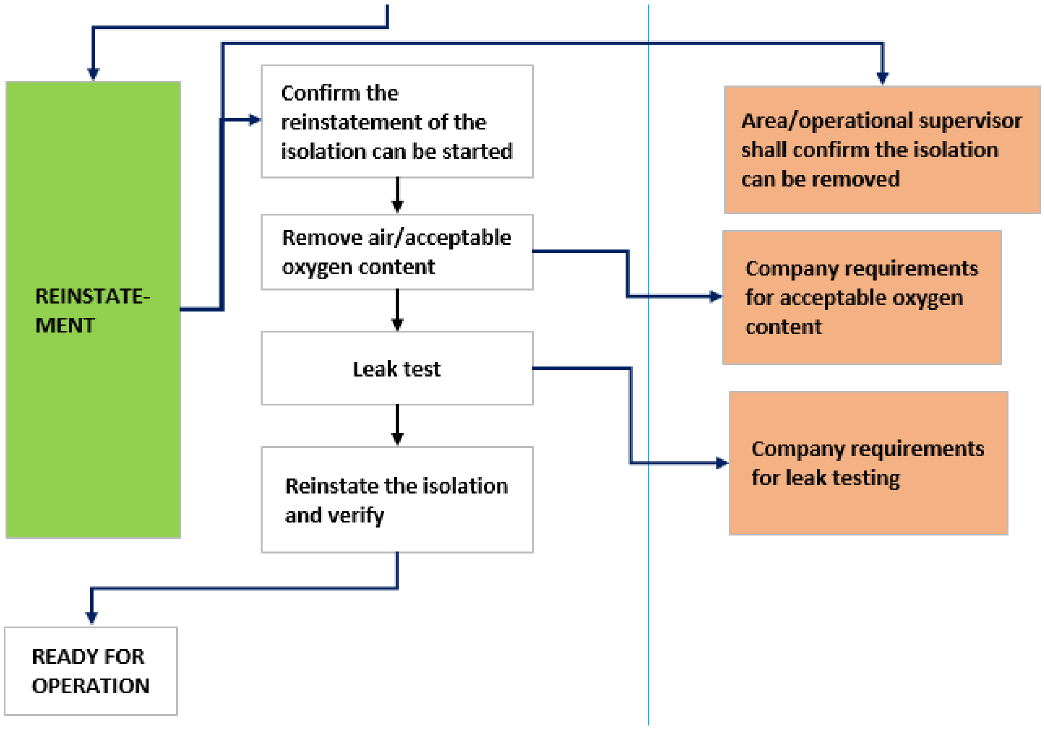

Figure 8 Subsidiary steps in reinstating the equipment/system.

Subsidiary steps	Recommended practice	Why
Confirm initiation of reinstatement	Completion of work on the hydrocarbon equipment shall be verified. This is usually noted on the WP when the work has been completed. The area/operations supervisor shall give permission for reinstating isolations. The need to observe a special sequence in the reinstatement shall be assessed. This shall be covered in the isolation plan.	
Remove air	Air in the system is normally removed with water, nitrogen or steam. • When using water, the system is filled from the bottom with air vented from the top. Once the system is water-filled, the air is	

	removed. A check should be made to identify possible pockets in the system which might still contain air. • When using nitrogen, normal practice is to pressurise the system a few times to reduce the oxygen content below five per cent. • The company should establish its own procedure for removing hydrocarbons.	
Leak testing	Before the equipment can be returned to operation, everything which has been affected – such as flanges, fittings, valves and seals – shall be leak-tested. When testing, the PSV in the system shall be operational to prevent overpressure. If one or more flanges cannot be leak-tested – on the flare system, for example – a specific procedure shall be established for these. The use of Kamos gaskets* or similar solutions against unpressurised systems should be assessed.	Companies should establish leak-testing procedures which cover the following points: - medium which should be used - pressure which should be used - duration of test - method for checking possible leak points - requirements for pressure loss during testing - activities which can be pursued in parallel with the leak testing.
Reinstate the isolations	The isolations shall be reinstated and all labels removed from the system. Valves included in the isolations shall be reinstated and control restored for actuator-controlled valves. All isolations shall be signed for in the valve and blind list (isolation plan) established for the work activity. Reinstatement of isolations shall be verified.	

*This is a type of gasket which can be leak-tested without pressurising the adjacent segment. The test is conducted by pressurising the actual gasket.

3 MANAGEMENT OF CHANGES

Should a change occur which could influence the isolations, the extent of the change shall be assessed in relation to the four main stages. This assessment shall cover an assessment of the risk which can arise as a result of the change, and an evaluation of the need for possible risk-reducing measures. Using a cross-disciplinary team to conduct the risk assessment would be appropriate in order to ensure that all elements in the isolation plan are covered by personnel with relevant expertise. The change should be approved to the same level as the original isolation plan. When the change has been assessed and approved, it is important that all personnel involved are informed about the change and the associated consequences.

Management of changes should be described in the company's procedures.

4 HANDOVER

Handover at crew changes is an important factor for avoiding mistakes in connection with the isolations. That applies to everyone involved in the task, including the performing technician, the area technician and the area/operations supervisor. Crew changes could be between day/night shifts or when a new shift comes on board. The company shall establish its own procedure for the way handovers should be carried out. That applies to both verbal and written handovers.

5 FLANGE OVERVIEW

The company should establish procedures for maintaining an overview of which flanges, fittings, plugs and so forth have been affected by a work activity. This is particularly important if several work orders are executed within a single isolation plan. These shall be labelled in order to ensure that they are leak-tested before the system becomes operational again. It could be appropriate to produce special labels for this purpose.

The work order will normally include a checklist (list of system breaks), which shall be signed off when the flange is broken and when it is reinstated. Blinds included in the isolation will normally be covered by the isolation plan.

6 COMPLEX WORK ACTIVITIES

Where complex work activities and/or a scope which includes several jobs are concerned, other precautions or special procedures may be called for – during a turnaround, for example. This requires special attention in the planning process in order to ensure that different work activities do not come into conflict with each other. The isolation plans shall be compatible – avoiding a position, for example, where one isolation plan specifies that a valve should be closed while another requires it to be open.