Guidelines for
Lifting Operations

International Marine
Contractors Association

www.imca-int.com

IMCA LR 006, SEL 019, D 060, M 187 – Rev. 1
March 2018

The International Marine Contractors Association (IMCA) is the international trade association representing offshore, marine and underwater engineering companies.

IMCA promotes improvements in quality, health, safety, environmental and technical standards through the publication of information notes, codes of practice and by other appropriate means.

Members are self-regulating through the adoption of IMCA guidelines as appropriate. They commit to act as responsible members by following relevant guidelines and being willing to be audited against compliance with them by their clients.

There are five core committees that relate to all members:

- Competence & Training
- Contracts & Insurance
- Health, Safety, Security & Environment
- Lifting & Rigging
- Marine Policy & Regulatory Affairs

The Association is organised through four distinct divisions, each covering a specific area of members' interests – Diving, Marine, Offshore Survey and Remote Systems & ROV.

There are also five regions which facilitate work on issues affecting members in their local geographic area – Asia-Pacific, Europe & Africa, Middle East & India, North America and South America.

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Date	**Reason**	**Revision**
October 2017	Initial publication	
March 2018	An extensive revision to all sections of the document with the inclusion of appendices on subsea lifts, diving operations, lifting personnel, lifting at extreme heights and dismantlement of offshore structures	Rev. 1

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Appendices

Definitions and Glossary of Terms

AHC	Active heave compensation
Banksman/signalman/ dogman	Definitions vary internationally. Generally, this identifies someone who directs the crane operator during the lift. This person does not handle the load
BS	British Standard
CB	Centre of buoyancy – the centre of mass of the fluid displaced by a floating or submerged body
Certificate (test and thorough examination)	An authenticated document which records that a defined test load (either functional or intentional overload) and thorough examination has been successfully carried out on an appliance or accessory and should include details of the equipment to which the load and examination was applied
CG	Centre of gravity – a point, near or within a body, through which its weight can be assumed to act when considering forces on the body and its motion under gravity
Competence	Competence can be described as the combination of appropriate training, current skills, knowledge and experience so that a person consistently applies them to perform tasks safely and effectively. Other factors, such as attitude and physical ability, can also affect someone's competence
Competent person (lift planner)	The competent person is someone with the skills and knowledge to plan and, if appropriate, supervise a lift
Competent person (lifting equipment examiner)	Designated person having the appropriate practical and theoretical knowledge of the lifting equipment being examined to enable identification of any defects or weaknesses and the assessment of their importance in relation to the safe use of the lifting equipment. Although the competent person may often be employed by another organisation, this is not necessary, provided they are sufficiently independent and impartial to ensure that in-house examinations are made without fear or favour (see section 3.2)
Crane operator	Person operating the controls of a crane
CT	Constant tension
DAF	Dynamic amplification factor, where the forces acting on a load amplify the force exerted by its own weight and defined as: $\text{DAF} = \frac{\text{dynamic load + static load}}{\text{static load}}$
DHL	Dynamic hook load: DHL = DAF x (weight of object + weight of rigging) + additional hook load due to extra loading Note: *'Extra loading' as for example from tugger line loads and guide loads*
DP	Dynamic positioning
EN	European Norm
Engineered lift	Lift that requires detailed engineering following established engineering standards and procedures
FoS	Factor of safety – the ratio between the minimum breaking load (MBL) and the safe working load (SWL)

HIRA	Hazard identification and risk assessment
HMPE	High modulus polyethylene
Hydrodynamic force	A function of slamming, dynamic effects of buoyancy, drag and inertia effects
Inspection	An inspection is defined for the purposes of this guidance as a visual check, supplemented where practicable by a function check. This is to determine no obvious damage or deterioration to the lifting equipment and to ensure that health and safety conditions are maintained, with any obvious deterioration detected and remedied in good time
JRA	Job risk assessment (also task risk assessment (TRA) or job safety analysis (JSA))
LARS	Launch and recovery system
Lift plan	Documented plan, which may form part of or refer to a manual, for the proposed lifting operation
Lift supervisor	The person who supervises the lift and the lifting team in accordance with the lift plan prepared by the competent person. It is recommended that only suitably experienced personnel should be asked to take on the role of lift supervisor
Lifting equipment	Lifting equipment is any equipment for lifting, lowering and suspending loads, and includes any accessories used in doing so
Lifting team	Personnel carrying out lifting operation. Minimum of three: lift supervisor/load handler/lifting equipment operator
Load handler	See Slinger
MBL	Minimum breaking load – is also referred to as minimum breaking force (MBF). The manufacturer guarantees that the equipment will not break at a lesser value when new (Note: 1 tonne = 9.81 kN)
MoC	Management of change – a means of safely making changes in a controlled manner
MRU	Motion reference unit
MSW	Metres sea water
NDE	Non-destructive examination
Non-routine lift	Lift with characteristics that significantly differs from existing routine lifts; lift where no routine lift plan exists; lifting of personnel
OBSROV	Observation class remotely operated vehicle
PHC	Passive heave compensation
PLC	Programmable logic control
PMS	Planned maintenance system – system which allows vessel operators to schedule and plan maintenance of the vessel and its equipment
QHSSE	Quality health, safety, security and environment
Report of Thorough Examination	The competent person (lifting equipment examiner) should provide a written report of thorough examination and any inspections or tests which have been carried out. The report should identify if there are defects and what you should do to correct them

Rigger	Definition varies internationally. Generally intended to identify a person who is experienced and competent in rigging lifting equipment and slinging loads. A diver's subsea rigging and lifting working knowledge should include buoyancy of items/DP footprint/lack of visibility/load delay due to effects of vessel movement, water added mass, currents and wave action and communication protocols
Risk	Product of hazard severity and hazard probability
Risk assessment matrix	Document that assists in quantifying risk
Routine lift	Lift with common characteristics that are repetitive in nature; lift where the significant elements involved are unlikely to change in a way that would impact on the safety of the operation
Scheme of Examination	The Scheme of Examination should ensure that all parts of the lifting equipment upon which safety depends are thoroughly examined by appropriate means and at such frequency as will allow defects to be detected and remedial action taken before the lifting equipment becomes dangerous
SDC	Submersible diving chamber (diving bell)
Sea state	The degree of turbulence at sea, generally measured on a scale of 0 to 9 according to average wave height
Significant wave height (H_s)	The significant wave height (H_s) = 4 x SQRT(m_0), where m_0 is the sea surface variance. In sea states with only a narrow band of wave frequencies, H_s is approximately equal to $H_{(1/3)}$ – the mean height of the largest third of the zero up-crossing waves
Slinger	May also be termed the 'load handler', is the person who has the responsibility of attaching/detaching and securing the load to the lifting equipment
Static load	A weight unaffected by external forces
SWL	Safe working load – the maximum static load that the lifting equipment is rated for under a given configuration
Technical authority	Person(s) who is technically competent and who can make an impartial judgement of the lifting operations plan
Thorough examination	A thorough examination (see section 6.2) is an examination carried out by a competent person, carefully and critically, and where necessary supplemented by other means such as measurement, non-destructive testing or other testing, in order to detect defects or weaknesses and to assess their importance in relation to the safety and continued use of the lifting equipment
Tugger (crane)	Small drum winch designed to assist marine/construction crew in manipulating heavy towing gear/deck cargo or controlling the movement of suspended loads during marine/offshore operations
Verifying authority	Classification society, flag state or other regulatory body
WLL	Working load limit. The maximum load that lifting equipment is designed for under normal use
WROV	Work-class remotely operated vehicle

1 Introduction

1.1 General

IMCA's Lifting & Rigging Management Committee has developed this guidance for offshore industry lifting operations including supporting manned diving operations.

This guidance is intended to show the essential elements which should be included in company procedures for lifting operations and provide industry recommended practice on the steps within a lifting operation process that promote safety. It is anticipated to be of use in world-wide offshore industry lifting operations.

Member companies who follow this guidance in international operations may require additional supplements to comply with local requirements.

The fundamental objective of this guidance is that if each step of the process outlined is followed then every lift should be carried out in a safe manner because it is:

- completed within an appropriate safety management system;
- properly planned;
- risk assessed;
- supervised; and
- carried out by competent personnel using the proper certified and maintained equipment.

The following matters are not considered in this document:

- launch and recovery systems for surface or closed-bell divers;
- launch and recovery systems for remotely or autonomously operated vehicles;
- the involvement of remotely or autonomously operated vehicles in unmanned subsea lifting operations;
- the use of chain lever hoists in the offshore subsea environment;
- the cross-hauling of bells;
- concrete mattress handling, deployment, installation, repositioning and decommissioning;
- the use of underwater air lift bags.

Such matters are covered in separate IMCA guidance documents.

1.2 Safety Management Systems

Safe, successful lifting operations rely on clear leadership to encourage safety and efficiency. The personnel performing them should do so in accordance with company safety management systems, which should contain, but not be limited to:

- commitment of senior management to provide clear policy objectives;
- corporate QHSSE procedures for lifting, hoisting and communications in the appropriate language;
- provision of adequate and appropriate personnel and equipment;
- provision of trained and competent personnel;
- requirements for inspection, maintenance, removal of unsuitable equipment and record keeping.

This document provides guidance and practical assistance to those involved with lifting operations.

1.2.1 Familiarisations for Operators of Lifting Appliances

There are many different types of lifting equipment on board an offshore vessel. Examples include: main deck crane; A-frame winches; other deck winches and tuggers.

Before using lifting equipment for the first time it is fundamental that new operators should receive an appropriate familiarisation from a competent person. This should cover, but not be limited to, the following: instructions for use; any operating limitations and restrictions; pre-use check routines; emergency stops; equipment risk assessment; safety systems/guards fitted etc. It is recommended that a copy of the operating instructions for the lifting equipment is made available to the operator.

On completion of the familiarisation the competent person should be satisfied that the operator has sufficient knowledge to operate the equipment safely.

A record of all familiarisations should be documented including a summary of the information provided and the names and signatures of the instructors and the persons being familiarised. Once dated and completed, the records should be filed.

Lifting equipment familiarisations will normally form part of the vessel induction process and company competence assurance scheme.

Reference IMCA competence frameworks:

- IMCA C 002 – *Guidance on competence assurance and assessment: Marine Division*
- IMCA C 003 – *Guidance on competence assurance and assessment: Diving Division*
- IMCA C 004 – *Guidance on competence assurance and assessment: Offshore Survey Division*
- IMCA C 005 – *Guidance on competence assurance and assessment: Remote Systems & ROV Division*

2 Summary of Guidance

This document contains guidance on the key aspects of lifting operations:

- personnel involved in planning a lifting operation (see section 3);
- pre-lift planning including lift categorisation;
- operational planning (see section 5) including risk assessments, selection of equipment and lifting teams, management of change, toolbox talks and records;
- inspection, examination and marking of lifting equipment;
- record keeping;
- appendices covering:
  - subsea lifts
  - diving operations
  - lifting personnel
  - lifting at extreme height
  - dismantling/demolition of offshore top-side and subsea structures;
- examples of documents in appendices.

2.1 Lift Planning Flowchart

The following flowchart and brief description define every step within the lift planning process. The steps remain the same for each location and work activity. However, the competent person would decide which lifts lie within the appropriate planning route.

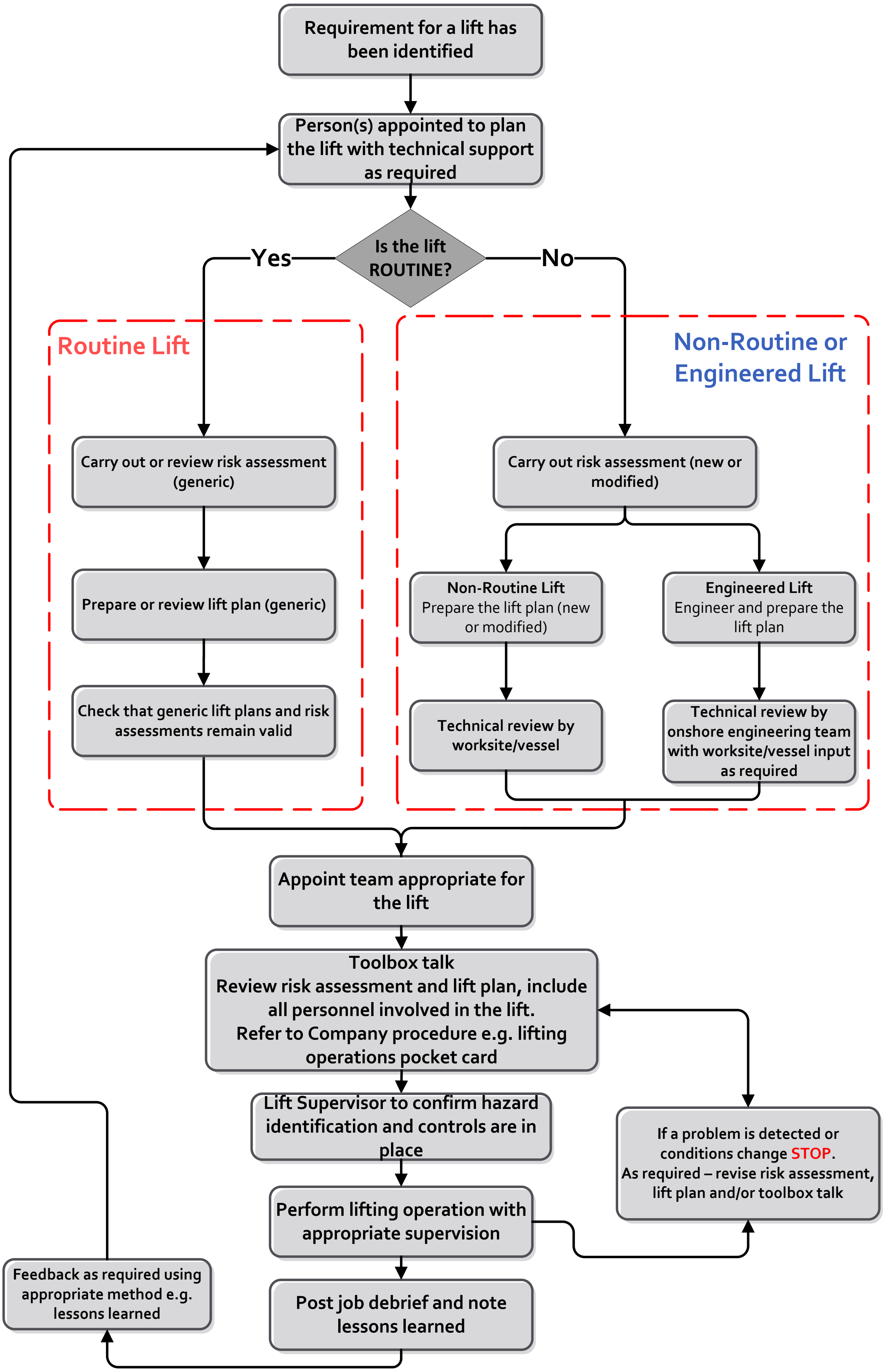


Figure 1 – Lift planning flowchart

3 Personnel

3.1 Responsible Person

The responsible person is defined for the purposes of this guidance as the person who has overall responsibility for work activities. This person might be, for example, the project manager, project construction manager, vessel master, offshore construction manager, shift supervisor or base manager.

3.2 The Competent Person – Appointed to Plan the Lift

The competent person is defined in this guidance as a specifically identified person who is designated by their company as having the combination of appropriate training, current skills, knowledge and experience so that a person consistently applies them to effectively plan, risk assess and supervise the specific lifting operation as described below.

The competent person may or may not supervise the lifting operation, but should always be the focal point of authority for the safety and technical aspects of the lift. In certain circumstances, the responsible person (see section 3.1) may undertake the duties of the competent person, providing they have the necessary competence and practical skills as described above.

The designated competent persons should know their competency limitations, work within them and know when technical support is needed. Consequently, for some lifts, there might be more than one competent person involved.

The competent person's responsibilities could include:

- categorising the lift (see section 4.1);
- risk assessment (see section 5.4);
- developing the lift plan (see section 5);
- technical review;
- selection of personnel (see section 3.4);
- selection of equipment (see section 5.3.3);
- toolbox talk (see section 5.9); and
- post-job debrief.

A review by a technical authority may be requested by the competent person if they require additional technical support.

3.3 Lift Supervisor

The lift supervisor can be the competent person or someone nominated by the competent person. The lift supervisor is defined in this guidance as the person who is charged with actively supervising the lifting operation on site. This could be a deck officer, diving supervisor, deck foreman, banksman, shift supervisor or similar.

Supervision should be proportionate to the exposure to risk created by the lifting operation and the experience and capabilities of the personnel involved in individual lifting operations.

Levels of supervision appropriate to the nature of the work and the competence of those involved in using equipment and assisting with the lifting operation should be established. These arrangements should be reviewed in the event of any changes to equipment, the lifting operation or to the personnel involved with the lifting operation.

The lift supervisor should be clearly identifiable, should have a clear view of the lift and should ensure that lifting activities follow the agreed plan.

The lift supervisor should always ensure that clear communication systems are in place and tested to ensure sufficient co-ordination between pickup and laydown areas. This communication is especially critical when visibility of the pickup and laydown area is restricted.

There may be a requirement for the lift supervisor to assist in the preparation of the load, for example with slinging activities; however, the lift supervisor should not touch the load during the lifting operation.

For loads being deployed subsea using vessel based lifting appliances in support of manned diving operations, the lift supervisor in control of the lifting operation when it is above the waterline may act as the banksman and should be in direct contact with the lifting appliance operator.

3.3.1 Dive Supervisor

When subsea lifting operations in support of manned diving operations are underway it should be recognised that the dive supervisor is the person in overall control of the subsea element of the lifting operation. It should also be noted that the dive supervisor decides when the lifting operation is to commence regardless of who controls the lift above waterline. The dive supervisor will communicate and co-ordinate between the dive team for diver positioning, the bridge crew for vessel positioning, and the deck crew/lifting appliance operator for deck and lifting operations. For lifts that go from a vessel to subsea (or vice versa) then the different phases of the lift are usually locally controlled by different people. For vessel based lifting operations it is usual that the deck foreman will control the lift above the waterline (or more accurately to a stabilisation point just below it) and the dive supervisor controls the lift below the waterline/stabilisation point. The handover points should be clearly understood and verbally confirmed at each handover point. The lifting appliance operator should only take instruction from one person.

During a subsea lift involving diving operations, the diver will pass information for manoeuvring the lifted object to the dive supervisor, and the dive supervisor will relay instructions to the lifting appliance operator, i.e. the dive supervisor will act as the banksman in direct contact with the lifting appliance operator and as the lift supervisor in control of the lifting operation below the waterline. The diver in the water will also need to perform the role of load handler/slinger, e.g. when releasing or attaching subsea loads.

The dive supervisor may require that dive team members assist in the planning, preparation and slinging of the lifted object prior to its deployment subsea.

Note that in some parts of the world subsea lifts are often carried out by dive teams independent of any deck crew support.

3.4 Lifting Team

Only suitably trained and experienced personnel should be selected, that is, those who:

- have had their competence to supervise and/or perform the type of lifts identified as satisfactory for the specific operation;
- have experience of, and demonstrated competency in, the safe use and operation of the equipment and techniques required to perform the subject lift in the prevailing situation and conditions.

If any personnel in a lifting team considers that the operation exceeds their level of competency or experience, they should stop the operation until a suitable person with the required competence and experience is able to assist or take over.

Appropriate personnel in the lifting team should attend and participate in pre-lift meetings, carry out pre-use inspections of lifting equipment and, if required, assist with the lifting operation.

They should be knowledgeable and attentive to the lift plan applying to the particular lifting operation.

Issues to be aware of include for example:

- implications of environmental/meteorological conditions including vessel motion and subsea visibility;

- hydrodynamic forces on behaviour of loads being deployed or recovered from subsea which includes slack line, shock loading, seabed suction and air entrapment;
- loads imparted into lifting appliance as a result of vessel changes in position;
- allowance for changes in centre of rotation caused by positive and negative buoyancy effects;
- use of lifting appliances in restricted locations (headroom, access, egress and stabilising arrangements);
- visibility and communications during lifting operations especially related to subsea lifts in support of manned diving operations;
- proximity hazards/subsea infrastructure/encroachment by other cranes/lifting appliances;
- prevention of load striking any person (including divers) or object/equipment/infrastructure;
- pre-checking of lifting appliance including rigging and identification of faults and defects;
- attachment, security and detachment of loads;
- overloading and de-rating of lifting appliance;
- overturning, tilting, slipping and dragging loads which potentially may also overload the rigging arrangement or lifting point;
- not to work under suspended loads at any time (this is of particular importance during lifting operations in support of manned diving operations where the diver maybe inside the drop cone);
- not leaving loads suspended especially for subsea lifts and when using active heave compensation;
- lifting of persons;
- continuing integrity of lifting appliances including lift ropes and accessories.

All personnel have the authority to stop any operation if they are concerned about safety.

Competence standards for offshore marine personnel can be aligned with IMCA C 002 – *Guidance on competence assurance and assessment: Marine Division*.

Competence standards for offshore diving personnel can be aligned with IMCA C 003 – *Guidance on competence assurance and assessment: Diving Division*.

3.4.1 Roles of the Lifting Team

To ensure offshore lifting operations are carried out in a safe manner they should only be undertaken by a team comprising a minimum of three persons, lift supervisor (banksman), load handler (slinger) and crane operator (lifting appliance operator).

The lift supervisor is the person who controls the lifting of the load and its final positioning at the landing site. He gives signals to the load handler for the attaching and detaching of the load to the lifting appliance and gives clear signals to the lifting appliance operator for the movement of the load. Lift supervisors should not get involved in the physical positioning of the load or of the attaching or removing of the load from the lifting appliance. They should retain an overview of the lifting operation.

The load handler is the person who has the responsibility of attaching/detaching and securing the loads to the lifting appliance.

The lifting appliance operator is the person who controls the movement of the load once it is lifted clear of the deck. When the load then approaches the landing area the lift supervisor resumes control. Where the distances or deck levels between the pickup and laydown areas are significant a second team with another lift supervisor and load handler can be employed to speed up the operations.

A significant proportion of the loads lifted offshore may require a load handler at each end of the load to undertake the attaching/detaching.

4 Pre-Lift Planning

4.1 Lift Categorisation

There is a wide range of lifting operations carried out in the onshore, offshore and subsea construction industries. To categorise all lifts as 'routine' or 'non-routine' or into a sub-category that would be applicable throughout these industries is likely to be very challenging. For example, a company might categorise a lift as routine because it may be carrying out such lifts over a long period on a very regular basis; another company would categorise the same lift as non-routine because it would be unfamiliar to them and involve extra planning.

It is, however, vital for companies to have procedures whereby a careful risk assessment is made for each lifting operation and that a lift plan is available or developed for all lifts. This might be a generic lift plan for what are perceived as routine lifts. In such a case, every lifting operation needs to be individually risk assessed, taking into account all relevant issues and the specific conditions at the time, so that the lifting team can check that the lift envisaged is covered by the established generic lift plan. If it is not, an appropriate lift plan should be developed.

When planning for offshore subsea lifting operations the competent person planning the lift should account for all phases of the lift and estimate the loading on the lifting appliance at each phase. The planner should compare the loading at each stage of the lift and check this against lifting appliance capacity and design the lift rigging to have sufficient strength. Note that the lifting appliance may have different capacities during different phases of the lifting operation – depending on the operating mode selected at the time.

The lift planner should be able to predict with accuracy what the maximum loading will be during all phases of the lift. The level of accuracy for the maximum loading will become even more critical upon approaching the lifting appliance SWL.

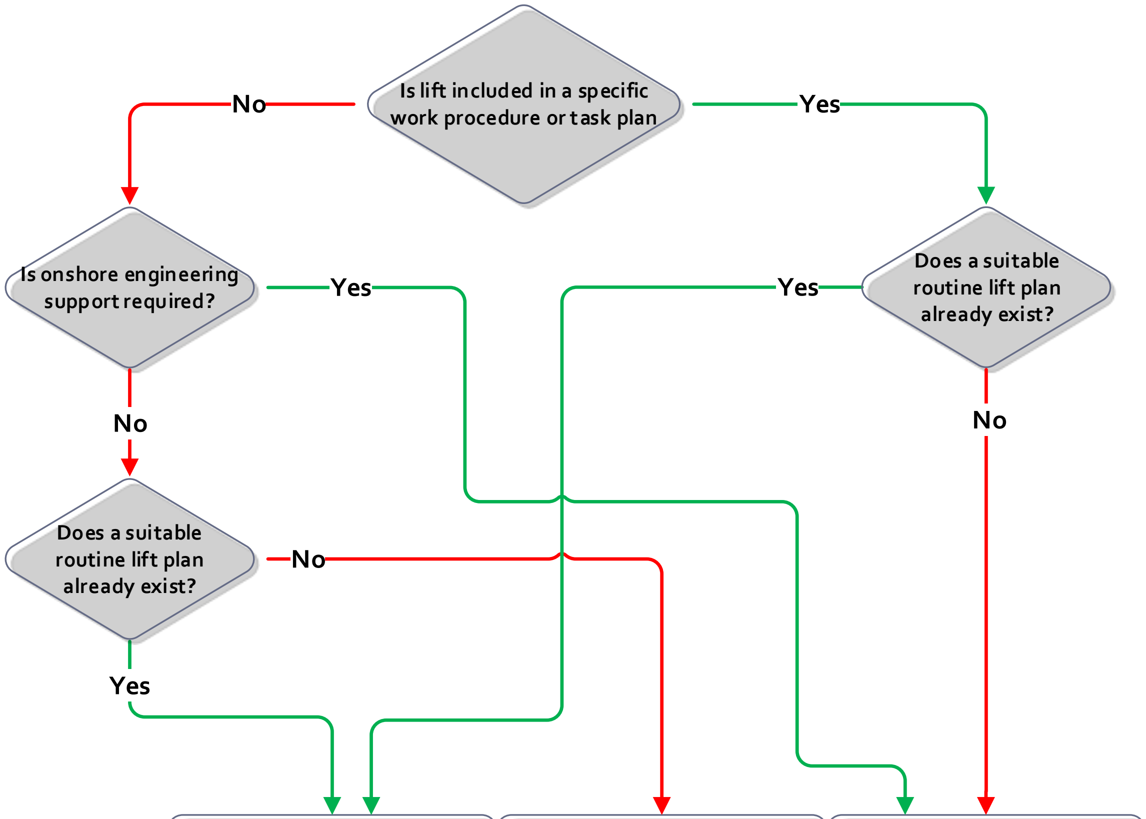
For simplicity in this guidance, only the terms 'routine', 'non-routine' or 'engineered' are used, such that if a lift cannot be defined as shown in section 4.1.1 to be routine, then it would be defined as non-routine or engineered.

Any lift plan should be well documented to demonstrate that the lift has been appropriately risk assessed and planned. This documentation should be easily understood and accessible to the lifting team.

Lift plans should be developed by a designated competent person (see section 3.2), with appropriate assistance where necessary (see section 3.4).

Guidance that will assist with the categorisation of lifting operations is illustrated in Figure 2.

Lift categorisation chart



	Routine Lift Plan	Non-Routine Lift Plan	Engineered Lift Plan
Definition	Lifts carried out on a worksite that do no require onshore engineering support Routine lifts: • Lifts with common characteristics that are repetitive in nature • Lifts where the significant elements involved are unlikely to change in a way that would impact on the safety of the operation	Non-routine lifts: • Lifts with characteristics that significantly differ from existing routine lifts • Lifts where no routine lift plan exists • Lifting of personnel	Engineered lift Lifts that require detailed engineering by onshore organisation following established engineering standards and procedures
Lift plan requirements	• A single generic routine lift plan will cover a range of similar lifts. • Routine lift plans must be reviewed and updated whenever any significant changes occur or not longer than every 24 months	Specific lift plan to be produced. Technical review during development of lift plan. *Offshore*: • Shift supervisor/dive supervisor • deck foreman *Onshore*: • Site supervisor or nominated person	Specific engineered lift plan is produced to support the task plan/standard operating procedures. Typical engineering input may include: • Structural/installation analysis, dimensional checks, rigging design calculations, lift drawings.
Who produces the lift plan?	Competent Person (onshore or offshore)	Competent Person (onshore or offshore)	The engineered lift plan in section 5.2 is completed as follows: *Offshore and Onshore*: • Engineering onshore • Competent person
Who approves the lift plan?	Competent person not involved in producing the lift plan		
Risk assessment requirements	• All lift plans are required to have a supporting risk assessment. • All personnel involved must be familiar with the lift plan and risk assessment. • Risk assessment to be in accordance with company risk assessment procedure.		

Figure 2 –Lift categorisation chart

4.1.1 Defining Routine, Non-Routine and Engineered Lifts

For the purposes of this guidance, three categories of lifting are identified:

1. routine;
2. non-routine;
3. engineered.

All lifts require a lift plan. When operations are considered 'routine' the company should have a process in place to ensure that sufficient planning has been conducted. Due to the repetitive nature of such operations, an individual plan should not be required on each occasion that the operation is conducted, unless any of the significant matters to which the plan relate have changed and need to be taken into account. If in doubt, a lift should be considered 'non-routine'. See Figure 3 for an example lift plan.

4.1.2 Routine Lifts

Routine lifts can be identified and described as:

1. Lifts with common characteristics that are repetitive in nature;
2. Lifts where the significant elements involved are unlikely to change in a way that would impact on the safety of the operation;
3. Where the identified lifting team is trained in the use of the specific lifting equipment and familiar with its limitations; and competent to complete the entire operation;
4. Where the lifting team has previously performed their identified roles;
5. Where all personnel involved are familiar with the written risk assessment and the lift plan for the operation being conducted; and
6. Where the lift plan is verified as the current issue before the operation.
7. The lift path **might not** be defined in the lift plan.

Routine lift plan requirements are as follows:

1. They are supported by a job risk assessment (JRA) (see section 5.4.1);
2. A single generic routine lift plan, developed by the competent person, should cover a range of similar lifts;
3. Routine lift plans should be reviewed and updated whenever any significant changes occur or not longer than every 24 months;
4. The lift plan should still be discussed/reviewed at the pre-lift meeting. Such pre-lift meeting can, for example, be in the form of a shift briefing at the start of a shift or in a toolbox talk as required during the shift;
5. The lift plan should be properly planned by a competent person together with the people normally using the lifting equipment;
6. The lift should be appropriately supervised and carried out in a safe manner.

EXAMPLE LIFT PLAN FORM – OFFSHORE

If any section of the form is not applicable mark as N/A		
Section 1 – HIGH LEVEL INFORMATION		
Originator:	***Name and position:***	***Date:***
Title/Description of the Lift:		**Lift Plan No:**

Lift Category: **Routine** ☐ **Non-Routine** ☐ **Engineered** ☐

Note: Lifting of personnel must be categorised as non-routine – refer to site/vessel procedures for permit/approvals.

Vessel/Site:	**Client/Project:**
LOAD DETAILS/CRANE DETAILS – include as applicable. t = metric tonnes m = metres	
Load Description: (include load dimensions)	
Static Weight in Air: t Include weight of load and rigging **Static Weight in Water:** t Include weight of load, rigging and maximum deployed wire (as applicable) **Dynamic Load:** t Maximum dynamic load on crane/appliance (as applicable)	**Water depth for Lift:** m **For engineered/non-routine lifts state the maximum allowable load or tension:** t Based on SWL of the weakest component. **Limiting environmental conditions:** Wind speed : knots/mph/ m/s (select units) Wave height : m
Crane(s) or appliance(s) to be used for the lift:	**Crane or appliance configuration: (e.g. main line, aux line, single fall, double fall etc.)**

Maximum required operating radius: m	**SWL @ this radius:** t	**Required hook height:** m **Available hook height:** m

REFERENCE DOCUMENTS – include as applicable	
Procedure Ref:	**Task Plan Ref:**
Risk Assessment Ref:	**Rigging Arrangement Drawing Ref:**

Section 2 – CRANE/APPLIANCE SPECIAL OPERATING MODES AND CHANGEOVER POINTS e.g. active heave compensation, constant tension, AHC gas pressure pre-charge requirement, AHC minimum load

Section 3 – LOAD CONTROL
Note: Use of taglines will be decided by the lift supervisor and discussed at the toolbox talk

Crane Tuggers:	☐ Yes ☐ No	**Number Required:**	**Operating Modes:**
Deck Winches:	☐ Yes ☐ No	**Number Required:**	**Operating Modes:**
Additional Comments:			

Section 4 – CRANE BLOCK CONTROL

Crane Tuggers:	☐ Yes ☐ No	**Number Required:**	**Operating Modes:**
Deck Winches:	☐ Yes ☐ No	**Number Required:**	**Operating Modes:**
Additional Comments:			

Section 5 – VESSEL STABILITY – Refer to marine department ballast plan/requirements	
Pre-Ballast Required: ☐ Yes ☐ No	**Ballast During Crane/Load Movement Required:** ☐ Yes ☐ No
Additional Comments:	

Section 6 – COMMUNICATIONS METHOD: State primary and (if applicable) secondary communication method(s) to be used
Primary Communication Method:
Secondary Communication Method (if applicable):
Language

Section 7 – RIGGING/LIFTING EQUIPMENT LIST – Only required if not listed elsewhere. If additional sketch is required use a separate sheet and attach to the lift plan

Section 8 – STEP BY STEP description. A high level summary. Include who is in charge of lift and any handover points		Responsible

Figure 3 – Example lift plan

4.1.3 Non-Routine Lifts

Non-routine lifts are those which do not meet all the criteria for routine lifts.

A non-routine lift can be identified and described as:

1. Lifts with characteristics that significantly differ from existing routine lifts;
2. Lifts where no routine lift plan exists.

The lifting of divers into and out of the water using DESIGN-compliant diver launch and recovery systems may be considered routine lifts. However, all other lifting operations involving the lifting of personnel should be considered non-routine.

Non-routine lifts require:

1. A job risk assessment to identify and mitigate the risks;
2. A completed lift plan, signed off by the persons identified in the relevant boxes of the lift plan;
3. A new specific lift plan based on a risk assessment, for example a hazard identification and risk assessment (HIRA) or site specific JRA; and
4. A pre-lift meeting or toolbox talk to be conducted involving all relevant parties. Those at this meeting would use the lift plan, relevant drawings and JRA as a basis to summarise the proposed lifting operation.
5. The lift path is defined in the lift plan.

See Figure 3 for an example lift plan which can be used for non-routine lifts.

The degree of planning can vary considerably and will depend on the type of equipment to be used and the complexity of the operation.

A non-routine lift plan should be prepared by the competent person appointed to plan the lift. This then needs to be reviewed and approved by another person competent to perform this role.

4.1.4 Engineered Lifts

Engineered lifts require detailed engineering by an onshore organisation following established engineering standards and procedures.

An engineered lift will require:

1. The completion of a risk assessment in accordance with company procedures;
2. The preparation of a specific lift plan prepared by engineering staff to support the project installation step-by-step procedures. The engineering analysis for the lift plan may need to consider such matters as: structural assessments; dimensional checks; rigging design calculations; the effects of environmental conditions etc., and detailed engineering drawings will need to be prepared;
3. The consideration of vessel stability, especially in circumstances involving the sudden loss of hook load. If counter ballasting measures are used to carry out the lifting operation, such as transfer of ballast water and/or fuel, or other measures, the effects on stability of a sudden accidental loss of hook load due to failure of the lifting equipment should be thoroughly assessed. Appropriate measures to safeguard the vessel should then be identified and implemented.

See Figure 3 for an example lift plan form.

4.2 Lift Plan Considerations

Some information is provided through any pre-engineering or assessment of the lift, but the plan and preparation for the lift should address all relevant local factors as well as any information already obtained.

4.2.1 Lifting Environment

All lifts are exposed to dynamic effects due to differences in hoisting/lowering speeds, crane and vessel motions and load motions.

Lifting activities are undertaken in different environments such as those found in onshore and offshore activities including:

1. onshore operations;
2. internal spaces of vessels and rigs;
3. mobilisations at the quayside or at sea;
4. transferring a lifted object from other vessels and platforms;
5. moving a lifted object around the deck at sea; and
6. deploying or recovering a lifted object in the sea, including placing and removing a lifted object on the seabed or on top of an existing structure either subsea or on surface.

Specific effects of offshore environments include:

1. vessel motion and stability;
2. weather, wind and sea forces;
3. surface, mid water and seabed currents;
4. adjacent structures, vessels;
5. seabed suction, hydrostatic and hydrodynamic loading;
6. axial resonance of crane/winch rope;
7. change in centre of rotation caused by positive and negative buoyancy effects;
8. noise, light, spray, etc.;
9. diminished subsea visibility.

All relevant environmental effects need to be considered.

In the case of jack-up vessels, all requirements for safe jacking should have been carried out. Once the jack-up vessel has been verified to be in a stable condition then the environmental conditions for that location need to be applied to the lift planning.

4.2.2 Communications

Communication options should be considered. They could be verbal, visual and audible with a number of people often operating different equipment, potentially each working in dissimilar environments (see section 5.7).

5 A Methodical Approach to Planning and Executing a Lift

5.1 Lift Plans for Routine and Non-Routine Lifts

Planning requires a combination of:

- ♦ initial planning to ensure that the equipment provided is suitable; and
- ♦ planning of the individual lifts to ensure they are carried out safely. In particular:
  - – the lift plan should be prepared by a competent person, together with others where necessary
  - – the lift plan should be based on a risk assessment
  - – the lift plan should address the risks identified by the risk assessment and should identify the resources, procedures and responsibilities to allow the lifting operation to be carried out safely
  - – the lift plan should include confirmation that the equipment selected is safe and remains safe for the range of operations for which it will be used
  - – the lift plan should define the pre-use checks required and their frequency
  - – the lift plan should include identification of methods of communication and language
  - – the lifting team should be selected
  - – the degree of planning can vary considerably and should depend on the type of equipment to be used and the complexity of the operation
  - – if the established company procedures are changed, then a management of change procedure is required
  - – where more than one 'employer' is involved in a lifting activity, the lift plan should detail specific roles and responsibilities for the operation. The lifting operation should be co-ordinated by the lift supervisor. Personnel involved in the lifting operation should be suitably instructed and consulted in the planned operation so that they are aware of their responsibilities, the control measures to be used and the sequence of events to be followed
  - – prior to commencing a lifting operation, a pre-lift meeting should be conducted with all relevant parties. Those at the meeting should use the risk assessment, lift plan and relevant drawings as a basis to summarise the proposed lifting operation. See Figure 3 for an example lift plan and note the wide range of items that the sample plan addresses.

5.2 Lift Plans for Engineered Lifts

This section covers issues relating to engineered lifts. Engineered lifts are those which are project-specific and the equipment has been specifically designed or selected for the operation. The planning process begins within an engineering department, resulting in an installation procedure being written and a lift plan for an engineered lift being developed.

Lift plans for engineered lifts are generally prepared onshore. Company procedures should set out a format which provides a simple and consistent practice for engineers to follow when preparing documentation for engineered lifting operations onshore or offshore. The engineering planning should incorporate careful analysis of the proposed lift.

An engineered lift plan and associated drawings should be prepared during the engineering phase and incorporated in the appropriate project installation procedure.

It should be noted that:

- ♦ The engineered lift plan would not be intended to replace the installation procedure which remains the primary procedure, but could act as a summary of points to be considered by all parties prior to commencing a lifting operation onshore or offshore;
- ♦ Preparing an engineered lift plan should have the effect of highlighting any concerns that need to be addressed in the project installation procedure; e.g. control of a swinging lifted object, appropriate crane modes for phases of the lift;
- ♦ An engineered lift plan should be treated as a live document right up to the execution of the lift. It should be subject to the same reviews as for a general lift plan. Any potential changes to the lift plan need to be implemented through the management of change procedure (see section 5.8);

- Once on site the engineered lift plan should then be finalised by the relevant competent person; and
- Where the lifting operation involves the fabrication of new lifting accessories, modifying existing lifting accessories, e.g. spreader beams, or selecting materials for lifting operations, the proposed design should be submitted to the competent person. There may also be a need to consult, for example, a verification body, a technical authority, or manufacturer, who would provide guidance on the suitability of the design. This competent person should conduct a design review or verification, taking into account design codes, standards and practices as well as compliance with all applicable regulations.

Following this format should provide consistency throughout a company's worksites from the outset, at and through the engineering planning phase and continuing through the execution of the lifting operation.

5.2.1 Rigging Specification Summary Drawing

For an engineered lift a rigging specification summary drawing should be completed during the engineering preparation phase for the lift (see Figures 4 and 5).

The following is the purpose of a rigging specification summary drawing:

- to summarise the rigging requirements from the engineering planning;
- to specify requirements for the lift rigging to the rigging suppliers;
- to specify requirements for the load tugger connections;
- to act as a material take-off table and quality control check for relevant company departments;
- to specify the centre of gravity (CG) and centre of buoyancy (CB) in two planes; and
- to provide the lift supervisor on site or offshore with all the details required on one drawing to refer to whilst rigging the load. This should include weight in air and weight in water submerged. Both engineered weight and actual weight of the object to be lifted should be included.

Sample rigging specification summary drawings provided in Figures 4 and 5 illustrate the typical details that should be included.

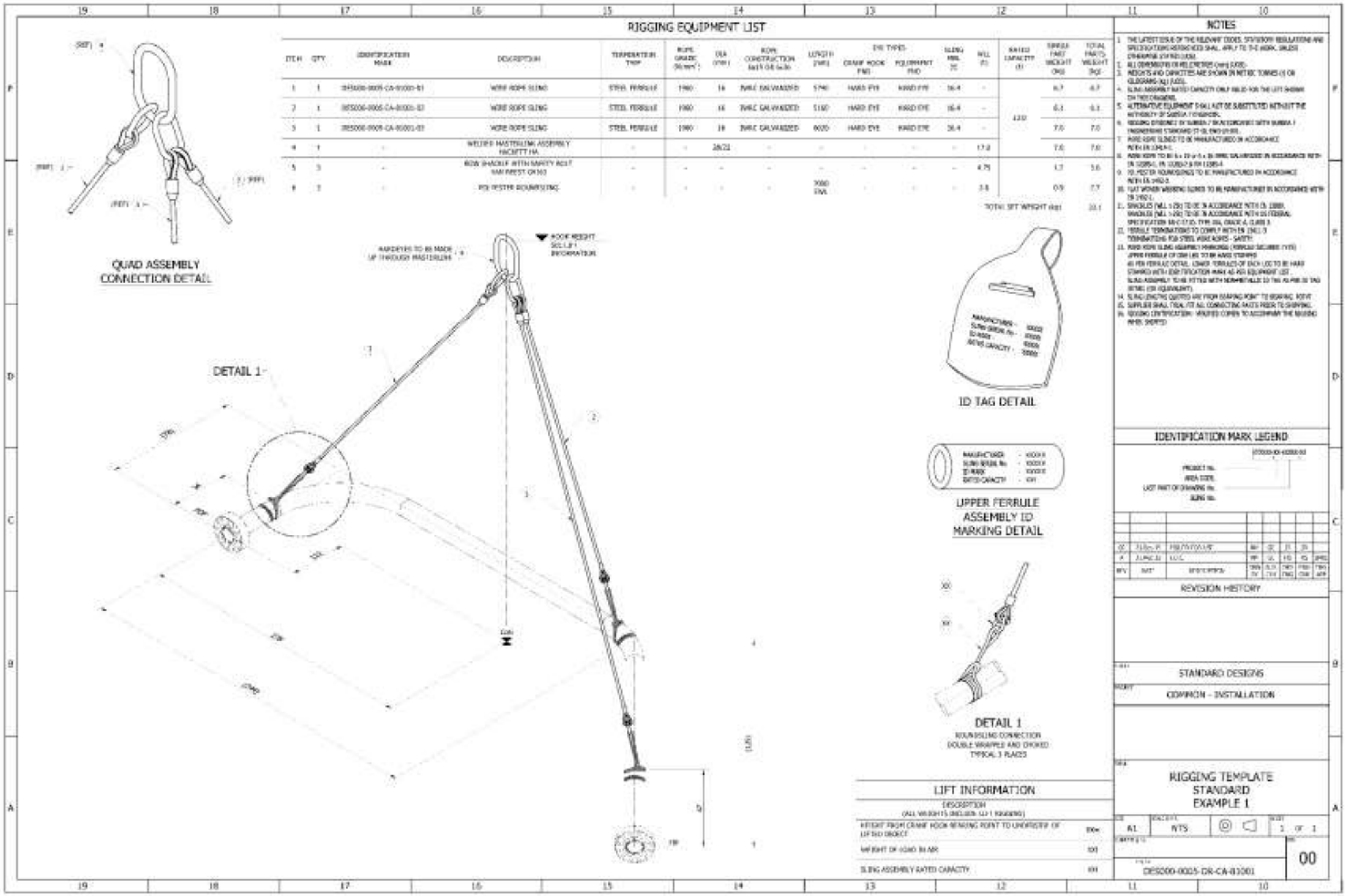


Figure 4 – Example 1 rigging template

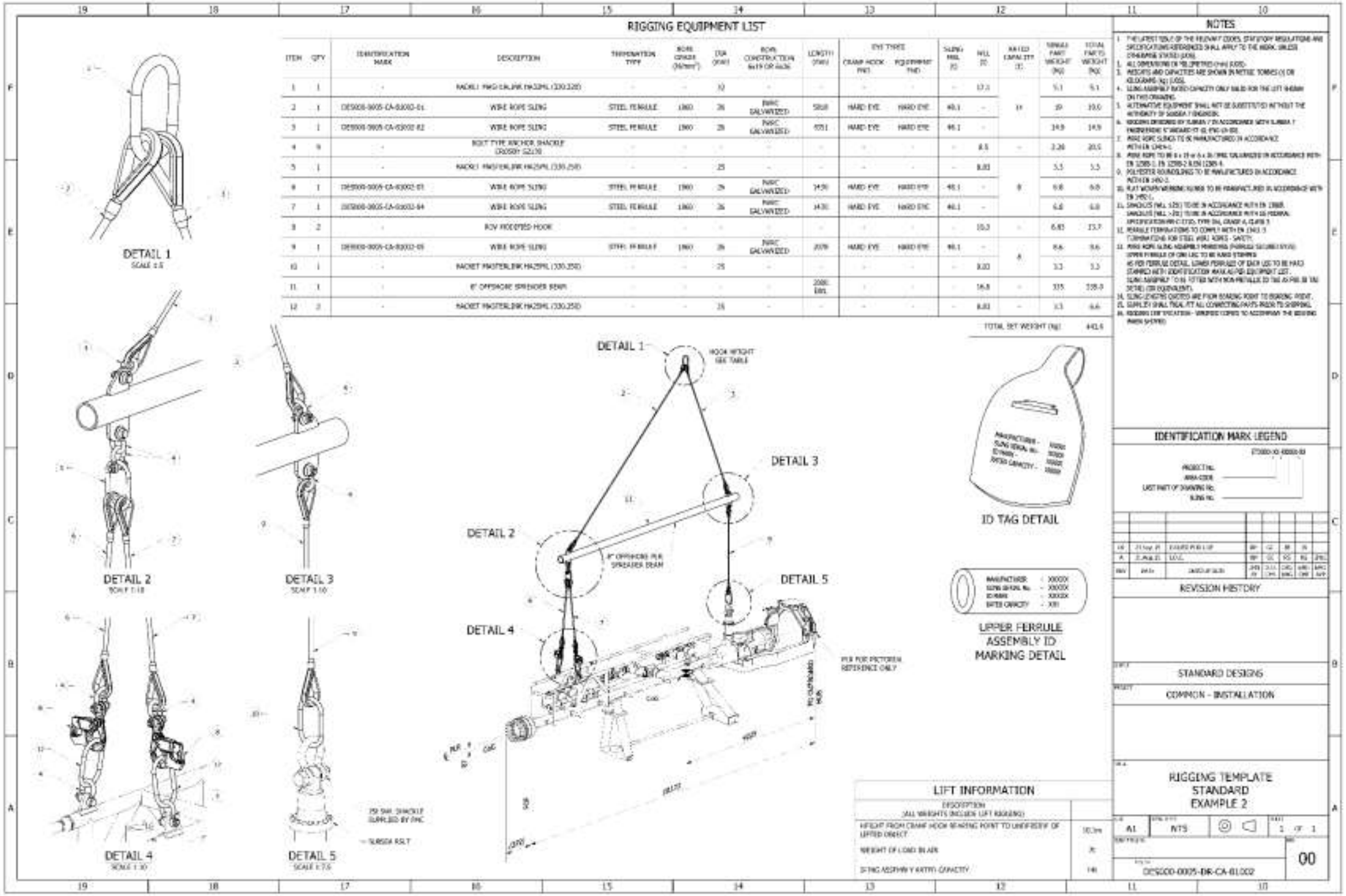


Figure 5 – Example 2 rigging template

5.2.2 The Use of Crane Charts for Engineering a Lift Plan

Load radius curves (crane curves) are graphical display(s) of the safe working load relative to the crane radius. Due to the complexity and variation of use of the crane there may be many sets of crane curves to present the full crane capacity in an understandable form. Unfortunately, there is no standard format for presenting this information and all crane manufacturers have developed their own methods of displaying this critical information.

The basic crane curve is a diagram and/or table showing the permissible crane safe working load relative to the possible range of hook radii. This is normally plotted as a curve which generally shows that the crane lifting capacity decreases as the hook radius increases. However, knuckle boom cranes do not follow this model.

The number of falls of rope and the permissible static loads for different dynamic conditions can also be displayed together with the associated vessel lift modes together with the associated design dynamic amplification factors. For harbour lifts it is imperative that the lift is evaluated on high and low tide.

It is essential to always check which crane curve is to be used when planning and engineering a lifting operation.

Note: Harbour lift (or shore based) crane curves should generally not be used to engineer offshore lifts.

Example graphics from a knuckle boom crane curve are shown in Figure 6.

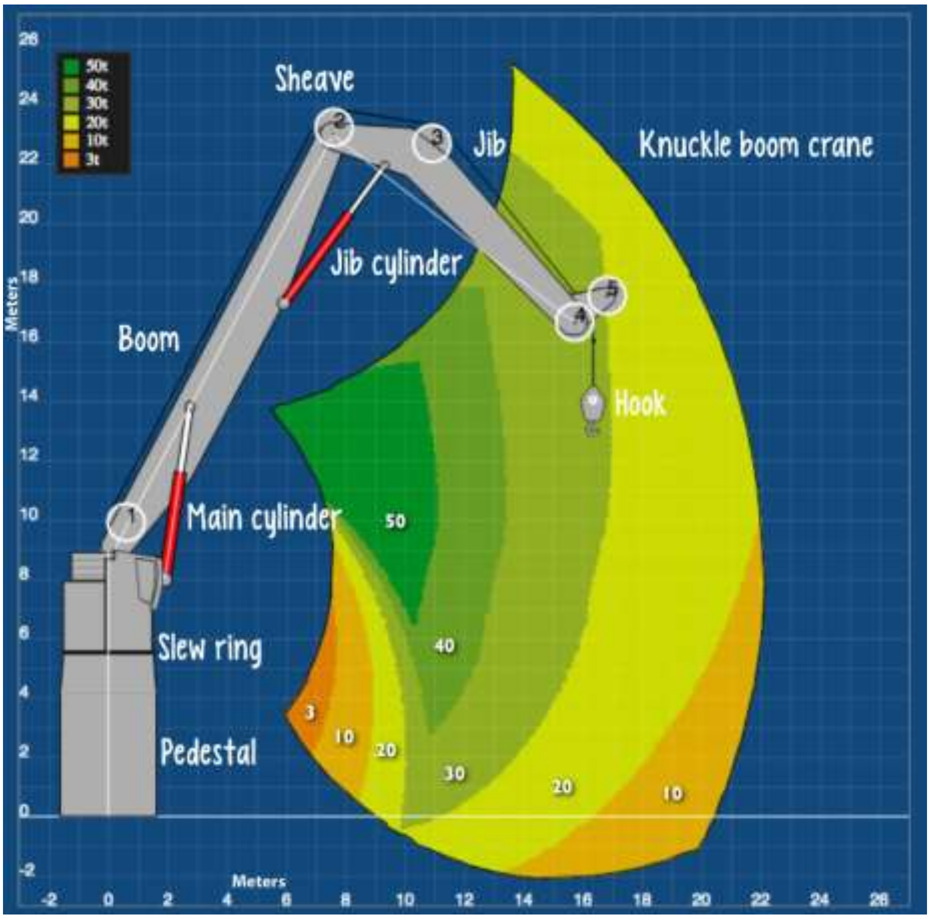


Figure 6 – Typical example of a knuckle boom crane curve

The shaded areas represent maximum lift capacity in relation to the rope exit point on the knuckle jib. Note that at a radius of 7.0m the maximum lift capacity varies from a maximum of 50t to only 3t due to the load acting on different parts of the boom and knuckle jib.

5.2.3 De-Rated Crane Curves

Current and wave motions and other environmental conditions will, to varying extents, influence the dynamics of an offshore subsea lift. The effects they have on the crane capacity is called 'de-rating'. De-rated crane curves define the operating parameters for the applied load-radius curve(s), to ensure that the crane is suitable, given the design assumptions made.

It should be noted that the limiting crane operational conditions should normally be expressed by the relevant combinations of the following limiting parameters:

1. DAF;
2. wind speed;
3. hoist line angle tolerances relative to crane (both side-lead and off-lead);
4. static heel and trim of crane vessel;
5. crane tip motions/accelerations due to waves;
6. motions/accelerations of the vessel where the lifted object is lifted from;
7. wave conditions, e.g. expressed as a function of significant wave height (H_s) and/or sea state.

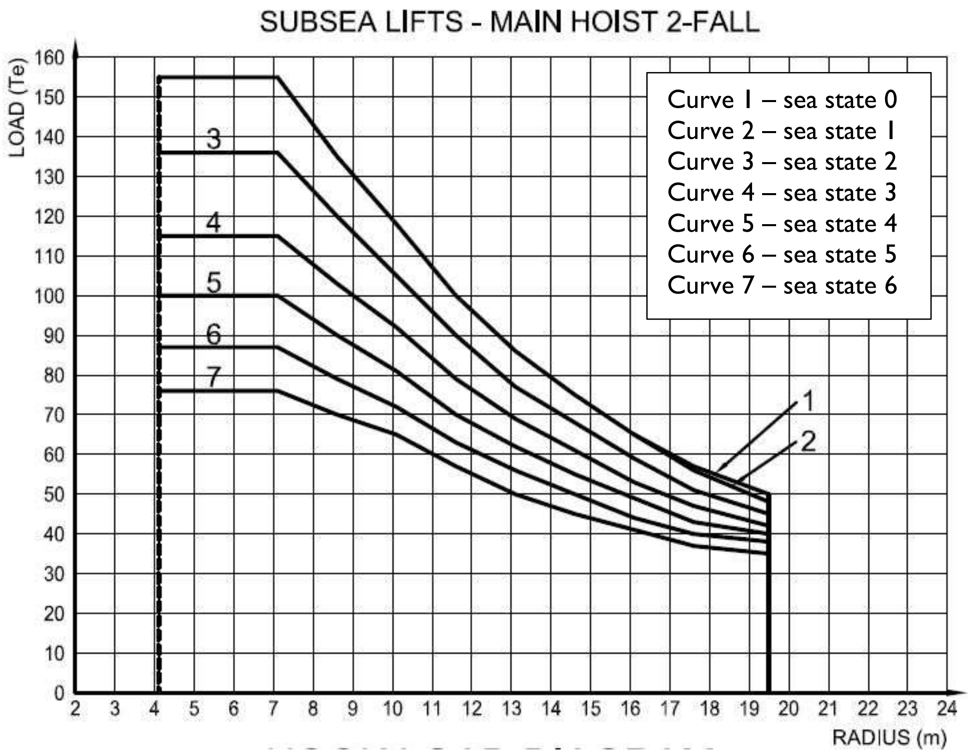


Figure 7 – Sea state de-rating

5.3 Considerations for all Lifts, Routine, Non-Routine and Engineered

The check bullets listed below are not exhaustive and are intended to purely act as reminders.

5.3.1 Initial Considerations for the Assessment of the Load and its Handling

For any type of lift an assessment of the load and associated elements of the lift are vital:

- What is the weight of the load?
- Is the weight verified?
- Is the load designed for offshore lifting, for example container type?
- Is the landing area load capacity adequate?

- Before using any lifting equipment, the members of the lifting team should check that appropriate and correct certification is present and correct for each item. It is the responsibility of the lift supervisor to ensure that only lifting equipment carrying valid and correct certification is used.
- The security and suitability of any positioning aids on the lifted object should be checked, e.g. transponders, light sticks, tag lines; markings, etc.
- Can slinging points be accessed safely?
- Connection of the tugger lines to the load when taking into consideration the following:
  - accessibility of connection points
  - weight of tugger line
  - rigging.
- Is the load slung in a stable fashion with no potential dropped objects in or on it?
- Is the centre of gravity (CG) and centre of buoyancy (CB) known?
- For offset CG/CB, consider the use of lifting beams, frames or asymmetric rigging arrangements.
- Does the load have integrity and internal stability, e.g. liquids?
- What are the rigging and crane loadings during up/down ending of the load?
- Is the shape or size difficult to sling?
- Is it a very long load, liable to rotate etc.?
- Will it flex under suspension?
- Does it require securing to its cargo carrying unit?
- Is it fragile?
- Is it high value?
- Are there chemicals in the load?
- Is the presence of stored or potential energy known? e.g. pressure vessels, live electrical sources, components which include mechanical potential energy, including springs etc.
- Is there an anticipated tilt on the lifted object?
- What offlead and sidelead will be imparted into crane and do these exceed structural limits of the crane or geometric limits from rope/sheave interaction?
- Particular attention should be given to the crane rope after landing a load: a sudden difference in the line tension can make the rope slack and release its torque, generating an uncontrolled movement which can be amplified by operational conditions, such as vessel movement and wind.
- On a floating vessel, a lift at height is subjected to amplified movement caused by the great distance of the crane boom tip from the centre of buoyancy of the vessel. In addition, landing of the load may cause a floating vessel to move due to the sudden loss of load in the crane which changes vessel stability.
- Are there any sharp edges that may contact slings? If so, consider use of protection where necessary, especially where synthetic slings are being used.
- Are all holding down bolts/sea fastenings removed?
- Removal of sea fastenings should be such that no vertical restraint will occur during lift-off. Personnel can be at risk if removals are not adequately planned and thought through.
- Are all necessary work permits and permissions obtained for the lift?
- The overall rigging arrangement for the lift should be assembled and connected as specified in the relevant lift plan.

- Lifting operations should not commence until pre-lift checks have been completed satisfactorily by competent personnel and it has been determined that all appears to be in order.
- On deck, there should always be adequate clearance for objects to be lifted around or between other objects.
- A final check should be carried out to confirm there is sufficient crane hook height available to overboard the lifted object.
- Relevant areas should be cordoned off.
- The security of the rigging should be checked to minimise the risk of accidental or unintended disconnection of the lifted object during all lifting phases,
- The lifting appliance connection point should be positioned over the lift centre of gravity to avoid uncontrolled horizontal movements. The load should be increased gradually to ensure that the lift rigging arrangement is aligned correctly.

To avoid any potential injury or damage, control measures such as bumpers, pivoting arrangements or guides may be considered.

5.3.2 'Tag' Lines

In certain circumstances light, soft lines may be used to assist in the handling of long and/or fragile loads. These are often referred to as 'tag' lines.

It should be recognised that whilst such aids may assist operations their use does introduce some additional risks, as described below.

- Potential injuries from dropped objects because of personnel having to work in closer proximity to suspended loads.
- Potential injuries resulting from personnel being dragged across the load handling area by a heavy load rotating in an uncontrolled manner and the tag line being snagged on limbs or clothing.
- Potential injuries resulting from tag lines being secured to adjacent fixed structures parting and snapping back because of a load rotating in an uncontrolled manner.

To mitigate some of the risks the make-up of tag lines should be as follows:

- Tag lines should be made up from single, continuous lengths of rope.
- Apart from the knot attaching the line to the load, there must be no other joints or knots in the line.
- Tag lines should be of sufficient length to allow personnel handling cargo to work in a safe position well clear of the load. In this regard it is recommended that the length of the line should be not less than 1.5 times the maximum height above the handling area at which the tag line arrangements are to be used.

When tag lines are being used the following precautions should be observed:

- Tag lines are an aid to positioning the load when landing, and as such should only be used when weather conditions permit the lifting of the item without the use of such arrangements. It should not be assumed that in more severe conditions the use of tag lines will allow the operation to be completed safely.
- At all times personnel handling tag lines should work at a horizontal distance from the load equivalent to its height above the handling area, maintaining an angle between the line and the horizontal of not more than 45°.
- All sections of the tag line, including slack should be kept in front of the body, between the handler and the load.
- Where two or more persons are handling the same tag line, all should work on the same side of the line. Any slack should be kept in front of the group.

- Tag lines should be held in such a manner that they can be quickly released. They should not be looped around wrists, or other parts of the body.
- Care should be taken when using tag lines whilst wearing gloves, to ensure that the line does not foul the glove.
- Tag lines should not be secured or attached in any manner to adjacent structures or equipment. This includes the practice of making a 'round turn' on stanchions or similar structures and surging the line to control the load.
- Where pre-installed lines are used consideration should be given to providing personnel with boathooks or similar equipment to retrieve the lines without having to approach the danger zone in the vicinity of the suspended load. An example of such circumstances would be when lines are attached to a load on the deck of a vessel, the load then being transferred to an offshore installation.

5.3.3 Considerations for the Selection of Lifting Equipment

Selection of lifting equipment is covered generally in section 5.5. Initial assessment should include the following:

- Is ballast and/or anti-heel system of the vessel adequate?
- Sling angles and lifting attachment angles.
- Are attachment points adequate?
- How are slings to be attached?
- Is the hook type appropriate?
- Manual handling of heavy rigging?
- Will divers or ROV be involved and are slings/attachments compatible with underwater work?
- Is there a lifting point available directly overhead?
- Is the sling arrangement suitable for the CG?
- Sling lay direction – left hand lay and right hand lay slings should not be connected in series.
- Will the layout of the slings affect control of the lift?
- Any problems with geometry of slings and crane hook?
- Is buoyancy attached to sacrificial slings for ROV cutting?
- Are remote controlled or local release shackles required?
- Are tag lines required and does the lifting team understand the safe use of tag lines?[1]
- Is a tandem lift necessary?
- Is cross hauling required?
- Will active and/or passive heave compensation systems be in use?
- Will the crane constant tension function be required?
- Are sheaves and attachment points adequate for the possible load tugger winch/crane loading?
- What crane tugger winch mode is to be selected for the specific operation, taking into consideration speed, constant tension or damping mode?
- What will be the expected maximum load tugger line force and speed?
- Is there a method of observing spooling on drums and rope path through sheaves?
- Is suitable lifting equipment available?
- Will lifting equipment need to be moved to another location(s) during the lift?

1 Reference to Guidelines for Offshore Marine Operations (GOMO) Appendix 9-C

- Is the load to be manipulated on the seabed?
- Will ROVs or divers be of use in the operation?
- Is the rope sufficient in length/construction for deep water?
- Will sling dynamics have an effect?
- Is there protection for any control and/or divers' umbilicals?

5.3.4 Assessment of the Lift Path and Movement of Lifting Equipment

The assessment should include the following:

- Will the load need to be rotated or changed in aspect to lift safely?
- Is there adequate space to lift and manoeuvre the load?
- Lifting to or from inboard/outboard – check free height over vessel's handrail.
- Is the lift path clear and appropriately cordoned off?
- Will movement of the vessel or lifting equipment during the operation impose problems with the lift path?
- Will movement of the vessel or lifting equipment during the operation negatively affect the load tugger winch operation?
- Are there any conflicting operations (for example other crane jibs working in near areas)?
- Is there sufficient crane boom clearance from other cranes, vessels, platforms or obstructions?
- Is the crane's slewing circle free from any potential obstructions? e.g. counter-ballast.
- Could the load contain potential dropped object(s) especially when up/down ending is required?
- What checks are required for clearance of subsea infrastructure, moorings and deployed submersible diving chambers (SDC)?
- Where is a 'genuine' place of safety for deployed divers during lifting operations in support of manned diving operations (refer to section A2-2 for drop cone analysis)?
- Is the set-down area suitable with respect to:
  - space?
  - weight bearing load?
  - stabbing arrangements or other guides?
  - sea fastening arrangements where applicable.
- If set down is in a subsea location is there:
  - observation?
  - control?
  - marking of the landing point?
  - adequate clearance from subsea infrastructure?

5.3.5 Environmental Effects

The following items should be taken into consideration:

- Will the load be adversely affected by windage? Consider that wind speed may vary at different lifting heights.
- Will vessel/crane movement affect the operation?
- Will the load move through potential changes in environment, for example the splash zone, on its lift path?

- How is the vessel controlled at the time of the lift, for example is it under way, on dynamic positioning, jacked-up, anchored, moored, berthed alongside; will a change of position, heading, trim, heel or vessel motion positively or negatively affect the environmental forces acting on the lift?
- Consider effects from waves breaking over decks.
- Is active and/or passive heave compensation to be used and has its use been risk assessed?
- Is constant tension to be used and has its use been risk assessed?
- If the load is going subsea is it suitably prepared?
- Will the load flood as it submerges or drain out water as it surfaces?
- What is the anticipated rate of flooding/draining?
- What is the possibility of the load having air entrapment?
- 'Slack line' and 'shock loading' considerations.
- If load is to be deployed or retrieved subsea, assess the effects of buoyancy and/or added mass.
- Has consideration been given to the effect of seabed suction on loads to be retrieved from the seabed?
- If working in deep water other dynamic forces on the load and the wire/fibre ropes might apply.
- Lifts can take place in a variety of environments each likely to affect the lift in different ways, for example to and from quay and vessel, on deck, vessel to vessel or vessel to platform.
- A vessel is rarely motionless and apart from movement induced by the environment, dynamic loading from forces such as a load passing through a splash zone or operating to and from the seabed can all affect its inertia. Thus, the effective weight can increase during certain parts of the operation.
- Possible use of motion reference units (MRUs) for monitoring crane tip accelerations.
- The effects of rain, snow, ice, wind, noise, poor underwater visibility, lack of light or the effects of light source(s) and shadow (for example crane operator or lift supervisor looking into bright sun; or from looking from light to dark and the effect on eyes or camera lens) can all affect the way in which a load will need to be controlled and handled.

5.3.6 Out of Plane Forces

Even in calm seas there will always be some (small) unsolicited movement of a suspended object. Lifting operations carried out in 'marginal' weather conditions can easily lead to situations where objects begin swinging out of control as they are lifted from the deck.

This swing induces component stresses on the lifting appliance that are not often considered. There can be side-loading of the crane jib if offshore lifting operations are carried out from vessels – especially those operating in unsuitable weather conditions. 'Side-loading' means a load applied at an angle to the vertical plane of the jib. 'Off-loading' may also occur. This is when the load line, under tension, deviates outwardly from the crane. See Figure 8.

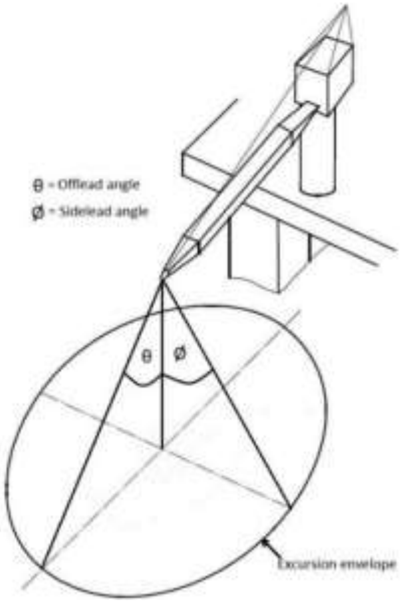


Figure 8 – Sidelead and offlead angles

A crane set on a moving deck is likely to experience significant side-loading forces. The maximum allowable limits for sidelead and offlead angles are generally included in the crane design specification. Even in calm conditions side-loading may also occur if objects are lowered to depth during periods of high tidal or current flow. In such circumstances, the lifted object and crane line may be significantly deflected from the rope exit point by the force of the tide/current. In addition to over-stressing of the crane there is also a risk that the crane rope may ride out of sheaves causing damage and potential catastrophic changes to the load's dynamic amplification factor which may result in loss of load. Consideration should also be given to the impact of side loading on the lifting points.

5.4 Risk Assessments

5.4.1 Job Risk Assessment (JRA)

A suitable documented risk assessment is needed for any lifting operation. However, this may already exist. For example, for a routine lift it may be in the form of a HIRA document or an operational review document. If a risk assessment already exists, then it should be reviewed for its applicability to the current situation prior to carrying out the lift. The assessment of lifting equipment should also be included in the JRA.

The competent person, together with the lifting team, should carry out a site specific JRA before the work begins. The competent person should ensure that appropriate controls are in place for those hazards identified in the written risk assessment such that the risks are managed as an integral part of the lift plan.

If lifting operations are being carried out in support of manned diving operations, then the risk assessment should include assessing and controlling the hazards and risks associated with the potential proximity of diving personnel, subsea assets and equipment and the area of deployment/retrieval of subsea loads. Consideration should be given to the potential 'drop cone' of loads which may become detached from the lifting arrangement and put the divers at risk (see section A2-2).

5.4.2 Risk Assessment Matrix

A risk assessment matrix can be used with the job risk assessment. This permits the quantification of the probability and severity of the hazards for a particular activity. The product of both indicates the level of risk.

5.5 Selection of Lifting Appliance

The competent person should identify the appropriate lifting appliance and accessories required considering general issues such as those identified in section 5.3; confirming that all the lifting appliances are fit for purpose, has appropriate certification and is checked for defects before use.

The competent person should take into consideration, for example:

- equipment to be sized for expected maximum dynamic load;
- the place where it will be used;
- the conditions under which it should be used;
- the purpose for which it should be used (e.g. if it is certified for subsea use?);
- inherent risks to health and safety as a result of its use;
- ergonomic risks;
- manual handling;
- maintenance and inspection requirements.

If selecting a crane for a specific project, IMCA LR 002/M 171 – *Crane specification document* – provides useful guidance.

5.5.1 Pre-Use Checks

Prior to use, the operators of lifting equipment and accessories should perform a pre-use check to identify faulty equipment. The frequency of checking is intended to detect faults due to wear and tear.

5.5.2 Vessel Stability

Vessel stability should be accurately calculated by those planning offshore/subsea lifting operations. The effects of raising loads from the deck and landing them elsewhere can affect the vessel's motion, trim, heel and stability, depending on the weight of the load in relation to the size of the vessel and the height and position of the crane boom rope exit point in relation to the centre of gravity of the vessel. This can be noteworthy even for relatively small loads, increasing in significance for heavy lift operations. Load misalignment during a lift off or failure of a tugger winch can potentially impact vessel stability.

When the lift is transferred to another floating unit the effects can be further complicated. Care should be taken that lift plans include proper consideration of the effects on vessel(s) stability.

In addition, the motion induced by changes in vessel stability can also affect the stability of the lifting equipment.

5.5.2.1 Loss of Hook Load Affecting Vessel Stability

If counter ballasting measures are used to carry out the lifting operation, such as transfer of ballast water and/or fuel, or other measures, sudden accidental loss of hook load due to failure of the lifting equipment should be considered at the most unfavourable point at which the hook load may be applied to the vessel, i.e. induce the largest heeling moment. Such loss will cause the ship to immediately roll away from the side of the lift. Consideration should be given to any potential down flooding points such as open hatches.

The safety of the lifting operation should be demonstrated by either complying with a simplified criterion based on the vessel righting lever curve properties to assess the maximum dynamic heeling angle. For lifts outside sheltered waters, the method below should be applied.

5.5.2.2 Simplified Criterion Based on Righting Lever Curve Properties

After the hook load is lost, the ship will heel over from the working list, ϕ_1, to the maximum (dynamic) list, ϕ_2, before settling at the equilibrium list, ϕ_C. Referring to the righting lever curve after loss of hook load for such operations, the following minimum stability criteria should be complied with: The angle of static equilibrium ϕ_C after loss of crane load should not be more than 15° from the upright or 17° in case the deck edge is not immersed. In sheltered waters an angle of static equilibrium of 20° is acceptable.

Reference should be made to the amendments to Part B of the 2008 Intact Stability Code section 2.9.5 – Sudden loss of hook load.

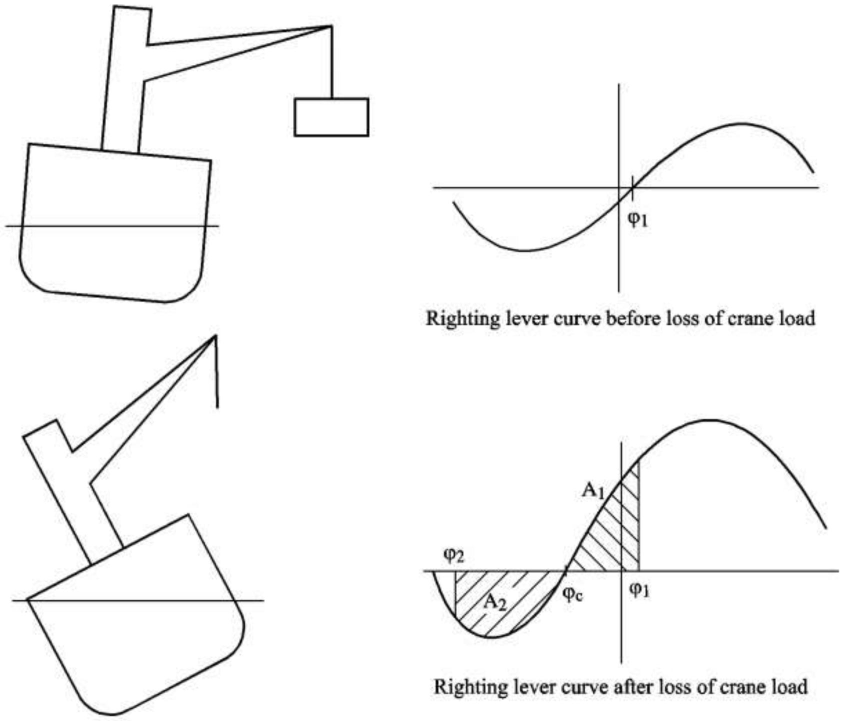


Figure 9 – Simplified criterion based on righting lever curve properties

5.6 Heave Compensation

It is important that all personnel, including client representatives, have an understanding of the function and capabilities of the heave compensation systems offered.

5.6.1 Passive Heave Compensation

A passive heave compensation (PHC) device acts as a spring device normally with a predefined, relatively low stiffness. They are typically hook mounted, but may be mounted on the vessel deck or integrated in the crane heave compensation system. It allows relative vertical motion while keeping load variations in the ropes, suspending the load within acceptable limits. Passive heave compensation systems normally require no power supply for their operation. For subsea lifts, PHC efficiency is dependent on the properties of the lifted object.

5.6.2 Active Heave Compensation

Active heave compensation (AHC) systems utilise actively controlled devices, which can operate in various modes depending on the required characteristics. They maintain a constant vertical position (AHC-mode) of a free hanging load to a reference point.

The introduction of AHC systems has been of huge benefit to the subsea construction industry over recent years. They involve real time automatic control of the winch or a compensating cylinder in order to counteract the vertical motion of the jib head. Information on crane motion, from which boom tip heave is derived, comes from a motion reference unit (MRU). AHC systems often make use of energy stored in pressurised nitrogen accumulators. An active system which does not take advantage of stored energy in accumulators would require additional energy to drive the winch or compensation cylinder.

While AHC can greatly reduce the movement at the hook, no crane AHC system can compensate for all vessel related movement (see Figure 10).

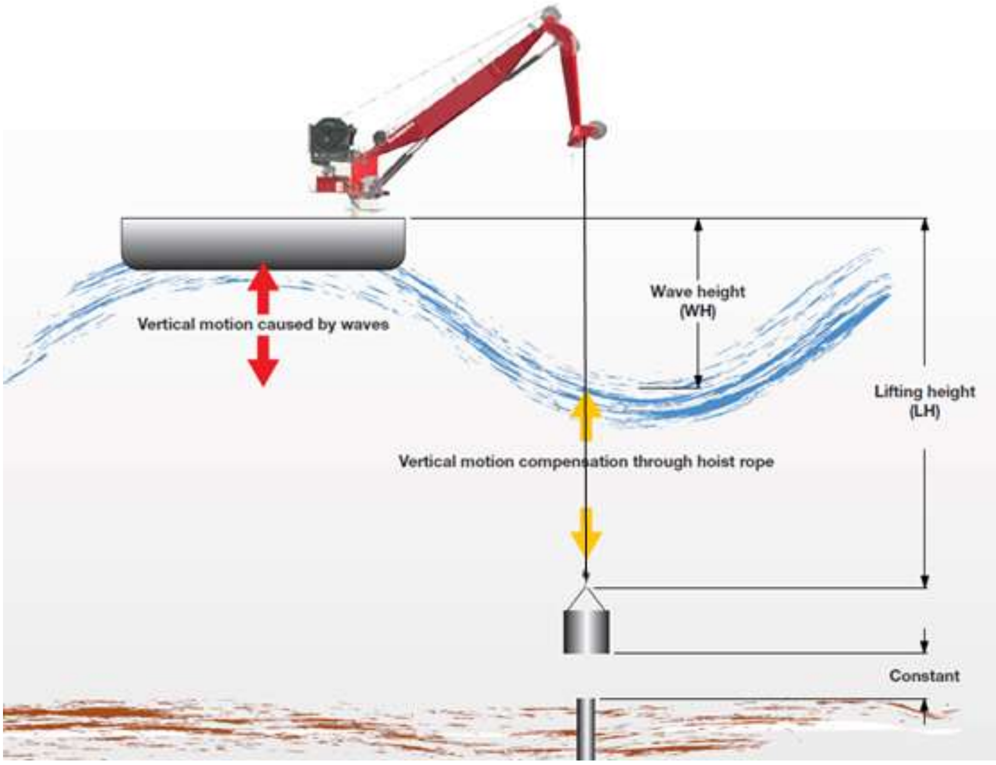


Figure 10 – Illustration of active heave compensation mode

It is important to understand that an AHC system controls the hook/load position and does not limit force transmitted back to the winch. Thus it is still possible to overload a crane whilst AHC is engaged. This is a particular risk if seabed suction occurs or if the hook is attached to a fixed point/structure. AHC should not be confused with CT (constant tension) which is much more suited to operations involving suction or fixed objects.

The benefits of AHC are primarily:

- to limit set down speed (and impact) of structures/loads when placing on the seabed/in location;
- To reduce the amplitude of the motion of a load and stabilise it to, amongst other things, enable ROVs or divers to place rigging on/remove from the hook safely or position the load in relation to another object and facilitate operations such as stabbing etc.

AHC should only be used sparingly and lifted objects should never be left on the hook for prolonged periods of time in AHC when there is no operational need. The heat generation in the rope due to tension and cyclic bending over sheaves (CBOS) can cause accelerated fatigue of the rope. Additionally, the prolonged use of AHC imposes unnecessary duty to the detriment of pumps, motors and gearboxes. Where difficulties are encountered during an operation with a crane in AHC, then it is prudent to reposition the crane with the winch back in normal mode (i.e. no AHC) whilst those difficulties are overcome (e.g. ROV repair). Project installation engineers and operations personnel should have in place contingency plans to take the crane out of AHC during its planned use, should the operation become prolonged or if difficulties are encountered.

It is essential to prevent excessive fatigue on a single section of rope which may render the whole rope unfit for further use.

IT IS RECOMMENDED to use AHC:

- through the water column when interacting with an ROV and/or divers;
- when presenting/landing a load from a floating vessel to/on a fixed object;
- during approach to seabed when setting down and disconnecting load/connecting (slack) rigging and raising a load from a firm seabed (no suction).

IT IS NOT RECOMMENDED to use AHC:

- in lieu of a constant tension mode with the aim of avoiding overload resulting from the motion of the vessel when attached to a fixed structure/point that is subsurface, e.g. for opening/closing hinged hatches on fixed subsea structures;
- in order to try to reduce dynamic loads when lowering a lifted object through the water column – PHC is more appropriate for this part of the operation;
- when lifting a subsea load that is subject to suction;
- for extended periods unless necessary;
- at the same water depth over a protracted campaign without monitoring rope condition;
- when weather conditions or operational constraints do not require it.

5.6.3 Combination Passive/Active Heave Compensation

This combines the two systems described above.

The capabilities of the system under varying loads and environmental conditions should be fully discussed between manufacturer and customer. An accurate measurement or estimation of vessel motions is critical in ensuring that heave compensation systems meet expectations.

5.6.4 Constant Tension (CT)

This is used to achieve a constant line-pull set by the crane operator. The line-pull is measured by a load cell and monitored by the control system. If the actual value differs from the preset value, the winch will either pay in or pay out rope to maintain the preset value. Instant adjustment of the rope tension is possible by changing the tension set point value.

Constant tension can, for example, be used to pre-tension a rope prior to hoisting a lifted object from a supply boat or after landing a lifted object onto the seabed. CT prevents lifted object bounce on the deck or being picked up again. However, its primary use is for the lifting of loads subject to suction or potentially at risk of snagging/jamming on underlying structures. Care should be taken to avoid the prolonged use of CT when recovering a lifted object stuck in the seabed. CT can also be used on crane tugger winches.

Although useful for loading/unloading supply vessels, great care should be taken by the crane operator when setting the tension so that unintentional lifting of the lifted object does not occur resulting in a dangerous situation. This system is useful for maintaining a vertical line once a lifted object has been set down on the seabed during subsea construction activities (see Figure 11).

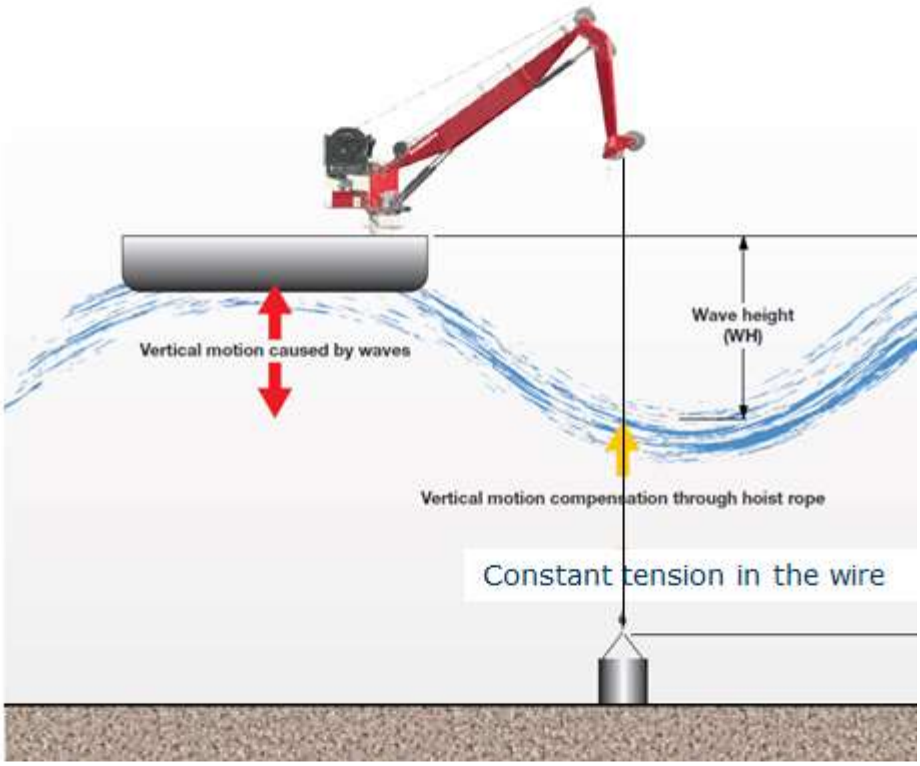


Figure 11 – Illustration of constant tension mode

5.6.5 Vessel to Vessel Lifts

Lifting a load from vessel to vessel presents additional risk factors than when lifting between fixed and floating locations.

When the lifting site and the landing site are floating they are usually both continuously moving and sometimes with differing motions. The crane operator should have been trained in this activity.

5.7 Communication

Failures in communications are often root causes of lifting incidents and can also be the most difficult to detect. Good training and adherence to correct procedures are vital but checking the actual situation at the worksite is of utmost importance. For example:

- are the personnel concerned all from the same company?
- do they all understand a common language?
- if not is there an established system of signals in strict use that they all know and understand?
- what different methods of communication can be used?
- what communication is required between the worksite and the source of any technical assistance elsewhere?

During manned diving intervention during a lift it is usual that the dive supervisor will be in overall charge of the execution of the work procedure when the lifted object is in the water. The dive supervisor will communicate and co-ordinate between the dive team for diver positioning, the bridge crew for vessel positioning, the deck crew/lifting appliance operator for deck and lifting operations. For lifts that go from a vessel into the water (or vice versa) then the different phases of the lift may be locally controlled by different people. The transfer of responsibility is key in this instance. For vessel based lifting operations it is usual that the deck foreman will control the lift above the waterline and the dive supervisor controls the lift below the waterline. However, the ultimate decision to commence the lift lies with the dive supervisor. The handover points should be clearly understood and verbally confirmed at each handover point. The lifting appliance operator should only take instruction from one person at a time during planned operations. However, anyone may call all-stop if there are unplanned events.

The following communications requirements appear in IMCA Diving Equipment Systems Inspection Guidance Notes (DESIGN) documents:

- Two-way voice communications with each diver and the standby diver/bellman should be provided.
- If diving is taking place from a vessel, then there should be both primary and secondary means of communication between the diving supervisor, the bridge and the crane operator. The primary link should be hard wired, immediately available and unable to be interrupted. One of these links should be able to operate without the need for external power supply.
- If a crane is in use in conjunction with diving operations, then there should be a dedicated communications link between the diving supervisor and the crane operator. Where possible this should be hard wired.
- If an ROV is in use in conjunction with diving operations, then there should be a dedicated hard wire communications link between the diving supervisor and the ROV operator.
- The diving supervisor should have verbal communications with the LARS winch operator. This should be dedicated and hard wired if he is remote.
- The diving supervisor should have voice communication with other areas, as relevant. This may include deck machinery operators, deck crew, etc.

Communication also extends to warning personnel of the lifting activity and keeping the lift area clear of personnel not involved in the lifting operation.

For comprehensive guidance on communications reference should be made to Parts A and C of IMCA M 205 – *Guidance on operational communications*, which provides general guidelines for operational procedures and specific operational guidance for systems and methods of communications in lifting operations.

5.8 Management of Change

Management of change (MoC) procedures can apply to all aspects of operations. Any member of the lifting team can request a management of change procedure to be invoked and suspend the lift. Assessment should then be undertaken to determine if an MoC is required. If it is required, the lift should not resume until the MoC procedures have been approved and implemented.

For further guidance on MoC refer to IMCA SEL 001 – *Guidelines for Management of Change*.

5.9 Toolbox Talk

Once at the worksite, the competent person should review the findings of the risk assessment and approved lift plan with the lifting team at a pre-lift meeting or toolbox talk. Individual responsibilities should be allocated to each person involved in the lifting operation, together with clear identification of the lift supervisor. This should also be included in the divers briefing prior to any dive basket/SDC deployment where subsea lifting is anticipated.

The risk assessment and lift plan should be discussed step-by-step to ensure that everyone clearly understands and agrees with the methods and control measures to be used. Using a lifting safety pocket card (see Figure 12) as a guide, any questions raised by anyone else involved in the lift should be discussed and accounted for within the risk assessment and lifting operations plan. If there is an agreed change to the risk assessment and/or lift plan, the documentation should be amended and re-approved by the competent person, following MoC procedures.

Typical prompts for a toolbox talk are provided in Figure 12, which shows IMCA safety pocket card number 3 – *Toolbox talks*. The prompts are as follows:

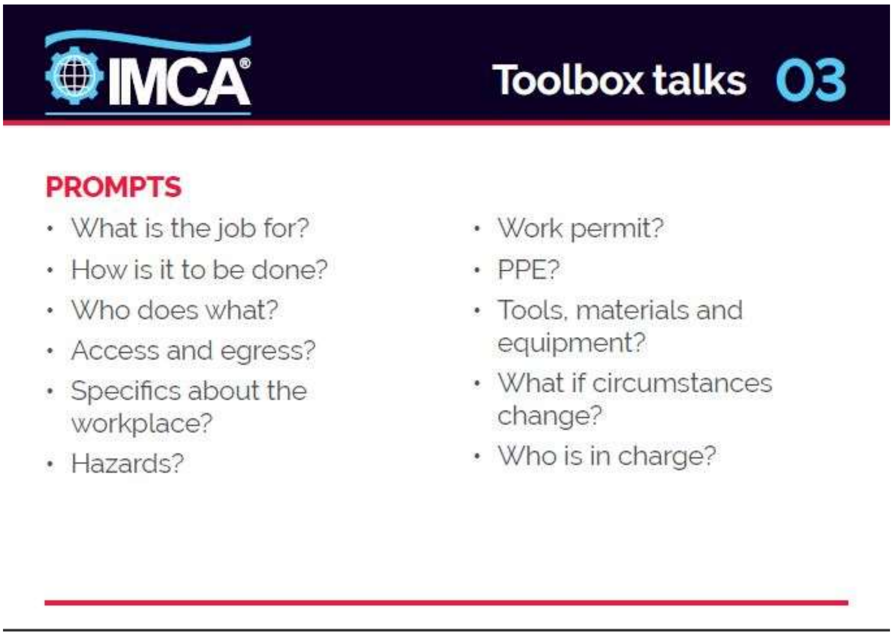


Figure 12 – Toolbox talks

5.9.1 Stopping the Job

This initiative is designed to provide all personnel with the responsibility and obligation to stop work when a perceived unsafe condition or behaviour may result in an undesired event.

The use of this initiative should be discussed in all pre-job planning and job risk assessment (JRA). During a toolbox talk, all personnel should be advised that they have the authority and responsibility to stop the job in the event of a potential unsafe condition or act.

If an unsafe condition or act is observed:

- take immediate action by stopping the work;
- notify the supervisor in charge;
- discuss and/or determine corrective measures with all involved;
- review and/or revise JRA as necessary;
- communicate corrective measures;
- resume work safely;
- record the stop work action details for lessons learnt purposes.

5.10 Records of Lifting Procedures

Information relevant to monitoring and controlling lifting operations procedures should be retained in order to demonstrate the effectiveness of company procedures and to assist in identifying opportunities for improvements. To assist those planning lifting operations, it is desirable that they have convenient access to the procedures, records of previous lift plans, risk assessments and any relevant material such as lessons learnt.

For lifting operations in support of manned diving operations it is particularly important for the diving supervisor acting as the lift supervisor/banksman to facilitate the recording of all appropriate information relating to the subsea lift.

6 Inspection, Examination and Marking of Lifting Equipment

At the time of manufacture, the initial integrity of any item of lifting equipment (device or accessory) will be demonstrated by appropriate documentation. If an item is manufactured or supplied in the EU, this would be an EC Declaration of Conformity as a minimum. In some, but not all, instances the individual item may have been subjected to an intentional overload and the subsequent issue of a Proof (Overload) Certificate. Outside the EU, similar documentation should be provided to comply with local legislation and the terms of the Purchase Order. Continuing integrity of such items is assessed and demonstrated in various ways during the lifespan of the equipment.

There are two forms of assessing lifting equipment:

♦ inspection (see section 6.1); and

♦ thorough examination (see section 6.2), potentially supplemented by NDE and/or proof testing.

6.1 Inspection

Inspections are usually carried out in-house by personnel with sufficient experience and competence to do so as specified in company procedures.

The requirement for pre-use checks should be recorded in the lift plan.

The results of the inspections should be suitably recorded and provided to the person(s) conducting the thorough examinations as this ongoing monitoring may provide useful information to the examiner (e.g. in the case of wire ropes, recording the trend of increasing broken wires found).

6.2 Thorough Examinations

Thorough examinations are a periodic activity of a more rigorous nature. They should be conducted by a competent person either from a third-party entity or an in-house appointed person deemed to have sufficient independence. Such persons should have sufficient theoretical knowledge and practical experience to be able to identify any defects and to assess the current status of equipment without fear or favour. Any recommendations by the competent person should be carried out.

Thorough examinations are undertaken carefully and critically and can be supplemented by additional activities such as non-destructive testing, application of a functional load test or application of an intentional overload test. Where an overload has been applied, post load-test thorough visual examination should be conducted to ensure that the test has not caused any permanent set or deflection and no other damage has been sustained. After an intentional overload, it is advisable to conduct appropriate NDE to ensure that the proof test has not identified any defects. The decision to undertake supplementary activities should be taken by the competent person carrying out the thorough examinations.

The periodicity of the thorough examinations is determined by the requirements of any regulatory authority.

A record of thorough examinations and any defects found should always be maintained.

Valid records of examination should be available for review at the location where equipment is to be used.

In addition to original Declaration of Conformity or report of Test and Thorough Examination, valid records of examination should accompany lifting equipment provided by others for use by the company.

Review of equipment records should identify necessary adjustments to the frequency of examination of equipment.

6.3 Frequency of Inspection and Thorough Examinations

6.3.1 Frequency of Inspection

All lifting equipment should be inspected in accordance with the company's planned maintenance schedule and with the requirements of relevant regulators, but as a general guide as follows:

- before and after use on each occasion (pre-use/post-use check);
- at weekly intervals for items of lifting equipment in use;
- at other intervals or under conditions identified by the manufacturer or risk assessment;
- where review of lifting equipment records indicates it may be prudent to do so.

6.3.2 Frequency of Thorough Examinations

All lifting equipment and accessories should be subject to thorough examination on an annual basis or as required by regional regulations.

In addition to the periodic thorough examination, lifting equipment should be thoroughly examined:

- before being brought into use for the first time, unless it has been accompanied by valid regulatory documentation or report of thorough examination;
- where the equipment has been involved in an accident, or dangerous occurrence;
- after a significant change in conditions of use (determined by the competent person), for example after installation/assembly/relocation/modification/repair;
- each time that an exceptional circumstance (such as overload) is liable to jeopardise the safety of the lifting equipment;
- after long periods out of use (determined by the competent person).

6.4 Reports and Defects

All thorough examinations should be recorded and any defects should also be recorded.

A report of thorough examination should detail the defects found or include a statement to the effect that the equipment is fit or unfit for continued safe use. The report of thorough examination should be retained for the minimum period required under the relevant regulations and should be retained for sufficient period to provide useful information for any future investigations into failure of similar items and copies made available as required by users.

The competent person should notify the relevant company focal point immediately upon discovery of any defect in the lifting equipment that, in the opinion of the competent person is, or could become, a danger, so that appropriate action can be taken to repair or replace the equipment, or otherwise ensure that potentially dangerous equipment is withdrawn from use.

Reports of thorough examination should be forwarded to the relevant company focal point as soon as is practicable. All defects, as soon as they are identified, should be immediately reported and appropriate action taken.

6.5 Maintenance of Lifting Equipment Used Subsea

It should be recognised that lifting equipment used in the marine environment and subsea is exposed to arduous conditions, and this may lead, for example, to rapid wear or to accelerated corrosion. The ingress of water, particularly saltwater, drilling powders/muds, silt and exposure to the marine environment itself can quickly greatly diminish the overall condition of lifting equipment.

It may be appropriate to take special measures to reduce the likelihood of such early deterioration in the condition of lifting equipment used in the marine and subsea environments, e.g. it might be advisable to wash down lifting equipment in fresh water regularly (for example following immersion) or to lubricate lifting equipment more frequently than would otherwise be the case. Advice should be sought from manufacturers and suppliers and their recommendations for maintenance should be observed.

Other items may be subject to a single immersion policy to ensure that they retain their functional reliability.

Reference IMCA LR 005/D 028 – *Guidance on the use of chain lever hoists in the offshore subsea environment*.

6.6 The Marking of Lifting Equipment

The identification of safe working load (SWL), operating mode and configuration for the safe use of equipment, is required to ensure that lifting equipment and accessories are used only within the range of operating parameters appropriate to their safe use.

All equipment and accessories provided should be clearly and permanently marked with their SWL (or WLL) and unique identification markings.

The marking of equipment should not damage it or alter its use.

6.6.1 Communication of Colour Codes

The purpose of colour coding lifting accessories is to provide a simple visual indication that equipment is compliant regarding in-date thorough examination and that correct certification is available.

The colour codes scheme should be explained to all personnel who use lifting equipment. The current colour should be displayed in prominent places around the operations area, such as the rigging loft, deck areas, crane pedestals, on safety notices, etc. The aim is to inform and remind personnel of the prevailing colour during a given period.

In some instances, project-specific lifting accessories, department-specific lifting accessories and client-owned lifting accessories may all be present on a single worksite and each may be colour-coded with different colours. If so, this should be clearly defined and explained to personnel on an individual project basis. Where possible, a single colour code should be used for all lifting accessories at a worksite.

When colour codes are due to change (transition periods), the current colour and a valid date will need to be displayed at prominent places throughout the operation site. During the statutory Thorough Examination period two colour codes may be valid until all equipment has been re-examined and changed to the new colour code. This will ensure that users of lifting equipment and accessories do not reject equipment which has the new colour code marked on it.

The company recognised colour should be implemented when the item of lifting equipment is quarantined.

6.7 Quarantine Process

Portable lifting appliances and accessorises that are deemed not fit for use should be stored in a separate quarantine area. The accessories should be suitably marked as quarantined equipment and appropriately colour coded.

The quarantine area should be clearly identified and be properly secured to prevent unauthorised access to avoid quarantined equipment being used.

Any rigging found to be, or suspected of being, damaged or out of certification, should be placed in the quarantine area and the lifting register updated to show that the item has been quarantined and the reason it is considered to be unserviceable.

6.8 Non-Conforming Lifting Equipment

Any portable lifting equipment found to be improperly marked should be removed from service, tagged as a non-conformant item and segregated in the quarantine area. Non-conforming items are those with:

- incorrect colour markings;
- no clear colour markings;
- SWL or WLL not marked or not clearly visible;
- no clearly visible unique identification number;
- damaged or unserviceable equipment.

6.9 Types of Certification

All lifting equipment should be issued with a manufacturer's certificate to prove that, when it was first made, it complied with relevant national or international directives, regulations, codes and/or standards. For example, in Europe, this document would normally be an EC Declaration of Conformity.

After a given period, one should verify that the equipment is still conforming to the original, as delivered, state. This means the following should always be present:

- original certification;
- inspection note, the inspection to be done by a competent person;
- proof/over load tests (if required by class/certifying authority). For lifting appliances, one should refer to ILO 152;
- Declaration of Conformity (compliance) (see Figure 13);
- report of Proof Test and Thorough Examination (see Figure 14).

EC DECLARATION OF CONFORMITY

Certificate no: TLDN04477
Customer order no: N134510
Order date: 06/10/2014
Customer:

Delivery details:

Serial No	Product	Description	Qty	Working Load Limit (WLL)	Proof Load Applied	Light Load Test Applied
14091121/00000062, 14090059/00000063	CCBTPS-0050-03 EB	Combined chain block & plain single trolley 0.5t 3mtr HOL c/w EXT Bar - Supplied in accordance with EN13157-2004	2	0.5 t	0.75 t	10 kg
00000168, 00000169, 00000171, 00000172	TPS-0100-EB	Trolley 1.0t Plain Single Bar extended width Supplied in accordance with EN13157-2004	4	1 t	1.5 t	

DECLARATION

I HEREBY DECLARE THAT THE ITEMS DESCRIBED ON THIS DOCUMENT COMPLY WITH THE ESSENTIAL HEALTH AND SAFETY REQUIREMENTS OF THE MACHINERY DIRECTIVE 2006/42/EC

CE

CERTIFIED ON BEHALF OF THE COMPANY

07/10/2014

Figure 13 – Example EC Declaration

Certificate of Test and/or Report of Thorough Examination

SI 1998 No 2307 Lifting Operations and Lifting Equipment Regulations

SI 2006 No 2184 The Merchant Shipping Vessels (Lifting Operations and Lifting Equipment) Regulations

[as amended by The Merchant Shipping and Fishing Vessels (Lifting Operations and Lifting Equipment) (Amendment) Regulations SI 2008 No 2166]

Name and Address of Employer for whom the Test/Thorough Examination is made (Client)	Location of Equipment Tested/Examined	Job No EM45454	Date of Test/ Examination	14 March 2017
International Marine Contractors Association 52 Grosvenor Gardens London SW1W 0AU	ABCD Construction Vessel Haven 1234 Rotterdam	PO No 56782	Date of Report	15 March 2017
			Report Number	IMCA17-483

Unique ID No	Proof Load Test Cert/ EC Dec/ equivalent Number	Equipment Description	Proof Load Applied (tonnes)	SWL (WLL) (tonnes) Inc angle/ radius if appropriate	Date of last TE	Manufacturer and date of manufacture (if known)	Safe For Use and/or Comment/ Limitations	Date Next TE Due
BG19	JS555	Padeye - fully welded construction located in Bell Garage	N/A	5 tonnes	18/4/16	Jones Shipyard 4/7/09	Safe for use	13/3/18

NDE Report No N/A | New Installation or Assembly No

Basis of Examination **(tick one)**	6 monthly under SI 1998 No 2307 Reg 9(3)(a)(i)*	☐	12 monthly under SI 1998 No 2307 Reg 9(3)(a)(ii)*	☑	Examination Scheme under SI 1998 No 2307Reg 9(3)(a)(iii)*	☐	Exceptional Circumstance under SI 1998 No 2307 Reg 9(3)(a) (iv)*	☐

* Or equivalent part of Regulation 12 of the Merchant Shipping Vessels (Lifting Operations and Lifting Equipment) Regulations **TE = Thorough Examination**

I hereby declare that, on the date above, the item(s) of equipment listed above was/were tested and/or thoroughly examined and that the particulars stated above are correct. Any qualification due to access limitation is described in Comments column above. If appropriate an NDE Report will be issued simultaneously.

Signature NAME and qualifications (in capitals)	OR	Signature NAME (in capitals, of person signing on behalf of or authenticating the Report)

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Figure 14 – Example Report of Proof Test and Thorough Examination

7 Record Keeping

A systematic method of record retention should be operated to ensure that information is readily available to competent persons.

The competent person should be able to access the relevant lifting equipment documentation.

Lifting equipment reports and records should be retained for periods that satisfy regulatory requirements as a minimum and for longer where they provide information useful for identifying trends or opportunities for improvements.

Documentation should be reviewed periodically in line with examination intervals and review of lifting equipment records and reports.

The relevant reports, records and other documentation could be kept in hard copy form or stored electronically. If a computer system is used to keep this information, then it needs to be protected from unauthorised alteration.

8 Related IMCA Publications

IMCA SEL 001	*Guidelines for Management of Change*
IMCA LR 001	*Guidance on wire rope integrity management for vessels in the offshore industry*
IMCA LR 002	*Crane specification document* – highlights pertinent issues in consideration of cranes
IMCA LR 005	*Guidance on the use of chain lever hoists in the offshore subsea environment*
IMCA LR 007	*Guidance on open parachute type underwater air lift bags* – gives guidance on subsea operations with air lift bags
IMCA LR 008	*Guidance on the manufacture and safe use of cable-laid slings and grommets* – is of particular use when using slings and grommets over 60 mm.
IMCA LR 009	*Guidance on the selection, safe use and inspection of high performance fibre slings used for engineered lifts*
IMCA D 024	*Diving Equipment Systems Inspection Guidance Note (DESIGN) for saturation (bell) diving systems* – gives guidance in particular regarding bell wire ropes
IMCA D 032	*Cross-hauling of bells*
IMCA D 042	*Diver and ROV based concrete mattress handling, deployment, installation, repositioning and decommissioning*
IMCA C 002	*Guidance on competence assurance and assessment: Marine Division*
IMCA M 205	*Guidance on operational communications, Part C – Communications in lifting operations*
	Crane Operators Logbook (for offshore vessels)

IMCA produces a number of safety pocket cards, videos and posters which aid focus on safety. They can be found on the IMCA website under Safety Promotion Materials at the following address:

https://www.imca-int.com/core/hsse/publications/safety-promotion/

Additional Considerations for Subsea Lifts

A1-1 Introduction

Subsea lifts using surface-based lifting equipment are 'blind lifts', i.e. they are lifting operations where the lifting appliance operator does not have a direct view of the lifted object or subsea landing/lift-off area.

The lifting appliance operator may have access to a monitor displaying images from ROV or from diver hat-mounted cameras, but this is still not the same as having a direct line-of-sight view. In all cases, the lifting appliance operator should always wait for instructions from the lift supervisor or banksman before moving the lifted object.

The retrieval of objects from the seabed may increase the load on the winch, therefore it may be necessary to de-rate the winch due to the accumulative forces acting on the winch barrel and flanges.

It should be determined if the weight of the rope is included in the crane curves, particularly for lifting operations at great water depths.

A1-2 Shock Loading and its Avoidance

When planning subsea lifting operations, whilst the goal is to avoid shock loading at all times, full account should be taken of its potential effects on rigging arrangements.

When an object is lowered into the water quickly, or is lowered through the water column too rapidly, some slack may develop in the rigging that is attached to the object. This may occur because of a combination of factors, e.g. the magnitude of the buoyant force exerted by the lifted object, the shape of the object and the associated resistance to descent of the object offered by the relatively dense medium of seawater.

When objects are being lowered or raised through the water column, crane line speeds should be taken into consideration.

A1-3 Vessel Set-Up Locations and the Initial Positioning of Lifted Objects Subsea

Lifting and lowering of objects directly above pipelines or other unprotected subsea assets should be avoided except for final placement.

At the selected overboarding position, the lifted object should normally be lowered to a depth some 10 to 15 metres above and offset from any subsea facilities. This is known as deploying the lifted object to the 'second stop point' depth (also known as the short mark).

Thereafter the lifted object can be moved methodically along a pre-planned corridor into its designated final holding position.

If possible an ROV should be used to monitor the lifted object while the required vessel and/or crane moves are underway.

Lifted objects should never be lowered directly to the bottom if there are diving bells, diving baskets or divers in the water.

A1-4 Pre-Lift, Lift-Off from Deck and Overboarding

A1-4.1 Preliminary Considerations

Prior to the commencement of an overboard lift refer to section 5.3.1 for Initial Considerations for the Assessment of the Load and its Handling.

Additionally, the following should be noted for subsea lifts:

- If load is to be lifted from air to subsea or vice versa, consider shock loads and changes to weight in air due to the effects of flooding or draining, seabed suction, plus marine growth or debris/grout and changes to weight in water due to buoyancy, air entrapment.
- If removing existing subsea structures, be cognisant of any added mass, changes to buoyancy and the centre of gravity and lack of lift points.
- If lifts involve diver intervention, consideration should be given to lack of subsea visibility, safe location for divers, use of subsea lighting/load positional beacons, safe area for deployment/recovery, diver umbilical snagging points/sharp edges/use of diver tag lines.
- Load/motion limiting systems may be used to minimise relative motions and dynamic forces during overboarding (see section 5.6).
- Tag lines, tugger lines, bumpers and guides may be used as positioning aids. If tag lines are used underwater they should be weighted. On the surface boat hooks may be used to reach for tag lines in order to avoid personnel positioning themselves under lifted objects.
- In deep-water deployment and retrieval, amplified vertical motions of the load can be caused by axial resonance of the crane rope which is fundamentally a function of the natural frequency of the lifting system due to the elasticity of the deployed length of lowering rope. This can occur even in a calm sea state. Therefore, during a deep-water lifting operation, a heave compensation system can be used to mitigate this vertical resonant motion of the load, which reduces the dynamic loads in the hoisting wire system. It should be noted that in some instances resonant motion can occur at the final deployment depth when the natural frequency is in the range of the expected period of vessel motions. In such cases a length of rope of dissimilar stiffness may be added to the system in order to alter the natural frequency, in the absence of active or passive heave compensation.

A1-4.2 Overboarding

During overboarding of the lifted object as a rule deck personnel should never:

- stand under lifted objects;
- position themselves between a lifted object and a wall, bulwarks or other obstructions;
- touch a lifted object being landed until it is below shoulder height;
- stand in the danger zone of any rope under tension if winch ropes are used to control the lifted object's horizontal movement;
- attempt to stop a swinging lifted object manually.

They should always:

- remain at a safe location while an object is lifted/landed;
- ensure that there is an escape path available to them.

Once an object has been raised from the vessel deck it should be moved along its planned lifting path and placed into the water without delay. If a load starts to swing or move in an uncontrolled way it should be swung overboard and immersed as soon as possible.

A1-5 Lifting Through the Splash Zone

When a lifted object passes through the splash zone it will be subject to a number of additional significant forces, which include:

- load changes due to the buoyancy effect;
- shifting or tilting of the load when the lifted object is submerged should the centre of buoyancy not be in vertical line with the centre of gravity;
- slamming loads induced by waves;
- drag, especially with large flat structures such as mud mats;
- snatch forces arising from slack slings.

Load/motion limiting systems can be used in this phase to reduce/prevent snatch loads.

It may be necessary to allow time for pressure equalisation/flooding of open objects once they have been submerged. Where the structure allows for free flooding this may take an appreciable amount of time. Pre-planned hold points will be required to provide time and stability for pressure equalisation.

Flood holes and vents may be monitored by ROV (if available).

A1-6 Stop Points during Lowering Through the Water Column

Two stop points are normally utilised during lowering through the water column.

The first stop point is deep enough to ensure that a potential spinning or swinging object is kept well below and clear of the vessel's hull, usually between –5 msw (metres sea water) and –50 msw. Disconnection of any crane tuggers can normally be carried out at this point. It is usual to reposition the crane after the load is below the vessel hull (–50 msw) such that the boom tip is as close to the vessel centre of motion as practicable. This ensures the minimum of boom tip heave induced by vessel pitch and roll.

The overboarding of the lifted object from lift off until the first stop point will be controlled by the deck lift supervisor.

At the first stop point, control of the lift is formally transferred from the deck lift supervisor to the subsea lift supervisor. When the subsea lift supervisor has accepted control and is ready to continue, he will further instruct the crane operator.

The second stop point (commonly referred to as the short mark) is discussed in section A2-4.

A1-7 Retrieval of a Subsea Object

The subsea retrieval of lifted objects is similar to their deployment but in the reverse sequence.

The object is connected to the vessel crane subsea, the crane/vessel is plumbed above the object to be lifted and the WROV/diver is used to ensure all the rigging is correctly installed and there are no twists/snags. When available, slings/rigging may be connected with AHC.

Where significant suction forces are a risk, the load should initially be lifted from the seabed in constant tension mode.

Once the lifted object is fully suspended on the crane, the WROV/diver should confirm again that all the rigging is correctly attached and the load is plumbed below the crane block. Retrieval of the object can then commence.

For larger items or those requiring specific positioning on deck, it may be required to stop the retrieval operation at approximately (–)30 msw in order for the WROV/diver to attach orientation rigging. The use of orientation rigging should allow the crane operator to better control the lifted object when slewing the crane and recovering the lifted object to deck.

For larger items and those where orientation tuggers are used, adequate deck space should be made available to land the lifted object. If required, fine adjustments of the object's position can be made after the initial landing on deck.

See section 5.3 for points of consideration when recovering a subsea lifted object.

A1-8 Security of the Rigging Arrangements Attachment to the Lifted Object During Subsea Lifting

Lifted objects that pass through the water column are subject to wave action and other physical forces which might cause objects to become unhooked from open or otherwise unsecure attachments.

Methods of attachment used for subsea lifts should be fully secure, i.e. they should be specifically designed to resist unintended detachment.

Screw pin shackles should in general be avoided in subsea operations, however if used it is recommended that the pin is locked in place using an appropriate securing arrangement.

A1-8.1 Crane Hooks and Sling Mounted 'Latch' or 'Snap' Hooks

Some crane hooks and sling mounted 'latch' or 'snap' hooks can become accidentally detached or re-attached during the course of subsea lifting operations.

Water movement both at the interface and subsea can cause upward movement of the object, as a result the relatively stiff sling(s) may be pushed upwards, causing they eye(s) of the sling(s) to twist past the tip of the hook, so that when the object drops downwards again, the eye of the sling(s) can pass between the tip of the hook and the safety catch and slide free (see Figure 15).

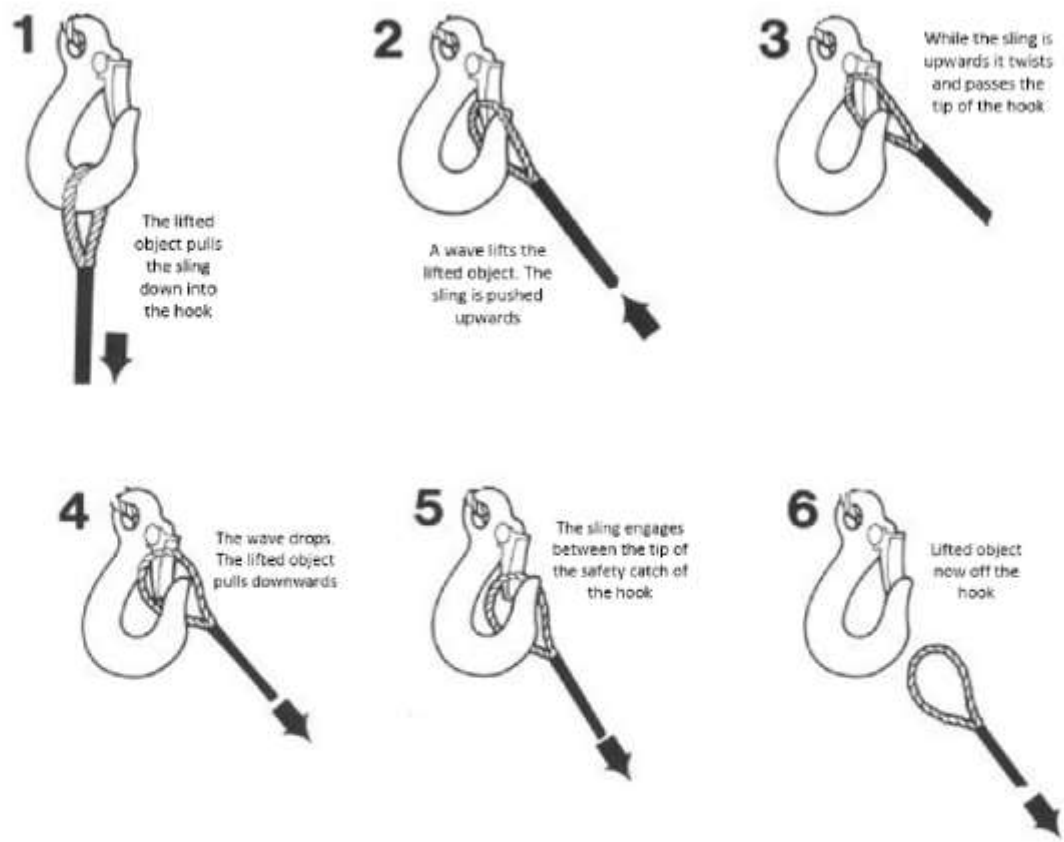


Figure 15 – Detachment of a sling from crane hook fitted with a traditional safety catch

Alternatively, the safety catch can be torn away. This can and does happen with any type of hook and safety catch, even when 'secured' with different devices such as ropes, wires, cordage, bolts, etc.

Hooks fitted with lockable safety latches should be used to avoid the possibility of lifted objects being detached or re-attached accidently.

The same issue can happen when dealing with multi-legged slings.

Figure 16 – Crane hook with lockable safety catch

In order to avoid the possibility of lifted objects becoming detached or re-attached accidently a safety hook of the locked gate type should be used when using multi legged slings (see example in Figure 17). This type of hook is fitted with a failsafe release trigger which is activated by the diver to release the object and is then snapped shut by him to prevent it becoming reattached.

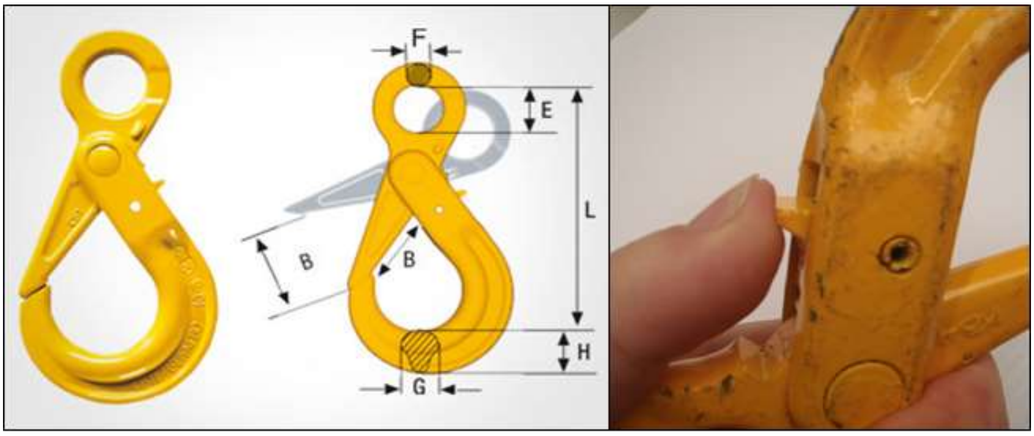


Figure 17 – Locked gate safety hook for use with sling mounted lifted objects

A1-9 Safety Considerations

When operations require a crane or winch wire to be attached to an object anchored to the seabed there are particular overload conditions that need to be considered at the planning stages. These overload conditions may be caused by:

1. Vessel drift-off or drive-off – due to DP system fault or vessel loss of power.
2. Lifting equipment malfunction– such as hydraulic hose failure.
3. Lifting equipment loss of power or control system fault.
4. Unexpected increased wave height and subsequent increased vessel motions.

A suitable written contingency plan should be included in the task plan/procedure and understood by everyone involved. Some measures that can be taken are as follows:

1. The primary mitigation should be to select equipment with suitable operating modes and safety systems for the task being carried out. This should be established at the planning stages.
2. Main deck cranes should be fitted with a manual/automatic overload protection system to prevent damage to the crane from overload.
3. Operating the vessel power system and having thrusters selected to maintain the vessel in the most reliable DP configuration.
4. Maintaining high vigilance and good manning levels of DP operators/bridge crew.

As a secondary mitigation method, the rigging may be designed such that it is weaker than the crane/winch rope or the lift points on the load. In the event of overload the rigging is the weakest point and will part first. Note that this may not fully protect the crane/winch or the rope as when the rigging parts the shock load may still cause damage. Rigging should not be undersized to the extent that an adequate factor of safety ceases to be maintained for lifting and also the rigging should not be intentionally overloaded above its SWL.

A1-10 Recovery of Lifting Arrangements to Surface

When recovering the lifting arrangement rigging and other objects, care should be taken. If the lift rigging is tilting, it may be hazardous to land it on deck and special precautions may be required. The lifting arrangement may also need to be drained of water prior to landing on deck.

Tag lines/tugger lines may be attached by ROV or divers to enable rotational control when lifting on board the vessel.

When recovering lifting arrangements to surface, same considerations stated in section A1-5 apply.

The landing area on deck should be sectioned off and the deck crew safely positioned to avoid contact with any swinging lifting arrangement or dropped objects from rigging. The need for bumpers and guides when landing the lifting arrangement on the deck should be evaluated.

Diving Operations

A2-1 Lifts in Support of Diving Operations

As stated in section A1-1 all subsea lifts using surface-based lifting equipment in support of diving operations are always 'blind lifts'.

In blind lifts, it is essential that the verbal communications link between the lifting appliance operator and the dive supervisor in dive control is clear and reliable. Therefore, where a crane is in use in conjunction with diving operations there should be a dedicated communications channel between the diving supervisor and the lifting appliance operator, where possible this should be hard wired.

For large or long loads the dive supervisor should ensure he has several means of evaluating the position of the lifted object, e.g. by use of ROV feeds, diver hat cameras, survey beacons etc. (see section A2-6 – Positioning Aids).

As well as providing the dive supervisor with information for manoeuvring the lifted object, the diver in the water will perform the role of load handler/slinger.

A2-2 Safe Location of the Diver(s) During Subsea Lifting Operations

During planning of subsea lifts in support of diving operations consideration must be given to a 'place of safety' for the divers.

A fundamental principle of lifting is that the load should not be carried or suspended over areas occupied by persons.

In poor underwater visibility the divers are not likely to see a lifted object until they are very close to it, in zero or poor visibility they have to rely on touch to find the lifted object. Even in relatively good visibility the lifted object may not become visible to the divers until it is close to them.

It is difficult to predict with confidence where any object dropped into or through water will land, as there is a tendency for dropped objects to deviate from the vertical when they fall through the water column. In the water, there will be a cone shaped area within which a lifted object dropped from a lifting appliance can fall. This equates to the danger zone for the diver. The size of the drop cone will depend on the shape and weight of the lifted object, the depth of the water and the strength of the current (see Figures 18 and 19). The subject is discussed in detail in section A2-2.1.

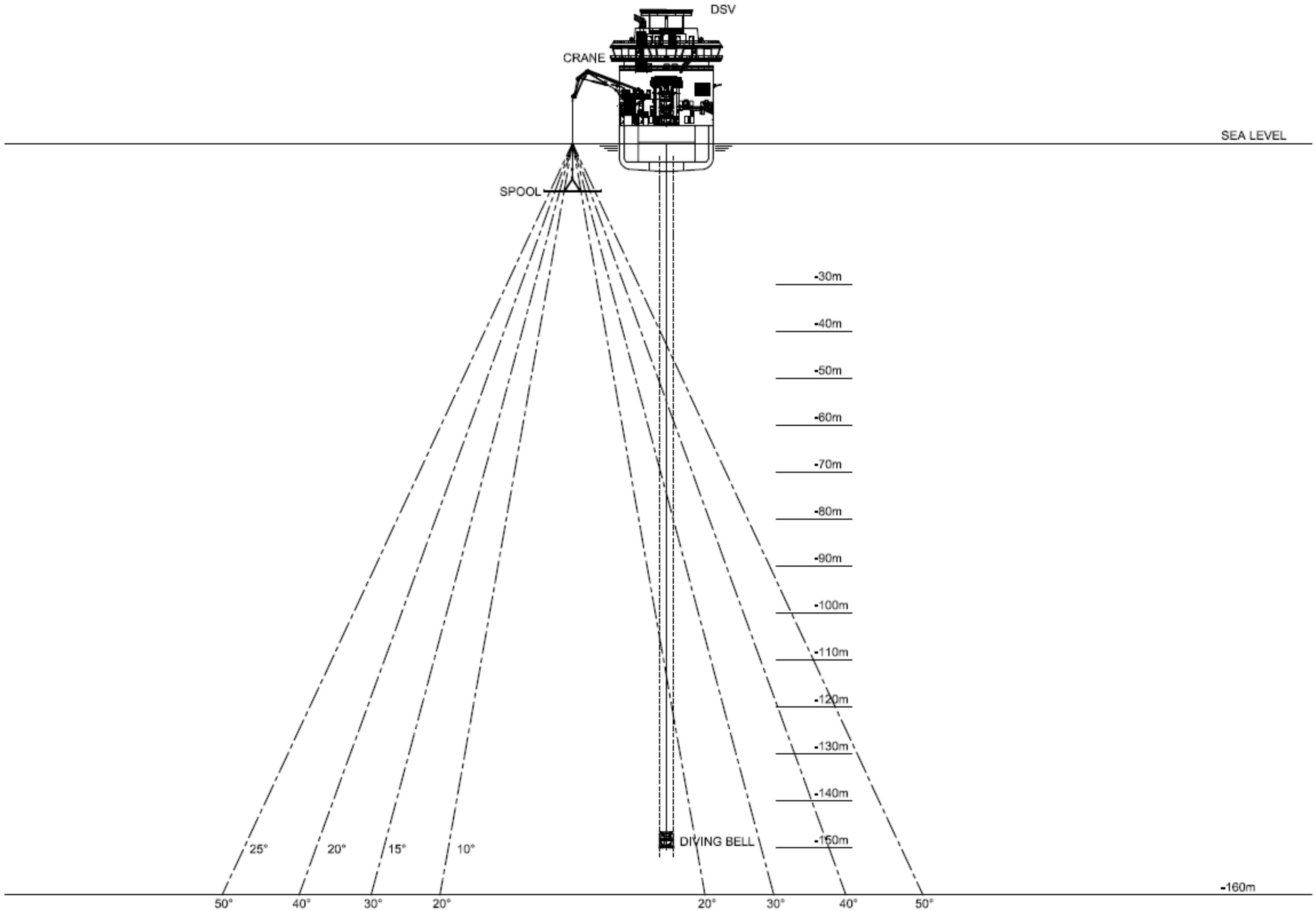


Figure 18 – End elevation scale drawing of a dropped object

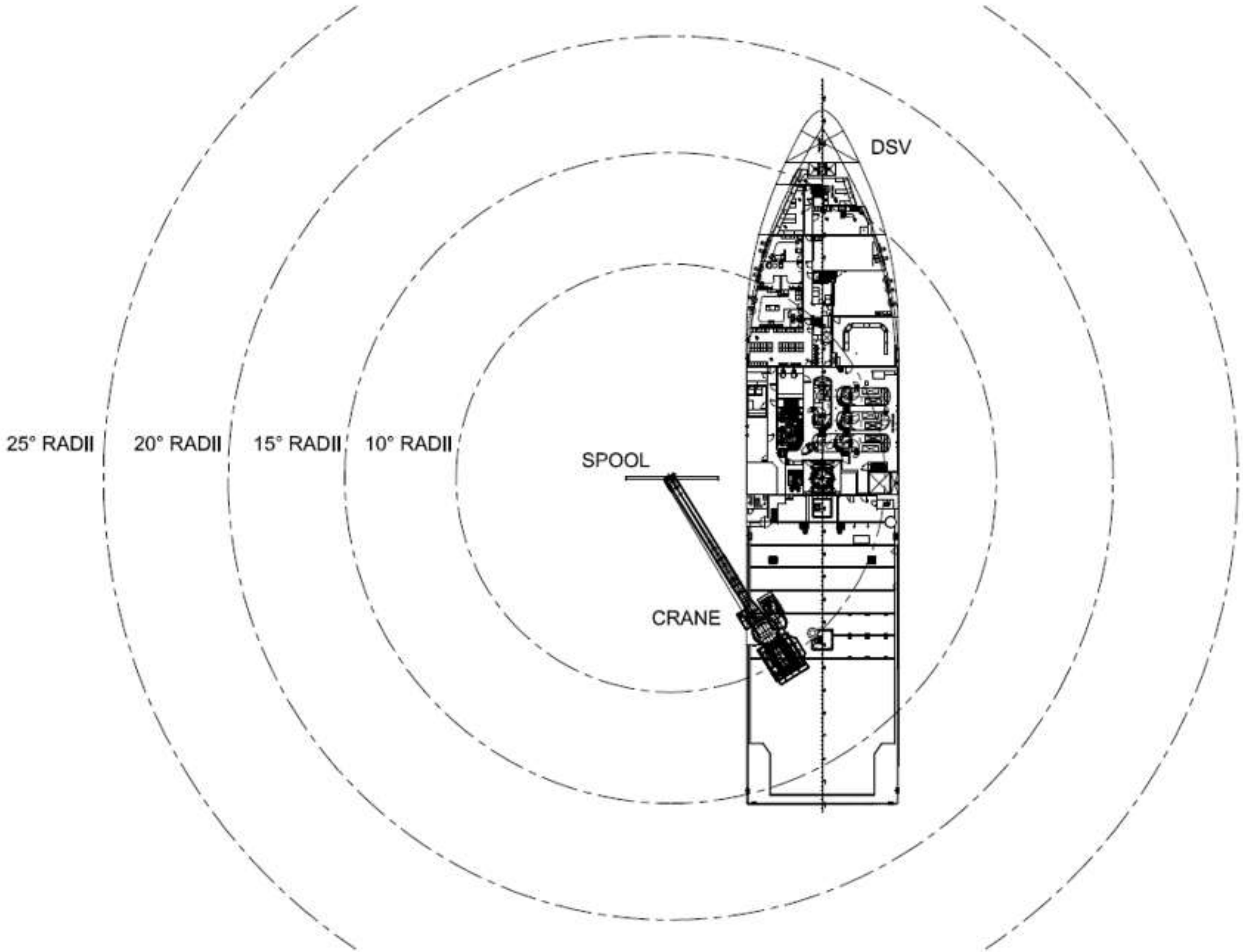


Figure 19 – Angular deviation from the vertical for a depth of 160 metres

A2-2.1 Assessing the Hazards Associated with Dropped Subsea Objects

A number of studies have been carried out to assess the risk of damage to underwater installations from dropped objects. Information on the subject appears in Recommended Practice DNVGL-RP-F107 Risk Assessment of Pipeline Protection, Sections 5.1 and 5.2. Diving contractors may wish to consider using the information and tools contained in this document when carrying out safe diver positioning assessments.

DNVGL-RP-F107 provides the table reproduced in Table 1:

Angular deviation of object category			
No	**Description**	**Weight (tonnes)**	**Angular deviation (α) (deg)**
1	Flat/long shaped	<2	15
2		2-8	9
3		>8	5
4	Box/round shaped	<2	10
5		2-8	5
6		>8	3
7	Box/round shaped	>>8	2

Table 1 – Angular deviation of object category

The angular deviations recorded for the three different categories of object in Table 1 are based on the normal distribution.

The normal distribution is defined as:

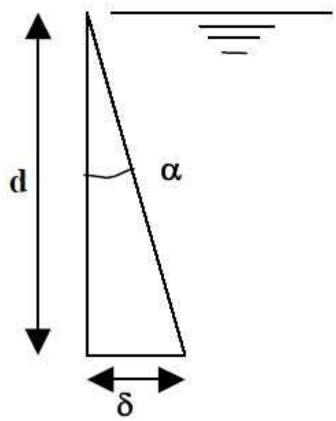
$$p(x) = \frac{1}{\sqrt{2\pi\delta}} e^{-\frac{1}{2}\left(\frac{x}{\delta}\right)^2} \qquad (9)$$

where:

$p(x)$ = Probability of a sinking object hitting the sea bottom at a distance x from the vertical line through the drop point.

x = Horizontal distance at the sea bottom (metres)

δ = Lateral deviation (metres), see Table 10 and Figure 8.



These angular deviations are based on a standard deviation of 1, accepted practice is to apply 3 standard deviations to ensure that 99.7% of objects fall within the drop cone diameter. This represents a suitably conservative approach and substantially lowers the risk to the diver or subsea infrastructure.

Some diving contractors have used the information contained in DNVGL-RP-F107 for subsea lift planning purposes to develop spreadsheet based drop zone calculators which allow them to identify angular deviation figures for given depths of water. One example is shown in Figure 20.

Water Depth (m) = 90

DNV dropped object excursion distances

Based on DNV Recommended Practice DNV-RP-F107 Risk Assessment of Pipeline Protection (2010)

Object No	Description	Weight in Air Te	Angular Deviation ά (angle from vertical) this is the angle when δ = 1.0	Lateral deviation at depth of d metres *Note: Cone angles whole cones not half cones*								
				δ = 1.0 (68% impact probability)	Cone angle for 68% impact probability	Minimum overboarding distance from asset (metres)	δ = 1.96 (95% impact probability)	Cone angle for 95% impact probability	Minimum overboarding distance from asset (metres)	δ = 2.58 (99% impact probability)	Cone angle for 99% impact probability	Deviation from centre of drop (m)
1	Flat / Long Shaped	< 2	15	0.268d	30.0 deg	24	0.525d	55.4 deg	47	0.691d	69.3 deg	62.2
2		2 to 8	9	0.158d	18.0 deg	14	0.310d	34.4 deg	28	0.408d	44.4 deg	36.7
3		> 8	5	0.087d	9.9 deg	8	0.171d	19.4 deg	15	0.224d	25.3 deg	20.2
4	Box / round Shaped	< 2	10	0.176d	20.0 deg	16	0.346d	36.0 deg	31	0.454d	48.8 deg	40.9
5		2 to 8	5	0.087d	9.9 deg	8	0.171d	19.4 deg	15	0.224d	25.3 deg	20.2
6		> 8	3	0.052d	6.0 deg	5	0.103d	11.8 deg	9	0.134d	15.3 deg	12.1
7	Box / round Shaped	> > 8	2	0.035d	4.0 deg	3	0.068d	7.8 deg	6	0.090d	10.3deg	8.1

Figure 20 – Drop zone calculator developed using information from DNVGL-RP-F107

A2-2.2 Overboarding of Tubular Objects

In the case of tubular shaped objects (and indeed any object) lifted in and out of the water from diving support vessels it may be appropriate to carry out a dropped object assessment based on the information contained in DNVGL-RP-F107 to help ascertain safe diver positioning.

The guidance in IMCA D 007 – *Overboard scaffolding operations and their effect on diving safety* – is applicable to platform over-the-side scaffolding operations and is not appropriate for DSV installation of other tubular shaped objects lifted during construction activities (such as spools, pig launchers etc.). IMCA D 007 recommends that between scaffolding activities and diving operations a minimum horizontal distance of 1.3 times the depth at which the diver is working should be applied.

A2-2.3 Divers' Position during Lifting Operations

On many occasions during subsea lifting operations it may be impractical to move divers and their equipment from their worksites entirely outside of the drop cone. Where this is the case the following options should be considered:

1. Recover divers to the SDC before commencing the lifting operation and keep them out of the water until the risks posed to them by the lifting operation have either been eliminated or reduced to a minimal/tolerable level.
2. Prior to commencement of the subsea lifting operation, station the divers at a suitable safe refuge within the drop cone. The divers should remain at this 'place of safety' until the risks posed to them by the lifting operation have either been eliminated or reduced to a minimal/tolerable level. Usually the divers can leave the 'place of safety' once the load is at the short mark and the crane has been slewed to the working position. The ROV would spot the load and the divers would have informed the dive supervisor that 'they have a visual' – meaning that they can see the load. Once the divers report this, then they can take over directions via the dive supervisor. In practice it may be the case that the only suitable safe refuge available to the divers within the drop cone will be inside the bell, under the bell or inside the basket.
3. Let the divers remain at the worksite and within the drop cone.

Despite the robustness of diver deployment devices, it should be noted that some dropped objects (particularly larger ones) will have the potential to cause significant damage to baskets, bells and clump weights as well as injury to their occupants. If a risk assessment concludes that this is the case then the options available to those in control of lifting operations is that described in points 1 and 2 above.

Divers should only be allowed to remain unshielded at the worksite or within the drop cone if an assessment concludes that any objects which may be dropped during the lifting operation do not have the potential to cause injury to the divers or damage to their diving equipment.

The diving supervisor always has the authority to decide whether it is necessary to recover the divers back to the SDC and in turn recover the SDC to a suitable height below the vessel hull.

A2-3 Underwater Visibility in Manned Diving Operations

The nature of the underwater visibility at any proposed worksite should always be ascertained well in advance and then fully considered during the preparation of diving project plans and lift plans. Special engineering measures may need to be developed and other arrangements may need to be put in place to assist divers working in very poor or nil visibility.

Good horizontal visibility is considered to be anything beyond 3 metres. Most divers feel comfortable in such conditions and generally find it straightforward to visualise the relative positions of subsea assets, lifted objects, hoist lines, winch wires, baskets, bells, umbilicals, ROVs, etc.

In very poor visibility (in the order of <1 metre) finding the job site can be very difficult. In some parts of the world, divers will see nothing at all once they have been lowered beneath the surface or locked out of the bell. In such circumstances it is very easy for divers to become confused and fail to build an accurate 3D picture of their surroundings in their minds. To complete major underwater heavy construction tasks safely and efficiently in such 'black water' conditions is difficult and takes meticulous advanced planning.

Positioning aids can be particularly helpful when lifting operations in support of manned diving operations are carried out in very poor underwater visibility.

A2-4 The Second Stop Point

The purpose of the second stop point is to ensure that there will always be sufficient clearance between the lifted object and the seabed or the lifted object and any subsea assets. Depending on the depth of water, and environmental conditions (including underwater visibility) the second stop point depth is generally around 10 msw above the seabed/subsea asset. Reference should be made to section A2-5 regarding the crane operator zeroing the line-out meter as soon as the lifted object touches the water. The second stop point depth is commonly referred to as the short mark.

If the lifted object is inadvertently lowered over a subsea asset, observance of the second stop point routine should prevent collision damage or entanglement. Similarly, if the lifted object is inadvertently lowered over the divers or their equipment observance of the second stop point routine should save them from harm.

The appropriate second stop point depth should be identified during the lift planning process and included in the lift plan and step-by-step procedures developed for the lifting operation. The lifting appliance operator and all other members of the lifting team should be familiar with the written lift plan and step-by-step procedures for the operation being conducted. However, the second stop point depth should also be reviewed offshore. The dive team should check the actual depth of water at the worksite. The diving supervisor should confirm the second stop point depth to the lifting appliance operator immediately before the lift.

A2-5 Lowering Through the Water Column

Maximum lifting and lowering speeds through the water column may be specified in the lift plan and the step-by-step procedures. Lifting and lowering at a defined maximum speed will help to ensure stability of the lifted object and reduce the likelihood of snatch loading.

As the lifted object may end up some distance from its intended location, lift planning should always take appropriate account of this uncertainty. Sufficient horizontal offset should account for drag and current as well as the geometrical characteristics of the lifted object.

During lowering of the lifted object through the water column the load on the lifting appliance will increase with water depth due to the weight of steel wire rope. This effect will need to have been considered at the planning stage, but is not normally a significant issue at manned diving depths.

Where possible an ROV should be used to monitor the stability and position of the lifted object as it is lowered through the water column to its second stop point depth and designated final holding position. Work class ROVs (if available) may also be used for rotational control of the lifted object.

Where it is required for the divers to guide the load to the seabed, the divers will locate the lifted object at its final holding position. This will often be the second stop point, but in situations where the second stop point is not the final holding position of the lifted object, any vessel and/or crane movements required to move the lifted object laterally from the second stop point to its final holding position should be done in small increments and at low speeds.

Once the lifted object has reached its designated final holding position, if the diver(s) cannot see the object it should be lowered in one metre increments until the diver(s) can make visual contact. ROVs are very helpful in these situations, both for providing light but also for spotting the lifted object.

A2-6 Positioning Aids

Acoustic positioning beacons are useful tools for diving and subsea lifting operations. Beacon tracking systems can provide real time images showing the positions of vessels, divers, ROVs and lifted objects relative to subsea assets and surface breaking offshore installations.

However, acoustic beacon tracking systems do have their limitations.

- Depending on the type of systems used at manned diving depths, their accuracy can be typically in the order of 0.5 to 1 metre, i.e. 1 to 2 metres between two beacons.
- For ultra-deep water operations where ROVs can only be utilised the accuracy of these systems can be questionable.
- Acoustic systems are subject to in-water disturbances – such as air bubbles.
- The location of the beacons may 'jump' on screen, especially in shallow waters (<30 m).

Reference IMCA guidance:

- IMCA M 244/S 017 – *Guidance on vessel USBL systems for use in offshore survey, positioning and DP operations.*
- IMCA M 200/S 013 – *Deep water acoustic positioning.*

The lifting appliance operator should always know the depth of water from the bottom of the lifted object. Acoustic beacons, WROV/OBSROV and/or line-out meters may be used for this purpose. If a line-out meter is used the crane wire should be set to 'zero' when the lifted object touches the water. It is essential that the lowest part of the lifted object is used as the reference point.

If acoustic positioning beacons are used for location and depth monitoring, then the vertical offset from the beacon to the lowest part of the lifted object should always be accounted for.

If, at any time, the lifting appliance operator does not know the depth of his lifted object, he should immediately stop all lifting appliance movements and notify the dive supervisor.

Markings can be used to help divers orient lifted objects correctly, e.g. bright stripes painted onto the centre line of mattresses, or markings on frames are simple but effective aids. Pad-eyes can be made more visible by painting them in contrasting colours.

A2-7 Handling of Subsea Lifted Objects

For the final positioning of lifted objects in poor visibility the appropriate use of guide wires, flange catchers, rope hoist and other mechanical aids is recommended. When selecting appropriate crane/vessel operating modes for final manoeuvring and placement, the following factors should be considered:

- the vessel's DP footprint (section 3.6 of IMCA M 103 – *Guidelines for the design and operation of dynamically positioned vessels*) with respect to the environmental conditions;
- the forces a sub-surface current may impart on the lifted object;
- The properties of AHC or CT mode (be aware of the potential limitations on crane movements during AHC mode);
- whether it is better to move the vessel rather than slew or boom the crane due to potential stability issues or excessive rope exit point movements.

Note: The above list of factors is not exhaustive.

The final positioning and placement of a subsea lifted object is a critical phase of the lifting operation, as is the first stage of recovering a lifted object to surface. In both situations divers will need to pass information for manoeuvring the lifted object to the diving supervisor and also act as load handlers/riggers. In poor visibility such duties will often require close approach of the diver(s) to underwater lifted objects.

An ROV may be used for observation of the lifted object during the first stages of recovery and the final stage of lowering to the seabed and where possible the final positioning and placement (when a lifted object is moved from its final holding position and manoeuvred into its intended resting place). ROVs may also be used to connect and disconnect lifted objects.

Whenever ROVs are involved in combined operations with divers in the same underwater space the guidance contained in IMCA D 054 – *Remotely operated vehicle intervention during diving operations* – should be followed.

The diving supervisor is responsible for co-ordinating all diver and ROV movement. If the diving supervisor is not co-located with the ROV pilot, he should have dedicated hard wired working communications with the ROV supervisor (or pilot).

A2-8 Diver Handling of Lifted Objects Lowered from Surface

Where it is required for the divers to guide the load to the seabed, the dive supervisor may require tag lines to be secured to the load. Tag lines should be sufficiently long and may be weighted to stop them from floating upwards and snagging. It is good practice to place strobes or light sticks on the tag lines.

When exiting the place of safety, the diver should formally report to the dive supervisor that he has left the SDC, clump weight or basket and is looking for the lifted object at its final holding position. During the search, the dive supervisor should give all necessary instructions to the diver to locate the object.

When the diver locates the lifted object, the diver should provide immediate feedback to the dive supervisor who then directs the lifting appliance operator.

The diver should continuously report the condition of the suspended object to the dive supervisor. Final positioning of the lifted object at its intended resting place should only continue if in the judgement of both diver and diving supervisor it is appropriate to proceed.

If a decision is made to abort the lift due to excessive movement of the lifted object, it may be possible to land and 'wet store' the object on a clear area of the seabed. This would be subject to the outcome of an assessment by the diver and dive supervisor.

During landing of the object the diver should ensure not to position himself or his umbilical underneath the lifted object or between the object and any underwater obstructions. In poor visibility this is not always easy. The diver should ensure to have an accurate mental image of his immediate surroundings before attempting to manoeuvre the lifted object into position. The diving supervisor should assist the diver to position himself safely.

If available, AHC systems should be used during the final placement phase.

Suction loads or locking loads during landing/recovery should be considered. If necessary, the effect may be minimised by, for instance, using constant tension.

Divers working with cranes should not specify which crane modes should be engaged at particular points in the lifting operation. The decision on engaging crane modes should be clearly stated in the lift plan and procedure.

When the lifted object is landed in its final position the crane operator should confirm to the diving supervisor that there is no lifted object weight on the crane. The crane hook block should not contact the seabed or any underwater structure. Care should be taken when a lifted object is to be connected to or disconnected from the crane as the hook may rise and fall due to vessel movement. Release of lift rigging can lead to torque build up in the crane wire rope and this should be taken into account.

There is a significant risk that rigging may not be completely disconnected from objects by divers, particularly in conditions of very poor underwater visibility. The diving supervisor should ask the diver to demonstrate that every rigging connection has been released and to count the number released.

There is a significant risk that disconnected rigging may snag or be inadvertently reconnected as it moves over and around the object in response to vessel movements above.

It is appropriate for the diver to make sure that the crane is not attached to the lifted object before returning to the place of safety. The diving supervisor should ensure that the diver has reached a safe position before the lifting operation commences. The disconnected rigging should then be raised very slowly and in small increments. During this process the crane operator should be asked to keep a continuous check of his hook load to ensure there is no lifted object weight on the crane. If the crane operator detects any unexpected loading, the operation should cease immediately and all equipment should be returned to a safe condition before investigation.

When the disconnected rigging is raised free of the lifted object, it should be returned to the previous final holding position of the lifted object. It should be held there until the diver confirms to the diving supervisor that he has returned to the suitable in-water refuge or to the surface. Only then should the hook and rigging be brought back to surface. During this process the crane operator should continue to monitor his rated capacity indicator (RCI) to ensure that he is recovering the expected weight and that nothing has been left connected or been accidently reconnected.

A2-9 Work Stations – The Deployment of Tools to Divers

On many dive sites, a subsea work station position is established to which tools and equipment is deployed to, and recovered from.

A rope called a 'down line' is often used as a direct access route to the worksite for the secure guidance of loads being deployed to the diver. The down line between the work station and the underwater worksite is only effective if maintained taut. Unless the end of the down line is taken from the surface to the underwater worksite by a diver, deployment of a weighted down line should be treated as a lift and should follow a routine lift plan. The diver(s) should be at a place of safety during deployment and recovery of a weighted down line to and from the underwater worksite.

A work basket or other container is used to hold small or loose material or tools being deployed to the diver. Work baskets and other relatively large loads are usually connected to the down line by a slack 'running line'. It is advantageous to monitor the descent or ascent of any substantial loads connected to the down line using an ROV. The diver(s) should be at a place of safety during the deployment and recovery of work baskets and any other objects assessed as having the potential, if dropped, to cause injury to divers or damage to diving equipment.

Loose items such as tools or other materials should be secured in the basket (i.e. lashed down) as there is always a possibility that the basket may tip and spill its contents during the lift.

The deployment of umbilicals and hoses via the down line or work basket should be treated in the same manner as described above.

A2-10 Deployment, Recovery and Relocation of the DP Taut Wire Weight

Deployment, recovery and relocation of the DP taut wire weight should all be treated as routine lifts and follow generic lift plans that are regularly reviewed. All taut wire movements should be agreed between the DP bridge and dive supervisor. It should be verified that the diver(s) is at a place of safety during the deployment and recovery of DP taut wire weights and any other objects assessed as having the potential, if dropped, to cause injury to divers or damage to their diving equipment.

A2-11 Operational Communications

During subsea lifting operations it is important to avoid using open-ended crane directions. As subsea lifts are blind lifts, directions for the crane should include approximate distances and direction of travel. This should ensure that, if communications with the diver are suddenly interrupted, unintended movements of the lifted object are less likely to occur.

IMCA M 205/D 046 – *Guidance on operational communications* – also describes and discusses the command and control of diving related lifting operations.

Lifting Personnel

A3-1 Lifting Equipment for Lifting Persons

For the raising and lowering of persons, the equipment should have in-date certification for man riding. Equipment which does not have in-date certification for man riding, raising and lowering of persons should only be undertaken in exceptional circumstances, when it is not practicable to gain access by less hazardous means. Where it is necessary to use such work equipment you should ensure that all precautions are taken to ensure safety, including appropriate supervision.

The need to use lifting equipment to transfer or lift people should be re-evaluated on every occasion. Ideally, the lifting of personnel should be eliminated as far as possible. If, after evaluation, there is no alternative, the equipment used needs to be specifically designed or adapted for that purpose and operated within its design parameters.

All equipment used for lifting of persons should be reviewed to ensure that risks to persons being lifted are reduced to as low as reasonably practicable.

It is also necessary to check what local regulators require, for example regulators can require that all equipment suitable for lifting of persons needs to be clearly marked, such as 'suitable for lifting persons' and that any equipment not marked in this way should not be used for this purpose.

It should be ensured that:

- all hazards associated with the lifting of persons are identified;
- all risks associated with the lifting of persons are addressed in the lift plan;
- lifting equipment for lifting of persons continues to meet appropriate specifications;
- personnel to be lifted are properly briefed on the procedure to eliminate any confusion during the operation.

The equipment risk assessment should result in a review of the technical specification to be applied to lifting equipment for lifting persons. This process should include consideration of current industry and manufacturing standards and relevant legislative requirements.

Risk assessment should include consideration of the nature and extent of the lifting operation required and that a safe system of work for individual lifting operations involving lifting of persons should be maintained.

The competent person (see section 3.2) should verify during thorough examinations (see section 6.2) that the technical specification for such equipment is and remains compliant with current requirements. Any item of equipment that does not comply should be recorded as defective in accordance with company procedures and removed from service.

A3-2 Cranes

The crane used in the lifting of personnel should be certified for man-riding.

Some cranes may be equipped with a man riding mode key switch, which disables functions such as: AHC, automatic and manual overload protection. In this mode, it is normal that hoisting and slewing speeds are reduced.

The behaviour of the crane swivel/hook block should be considered when planning man riding operations, in particular with swinging motion in anti-phase to the personnel carrier.

The transfer carrier should be correctly rigged onto the crane prior to transfer and the crane hook pennant should be of sufficient length to keep the hook well clear of the personnel being transferred. Personnel lifts should only be conducted where there is line of sight (full visibility) between the equipment operator and signaller, and between the signaller and the person being lifted.

A rescue plan should be in place for all personnel lifts and referred to in the lift plan.

Tag lines are often attached to the underside of the carrier to enable control of the swing when raising and lowering the carrier. Consideration should be given to the length/position of the tag lines to guard against the possibility of the tag lines becoming snagged.

A test lift without personnel should be carried out prior to the lift. Take particular care where there is confined access, potential for snagging or other hazards.

The personnel carrier should be checked before use and should be in good condition at the time of use. The carrier should be marked with its safe working load. It should be appropriately certified with a current certificate of test and/or inspection. The carrier should not be operated beyond its safe working load.

Refer to IMCA SEL 025/M 202 – *Guidance on the transfer of personnel to and from offshore vessels and structures.*

Lifting at Extreme Heights

A4-1 Definition of Lifting at Extreme Heights

Lifting at extreme heights is to be defined in this appendix as "the installation of a lifted object at a height above the deck, which requires additional care and attention over normal slinging and rigging arrangements".

A4-2 Scope of this Appendix

The scope of this appendix is to provide information and guidance regarding the possible issues which can be encountered when performing lifts at extreme heights and/or reverse lifting.

Reverse lifting is the condition where a significant length of the wire rope has been spooled off, then spooled back on the drum with no, or very limited, tension and then the load is applied.

Although not exclusive, lifting at extreme heights is frequently performed in the renewable energy industry, in particular when installing and assembling wind turbines. Reverse lifting occurs as a direct consequence of having to lift at extreme heights or when performing subsea lifts.

A4-3 Possible Issues When Performing Lifts at Extreme Heights

Lifting a load from a vessel to an extreme height presents additional risk factors to the crew and vessel which affect the entire operation.

The following topics require special consideration when planning and executing lifts at extreme heights:

A4-3.1 Wind

Wind speed and direction may vary from sea-level to the working height. Typical offshore wind renewable energy components, e.g. blades, are relatively light and very susceptible to wind influence. Wind influence should be taken into account when preparing these lifts and during execution. Tag lines and tugger arrangements should be part of the lift plan. See also section A4-3.3.

During the lifting operation, real time wind data as well as 1 and 10 minute mean values shall be available for the safety of the lift. A typical anemometer setup would consist of one anemometer at the crane boom tip and two at the A-frame of the crane. Where wind speed measurements at the relevant heights are not possible models may be used to derive wind speeds at the height of lifting. In addition, as a minimum two independent weather forecasts should be available and interpreted before commencing the lift.

A4-3.2 Dynamics

Lifting at extreme heights usually involves high attachment points and significant changes in hoisting rope length during the lifting operation. The load may behave differently at different positions due to different natural frequencies at varying rope lengths. When planning a lift this should be considered.

A4-3.3 Special Lifting Tools and Guide Systems

Special lifting tools for attaching loads to the hook and guide systems, e.g. along the crane boom, can improve safety and workability of the operations to a great extent. In addition these systems generally remove the need for access of personnel working at height to attach or detach the load.

Mitigating measures for cases where a special lifting tool or guide system fails to operate properly shall be in place to avoid being stuck in any situation without a means to a safe state.

A4-4 General Safety

Lifting at extreme heights poses additional challenges on several aspects:

- Tugger winches should be fitted with high modulus polyethylene (HMPE) fibre rope whenever possible and relevant to minimise the effect of stored energy dissipation (snap back) and for ease of handling.
- Access/egress of personnel working at height should be considered and avoided whenever reasonably practicable. If it cannot be avoided, it should be noted not all crew members are comfortable working at extreme heights.

A4-4.1 Planning of the Lift

In the wind industry lifting at extreme heights is predominantly during wind turbine installation with typical long load paths near other components and vessel structures (legs). Planning such a lift requires particular attention to lines of sight for the crane operator as well as the lifting supervisor. In addition, collision checks shall be performed for the full load path of the lift not only for the load but also for the crane boom and its outfitting, tugger wires, tag lines, special lifting tools and any other structure in the vicinity of the lift path. Where elevated work platforms are used these should be considered in above planning of the lift with additional care.

Dismantlement of Offshore Structures

A5-1 Introduction

This appendix relates only to operations associated with the removal or dismantlement of offshore facilities which involve the use of cranes installed on a marine vessel of any type or a mobile self-elevating unit.

It does not relate to any of the following general activities associated with the removal of all offshore structures:

1. Obtaining the necessary permissions and approval from the relevant regulatory authorities.
2. Preliminary **decommissioning** activities, including but not limited to:
   a plugging and abandonment of wells
   b identification and removal of hazardous materials.
3. Removal of process liquids to render the structure 'gross hydrocarbon free'.
4. Disconnection of service facilities on the structure.

A5-2 Codes, Standards and Guidelines Relating to Demolition Operations

The preparatory engineering and planning associated with demolition, together with the execution of the work itself, will be based on the current relevant codes, standards and guidelines published by the relevant regulator or other competent professional bodies relating to such operations.

Where any item is designated as 'SCRAP' the regulator or other body verifying or approving the operation may consider some relaxations, but only when these can be proven not to introduce an increased level of risk to the environment and personnel or plant employed on the works. Some minor damage to the item itself may be acceptable, but only where such damage does not compromise its overall structural integrity.

Where any item has been designated for 'REUSE' it should be considered as a new object and the current codes, standards and guidelines will always apply.

A5-3 Preparations and Planning for Demolition Operations

A5-3.1 Engineering and Planning

The engineering review and planning for the demolition of an offshore structure should be undertaken in a similar manner and in accordance with the best practices which relate to other marine operations.

Except where the structure has been significantly damaged due to any preceding incident such operations are not to be considered as 'emergency' or 'salvage' activities.

A5-3.2 Operational Procedures

A full set of operational procedures should be prepared as for any other marine operation.

For the operations to which this Appendix relates these procedures are included in the main document.

A5-3.3 'Piece Small' Demolition

Where an offshore structure is demolished using this methodology lifting operations may be supported by the installation's own cranes, temporary appliances mobilised for the purpose or cranes installed on a vessel or mobile offshore unit located immediately adjacent to it.

Material generated by piece small demolition will normally be loaded into, lifted and transported in standard offshore open-top cargo carrying units.

Lifting and transportation should normally be undertaken in accordance with the requirements and guidelines relating to general logistics support and are, therefore, not considered further in this appendix.

A5-3.4 Lifting Arrangements on Object(s)

The arrangements whereby the object is lifted, placed onto the transportation vessel and loaded-in at the disposal facility may include:

1. Original arrangements used for initial installation, demonstrated for continuing fitness for purpose.
2. Replacement arrangements similar to the original arrangements.
3. Internal lifting tools, particularly where primary structure vertical tubular members can be easily accessed.
4. Temporary lifting arrangements using the existing structure including:
   a. pad-eyes or pad-ears formed in or attached to primary structural members
   b. lifting rigging led around primary tubular members.

   Supplementary strengthening and/or stiffening arrangements may also be required in these circumstances.

In all cases the rigging and load paths from the lifting arrangements on the object(s) to the crane hook(s) should be checked to ensure that they are clear of all obstructions.

A5-3.5 Connection of New Material to Old

In certain circumstances, it may be necessary to attach new material to that of the existing structure.

In those circumstances reasonable efforts should be made to identify the characteristics of the original material and to ensure that any attachment is compatible with it.

Should information relating to the characteristics and condition of the original material be limited then the entire load-path through the structure is to be thoroughly analysed to identify any points at which unacceptable stresses may occur, particularly any occurring in the way of the connection between the old material and the new.

A5-3.6 Extended Lifts

Operations involving the transportation of an item whilst suspended from a vessel's crane(s) will require extensive preparation and planning.

Particular aspects of such transportations will include:

1. Effects on vessel's structural strength and stability which may require specific approval from the flag state or classification society.
2. Fatigue life in the load paths of the lifted object(s) transported by this methodology.
3. Fatigue life of the lifting appliances and arrangements on the vessel itself.

All operations involving the carriage of items whilst suspended from the crane(s) on a vessel are to be planned and executed as 'restricted transportations'. Please refer to the relevant (or typical) marine warranty surveyor's guidelines for the planning and management of such operations.

A5-3.7 Inspections of Structure Before and During Dismantlement

By Owner and/or Duty Holder

An initial review of available information will establish what information relating to the facility is/is not available.

Following this review a physical inspection of the structure to be dismantled in order to confirm its current status is essential.

This inspection should be undertaken prior to commencement of detailed engineering works and may thus be necessary several years before the start of physical works in the field.

Inspection by Potential Contractors

The outcomes of the preliminary inspection by the owner and/or duty holder referred to above are to be included as important information in any invitations to potential contractors to tender for the associated work.

However, in order that the nature and extent of the work associated with the dismantlement of the structure is fully understood and that sufficient resources will be available to complete in a safe and timeous manner it is highly recommended that potential contractors arrange for a physical inspection of the structure to be dismantled before any formal offer to undertake such work is submitted.

Prior to Commencement of Actual Work

Prior to the commencement of the actual works it is recommended that the lead contractor undertakes a general 'as found' inspection of the structure in conjunction with a representative of the current owner to confirm its status at the start of the works. At this stage it is particularly important to identify and record outstanding matters requiring further resolution which could adversely impact the safe execution of the subsequent works.

Inspections whilst Work is in Progress

Periodic inspections may be required whilst the works are in progress.

Where the work has been halted, an 'as left' inspection should be undertaken before the structure is abandoned to ensure that it is being left in a safe condition.

Prior to full resumption of the work an 'as found' inspection should be undertaken to confirm its status, including any potential safety hazards which might have emerged in order that these can be immediately rectified.

On Completion of Works

On final completion of the works an 'as left' inspection should be arranged to confirm that the requirements have been complied with.

A5-3.8 Analysis/Modelling of Structures

The analysis and physical modelling of existing structures to be dismantled, some of which may have been in place for many years, is likely to be much more complex than for a new installation.

This is due to many factors, which should be taken into consideration, some of which are listed below:

1. Uncertain quality of basic materials.
2. Effects of corrosion.
3. Through-life modifications.
4. Potential composite structures.
5. Changes in load-paths when current structure is lifted.

Contractors for such works should not underestimate these important and essential points.

A5-3.9 Original Service Arrangements

The arrangements used for original installation of the structure are unlikely to have been maintained and may not be operational.

This should be borne in mind when planning for any dismantling and removal works.

In the context of this particular appendix this would include the generation of any buoyancy within the structure itself to reduce the hook-load for complete or partial in-water lifts.

A5-3.10 Very Large Topside Modules

The removal, transportation and delivery to eventual disposal site of very large modules installed in recent years (>5,000 tonnes) will require detailed consideration on a case-specific basis by all parties likely to be involved.

A5-4 Uncertainties Relating to Dismantlement Operations

A5-4.1 Lack of Information

Full details of the present status of the facility to be dismantled may not be available for a number of reasons, including:

1. Changes in responsibility for operation and maintenance of the structure, including maintenance of records of modifications.
2. Information regarding the original installation methodology being no longer available.
3. Information stored on media no longer in use/supported.
4. No regulatory guidance or information relating to dismantling operation.

A5-4.2 Characteristics of Items Being Lifted

Having regard to section A5-4.1, uncertainties may exist regarding:

1. The actual weight of the item to be lifted.
2. Its actual centre of gravity.
3. The actual status of any lifting points which might remain in place.
4. Integrity of structural pathways.
5. Status of access arrangements, including walkways, etc.
6. Potential for the presence of hazardous material.